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Civil Engineering Report

Housing Development in

Raheen, Limerick

Client: DW Raheen Developments Ltd.

Our Ref: 18112

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1 Definitions:

OPW	Office of Public Works
O.S.D.M.	Ordnance Survey Datum Malin (head)
FFL	Finished floor level
FSU	Flood Study Update (OPW)
I.L.	Invert level
G.L.	Ground level
Has	Hectares
L/S	Litres per second
M	Metres
Mm	Millimetres
m^2	square metres
m^3	cubic metres
PE	Population Equivalent
DOE	Department of Environment
SDWHA	Site development works for housing areas (1998)
DMURS	Design Manual for Urban Roads and Streets
GDSDS	Greater Dublin Strategic Drainage Study
LSMATS	Limerick Shannon Metropolitan Area Transport Study
NDF	National Development Framework
NIS	Natura Impact Statement
AA	Appropriate Assessment
EIAR	Environmental Impact Assessment Report
CWMP	Construction
DWMP	Demolition Waste Management Plan
SMP	Soil Management Plan

1.1 Standards & Guidance

The primary guidance for a development of this nature is the DOE SDWHA document. The age of the document does mean a number of standards quoted have been superseded. Where required the current standards have been consulted.

1.2 Roads

Basic design principles are defined in the DMURS and in the DOE SDWHA, however detailed design is dictated by the TII design manual for roads and bridges. The design of housing estate gradients are also heavily influenced by the building regulations part M.

1.3 Foul Sewers

The sewer networks have been simulated using loading specified under EN 12056:Part 2 for foul water loadings and using the Hydrodynamic Hazen Williams flow simulation. The difficulty in assessing foul sewer total capacities and peak velocities is accommodating the variance between the two; a single house may have a projected peak flow of 1.8l/s yet 87 houses have a projected peak of 16.82l/s.

1.4 Surface Water System

The initial sizing is done based on the UK Modified rational method in accordance with SDWHA and building regulations guidance. Detailed design is done using synthetic evented from OPW Flood Study Update data (DDF tables). CFRAM sources are used to simulate flood risk.

1.5 Watermains

The system must be designed in consultation with Irish Water and connections are designed and completed by the water authority. Any Associated works on the public road will be completed by Irish Water contractors.

2 Introduction

2.1 Site Description

The development site is located in Raheen, Co. Limerick. The development site is located to the south of the N18 national road and bounded to the west by the R510 regional road.

2.2 Executive Summary

DW Raheen Developments Ltd. are seeking a ten year permission for a strategic housing development consisting of the provision of 384 residential house and apartment units on a ca. 10.44 hectare site located in Ballykeeffe, Raheen, Co. Limerick.

The site is greenfield land that is enclosed by existing residential development to the south and east, the R510 to the west and open land to the north. Access to the site is provided by an existing entrance off a roundabout on the R510 regional road.
The proposed development will provide as follows:

- 202 no. housing units, comprising a variety of forms to include bungalows, detached, semi-detached and terraced houses. A mix of house sizes are proposed to include 20 no. two bedroom houses, 156 no. three bedroom houses and 26 no. four bedroom houses.
- 182 apartment and duplex units across 25 small scale blocks, 2 to 4 storeys in heights, throughout the development. The apartments and duplexes provide a mix of one, two, three and four bed units, comprising of 10 no. four bedroom duplex units, 10 no. three bedroom duplex units, 6 no. two bedroom duplex units, 18 no. three bedroom apartments, 92 no. two bedroom apartments and 46 no. one bedroom apartments.

The proposed development also includes;

- A childcare facility measuring 761.75m2, providing 79 childcare places (55 full time and 24 after school places), located at the south-western edge of the development.
- The provision of 377 no. car parking spaces and 311 secured bicycle parking spaces.
- The provision of 3 no. ESB sub-stations, ancillary services and infrastructure works including foul and surface water drainage, attenuation areas, landscaped public open spaces (approximately 29,500m2, or 28.2% of the total site area), landscaping, lighting, internal roads, cycle paths, and footpaths.

A Natura Impact Statement (NIS) and Environmental Impact Assessment Report (EIAR) have been prepared in respect of the proposed development.

Servicing of the site can be achieved in the following manner;

- Irish Water trunk mains for potable water & sewerage traverse the R510 regional road running from south to north. Any Associated works on the public road will be completed by Irish Water contractors. Design approval has been issued by Irish Water, see Appendix 11.
- A complete set of access roads are to be constructed within the proposed estate along with an existing entrance from a roundabout on the R510 road at the southwest corner of the estate. Construction access is provide in order to facilitate phases development and occupation without disturbance of new occupants.

- Two way cycle lanes are provided parallel to the R510 road and a shared pedestrian and cycle path circles the development to the North. Internally all roads are to be shared for cyclists and motorists, with plazas shared for all road users.
- Surface water to be dealt with by a new storm water system, coupled with multiple attenuation tanks (Appendix 7.3) and outfall to an existing on site drain at the western edge of the site. No works are proposed on the public road or outside the site as the discharge is to existing drains, these already accept the greenfield runoff from the lands being developed. All construction works are to incorporate the recommendations of the CWMP and SMP carried out by SLR Consulting. Soakaway testing on site found the ground unsuitable for reliable percolation, see Site Investigation Interpretative report.

3 SURFACE WATER

3.1 Brief:

Provide a sustainable drainage solution, both in terms of discharge rates and long term maintenance.

Associated drawings:

- 18112 - C05,
- 18112 - C08,
- 18112 - C09,
- 18112 - C12.

3.2 Appraisal

A number of key factors were considered in order to define the scope of assessment:

- Development size,
- Available public infrastructure (sewers / waterways),
- Local Authority preferences,
- Greater Dublin Strategic Drainage Study,
- Ground conditions,
- Flooding,
- Runoff,
- Pipe Sizing,
- Attenuation/Storm initial sizing,
- SUDS design,
- Tank design,
- Outfall testing,
- Potential levels of site cut/fill.

After our initial appraisal the more detailed investigations were undertaken in certain areas this is detailed as following;

3.2.1 Available Infrastructure

There is a large wetland area in the low-lying lands to the northern end of the property. This area is currently utilised by Limerick City and County Council to attenuate the Raheen area. There are two known culverts that drain this low area; one under the R510 near the outfall from the 2.1m public culvert and one at the northern tip that runs under the railway line. Both integrate into the backdrain system in the area and then ultimately discharge into the Shannon river (refer to Flood Risk Assessment by JBA for further detail).

Flood Risk Assessment

Due to the proximity of risk zones A&B on the lands a flood risk assessment was appropriate to quantify and review the risk of flooding. The report confirms that the assessment is warranted and clarifies that the actual risk of flooding, when the river defenses are considered, is low.

3.2.2 Local Authority Preferences

The local authority has set a requirement for Greenfield runoff for this development. This means attenuation is required on all parts of the site. The local authority is conscious of maintenance and safety in this regard, especially in private housing estates that may be taken in charge in the future

hence traditionally permeable paving or block paving of any kind is not a preference due to the ongoing cleaning. Similarly, filter drains and soakaways that may require maintenance or are susceptible to blockages are not preferred. Generally, open water or uneven ground is seen by the Local Authority as a hazard, requiring the introduction of fencing and is not a preferred option. Soakaway testing carried out in summer 2021 confirms that the ground has poor drainage characteristics; 4-10mm/hr.
Underground storage with flow restriction thus becomes the primary choice for attenuation systems. Three typical systems are;

- Large concrete tanks, these are easily accessed and washed out in a manner more typical for the authority staff.
- Underground oversized culverts or stone filled culverts, again these are not dissimilar to french drains in relation to maintenance and come as certified systems.
- Proprietary systems certified to a European standard such as arched or crate systems.

Greater Dublin Strategic Drainage Study

The design approach is influenced by the guidance in Volume 2 of this document, while some of the Dublin specific variables have been replaced by salient local values, broad alignment with the intention of the guidance is achieved as relatieve to table 6.3 of GDSDS as summarised in Table 3.1 below;

Criteria	Sub criterion	Return Period (Yrs)	Design Objective	HOM Clarification	HOM Calculation	HOM Appendix
Criterion 1 River water quality protection	1.1	<1	Interception storage of at least 5mm, and preferably 10mm, of rainfall where runoff to the receiving water can be prevented.	Adequate cropped gullies to be provided and ensure 15mm step in any kerb or access from the road surface to prevent overland flow <15mm.	Attenuation tanks intercept all runoff from impermeable areas before entry to the surface water system. The discharge is further attenuated by the lands to the northern part of the lands and Bunlicky Lake prior to discharge to the Shannon	
	1.2	<1	Where initial runoff from at least 5mm of rainfall cannot be intercepted, treatment of runoff (treatment volume) is required. Retention pond (if used) to have minimum pool volume equivalent to 15mm rainfall.	N/A	N/A	
Criterion 2 River regime protection	2.1	1	Discharge rate equal to 1 year greenfield site peak runoff rate or 2l/s/ha, whichever is the greater. Site critical duration storm to be	Greater of 1yr greenfield runoff rate (0.85 times Qbar) or 2l/s/ha to	Greenfield runoff rate (0.85 Qbar). SUDS initial sizing used to establish	A1

			used to assess attenuation storage volume.	be used as outflow.	critical storm durations.	
	2.2	100	Discharge rate equal to 1 in 100 year greenfield site peak runoff rate. Site critical duration storm to be used to assess attenuation storage volume.	Discharge to be taken as Qbar factored by 1.96 or 2.6Qbar as per table 6.6 if justified.	SUDS initial sizing used to establish critical storm durations. 1.96Qbar used for peak elevation flow rate sizing.	A2
Criterion 3 Level of service (flooding) for the site	3.1	30	No flooding on site except where specifically planned flooding is approved. Summer design storm of 15 or 30 minutes are normally critical.		1:30yr storm calculated using MET DDF data.	-
	3.2	100	No internal property flooding. Planned flood routing and temporary flood storage accommodated on site for short high intensity storms. Site critical duration events.	Overflow is allowable, unless there are low points in the development that are particularly at risk from development overflow.	1:100yr storm calculated using MET DDF data. Modelled with 1:200 tide levels at outfall.	A3
	3.3	100	No internal property flooding. Floor levels at least 500mm above maximum river level and adjacent on site storage retention.		No overtopping of manholes, therefore no site flooding or internal property flooding.	A3
	3.4	100	No flooding of adjacent urban areas. Overland flooding managed within the development.	Overflow of manholes allowed, as long as no urban lands outside the development are down stream.	Overflow provided at high level upstream of Tank 2, though calculations show this outfall is not utilised at 1:100yr event, only on condition of backing up due to blockage or flood event. Overflow is to green field lands only to the north	A3

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.	N/A	N/A	
	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.	Preferred option.	1.96 QBAR discharge rate used. 1:100hr 6hr event	A1
	4.3	100	Maximum discharge rate of QBAR or 2l/s/ha, whichever is the greater, for all attenuation storage where separate "long term" storage cannot be provided.	N/A	1.96 QBAR discharge rate used. 1:100hr 6hr event	A1

[1]

The adoption of the factored Qbar runoff, in accordance with the guidance, has been done using the more conservative factor of 1.96.

3.2.3 Ground conditions

Generally the ground varies from sandy gravel with rock outcrops to the south to fluvial tils and heavy ground to the north. Infiltration testing was carried out in 2021, however the ground was found to be unsuitable for any significant amount out soakaway and hence this has not been considered beyond private driveways and rear gardens.

IT01	**IT02**	**IT03**	**IT04**	
1.28E-04	7.86E-05	1.39E-04	7.44E-05	m/min
2.14E-06	1.31E-06	2.32E-06	1.24E-06	m/sec
0.008	0.005	0.008	0.004	m/hr
0.128	0.079	0.139	0.074	mm/min

3.2.5 Runoff

Greenfield runoff rate has been estimated with three methods;

- IH124 (factored linearly from 50ha, as per IPC)
- Asad 345

[1] Table 6.3, Vol. 2 of GDSDS criteria.

- Technical Report 49

We have also looked at the methods employed in the FSU (OPW Flood Study Update) in relation to replacement of the SOIL variable for WRAP and definition of BFI from the following;

- Soils (Teagasc)
- Subsoil Vulnerability / Permeability (GSI)
- Aquifer (GSI)

In accordance with OPW guidance the FSU is not appropriate for the catchment area (<5km2) hence the methods above were chosen and reviewed.

As the site is in an area of poor SOIL based on the WRAP from the FSR the Qbar is relatively high for the existing lands, this is affirmed by the BRE 365 testing results. In order to be conservative only the impermeable areas shall be used to feed into the area calculations when calculating the design outflow, rather than the entire site (which is often used). The resulting Qbar of 6.41l/s/ha is (see 7.2.3) is more conservative than ADAS 345 figure of 13.81l/s/ha, FSR 6 variable figure of 7.27 l/s or the Technical report 49 value of 8.27l/s/ha. Thus the IH124 was chosen as the appropriate method.

3.2.6 Pipe sizing

The initial pipe sizing was done using the UK Modified rational method annual storm with peak rain of 60 mm/hr. This was then tested to ensure no surcharging for the 1:5yr event. The site is 10.44ha including permeable areas.

3.2.7 Attenuation/Storm initial sizing

The initial attenuation sizing was based on the FSR UK MOD RAT method based on an overall 40% impermeable figure for the total site areas associated with each of the catchments. This was further refined once all impermeable areas were defined.

3.2.8 SUDS design

SUDS was designed on the basis of a "do nothing" vs "do something" analysis of the development lands. These lands currently are farmed agriculture and fall from south to north.
The development will introduce substantial impermeable areas, this will reduce the ability of the ground to soak rainfall or hold rainfall for evaporation. The net result will be an increased volume of rain being discharged and an increase in the speed of the rain reaching the discharge point. To counteract this storage is employed to hold the rainwater and mimic the pre-development condition.

Final full system design was done based on a synthetic 6hr storm with total intensity taken from the DDF tables provided by Met Eireann. 1:30yr 30 min, 1:30 yr 4hr and 1:100 yr 6hr values were used to simulate the entire system. These values were increased by 20% to allow for climate change (this is in keeping with the proposed updates to development plan guidance). An overflow has been provided at the upstream manhole of the attenuation system for Catchment 2 (middle of site, see Appendix A1 image depicting 3 No. site catchments) in order to alleviate possible flooding to road areas in the event of blockage/damage. This overflow will divert this floodwater to the green area to the north of the development during a 1:200 yr undefended coastal event or system blockage at the main outflow.

3.2.9 Tank Design

The initial design allows for any type of tank, more detailed design is then done using StormTech SC-740 chambers. With trapped gullies and the StormTech distribution pipe system, little grit and/or oil is expected to enter the system, hence the hydrocarbon interceptor is proposed just before the final outfall. As detailed in Appendix 7.3 three attenuation constructions are proposed with 580, 250 and 134 SC-740 units in "tank 3", "tank 2" and "tank 1" respectively.

JBA have completed a flood risk assessment for the development, setting recommended floor (5.67m OD) and road levels etc. (see Drg. No. 18112 - C10 (for proposed levels). The flood risk is coastal, hence there may be a need to review the potential restriction of the outfall imposed due to overtopping of the banks and failure of the defenses. It is noted that the flood level in defended areas is likely to be lower than that of the main river channel.

3.2.10 Outfall testing

On foot of the concerns raised in the JBA report detailed simulation of the proposed network was done with a surcharged outfall. Using the adjusted tidal prediction model discussed in Appendix A3, the 0.5% AEP prediction is to be used to model a restricted outfall for a 1:100yr 6hr rainfall event. The nature of a coastal surge is such that it occurs during prolonged periods of wind and low pressure. This gives a peak tide level of 5.17m OD at the outfall. This is extremely conservative given the distance to the river and the volume of land to be filled between the site and river. The main outfall (Drg. No. 18112 - C12) is to be fitted with a flap valve, thus utlisiting the storage capacity of the tank systems if there is a flood event or blockage etc. downstream.

3.3 River protection

As detailed above the surface water design addressed criteria 1 & 2 of the GDSDS in relation to design of the final system. During the construction phase of the development a 10m buffer and screening fence for silt is recommended in accordance with the SLR Consulting SMP and the CWMP, see drawing 18112-C37;

- Surface water runoff within the site will be directed to the existing attenuation area prior to discharge to receiving waters via existing culverts. All surface water from construction areas will be treated for the removal of hydrocarbons and grit prior to discharge to the attenuation area.
- A 1.5 m fence with debris / dust netting will delineate a buffer zone of 10 m, where space allows, between the existing attenuation area (including the existing surface water pipe outfall and two culverts) and construction work.
- The proposed buffer zone behind the fencing along the watercourse will remain untouched during construction with all natural vegetation left intact. There will be no construction activity permitted within the buffer zone at any time during the development of the site.

Surface water run-off from the completed development will be directed to an engineered surface water system, coupled with multiple attenuation tanks. The surface water system will consist of front, middle and rear systems with hydro-brake restricted flow rate matching the contributing areas and return periods. Collected surface waters will pass through a hydrocarbon interceptor before the final outfall and discharge will be further attenuated by the lands in the northern part of the property prior to discharge to the River Shannon.

3.4 Conclusion

The surface water system shall consist of a front, middle and rear systems with hydro-brake restricted flow rate matching the contributing areas and return periods. The surface water storage locations proposed are isolated from the current field storage areas that are used for the public systems, to ensure controlled discharge is achieved. Irish Water have accepted the connection location and the network design proposal.

4 FOUL WATER

4.1 Brief:

Assess the layout and site levels to provide an efficient and effective layout.

Associated drawings:

- 18112 - C05,
- 18112 - C06,
- 18112 - C07.

4.2 Available infrastructure

The public sewer runs south to north along the R510 road adjoining the northwestern boundary of the site.

4.3 Appraisal

A number of key factors were considered in order to define the scope of assessment;

- Development size.
- Available public infrastructure (sewers / waterways).
- Ground conditions.
- Potential levels of site cut/fill.
- Local Authority preferences.
- Environmental impact.

4.4 Irish Water

A pre-connection enquiry was submitted to Irish Water, see attached response (0587989218) confirming feasibility of connection;

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

Detailed design has been submitted and full approval was granted in September 2020 (0587989218).

4.5 Conclusion

The foul system is relatively straightforward and was dictated by the road layout and location of public infrastructure. Gradients are as per Site Development Works For Housing Areas and the design has been prepared in accordance with the Irish Water standards.

5 Potable Water

5.1 Brief:

Water main is being provided to connect to the existing Irish Water infrastructure on the R510.

Associated drawings:

- 18112 - C11.

5.2 Available Infrastructure

An existing 300mm diameter ductile iron public water main is located on the R510 along the western boundary of the site.

5.3 Irish Water

A pre-connection enquiry was submitted to Irish Water, see attached response (0587989218) confirming feasibility of connection;
Irish Water has reviewed your pre-connection enquiry in relation to water and wastewater connections at RAHEEN, CO. LIMERICK. Based upon the details that you have provided with your pre-connection enquiry and on the capacity currently available in the network(s), as assessed by Irish Water, we wish to advise you that, subject to a valid connection agreement being put in place, your proposed connection to the Irish Water network(s) can be facilitated.

Detailed design has been submitted and full approval was granted in September 2020 (0587989218). See appendix 10.

5.4 Conclusion

It is proposed to connect to the above-mentioned public water main. Irish Water have issued confirmation of feasibility and full design details have been accepted.

6 Roads

6.1 Brief:

Provide the safest and most efficient layout to service the development units. Address road safety issues arising from appraisal of the site and/or concerns of local authority roads engineers or local residents.

Associated drawings:

- 18112 - C01,
- 18112 - C02,
- 18112 - C03,
- 18112 - C04,
- 18112 - C13,
- 18112 - C15,
- 18112 - C16,
- 18112 - C17,
- 18112 - C19,
- 18112 - C33,
- 18112 - C83.

6.2 Appraisal

A number of key factors were considered in order to define the scope of assessment;

- Development size.
- Ground conditions.
- Potential levels of site cut/fill (see Drg. No. 18112 - C33).
- Local Authority preferences.
- Environmental impact.

After our initial appraisal the more detailed investigations were undertaken in certain areas this is detailed as following;

6.3 Planning History

The previous permission on these lands was the 09756 permission for 111 units (granted 12/06/2009) and the part 8 application 086009 by Limerick County Council (granted).

The access to these lands was formed as part of the 032528 permission with the construction taking place between 2004 and 2006;

 [2]

 [3]

The 2009 permission covered an area of approximately 6.7ha and proposed circa 277 parking spaces. During the application, master planning of the remaining lands in the area was discussed and the link to the minor roadway to the East was discussed. Overall the review of traffic impacts on the newly constructed roundabout was minor. This is unsurprising as the decision to service these zoned lands using a roundabout was made in the previous application.

The current proposal includes 386 units and covers a larger area of 10ha. National strategy has long been to limit dependence on cars and the goal to limit total traffic volumes to 2005 levels is admirable and with recent developments in vehicle sharing (gocar etc.) and improvements in public transport and cycle networks we are closer than ever to having real alternatives to traditional vehicle usage. The 2018 apartments guidelines advise not only for greatly reduced parking provision for apartments (none in some cases) but also advocates for lowering of overall parking provision for higher density developments in suburban areas. Modal shift (changing from car use to alternative options) of approximately 20% is expected by the Local Authority, hence a site-wide target of 20% less than the 2010 development plan requirements for parking would be in keeping with more modern guidance and is expected to be in line with the soon to be published metropolitan area transport strategy.

6.4 Urban road design manual

Following discussions with roads engineers in the various departments within Limerick City & County Council the access road from the roundabout (R510) is best described as a local link road in a suburban area hence a design speed of 30 kph is appropriate. It falls somewhere in the middle of much of the guidance in this document as the road will have development on one side only. It is envisaged that the regulatory speed would be 20 kph. All other internal roads are Local roads in a neighbourhood setting hence a 10-30kph design speed is required. To ensure consistency in the development a design speed of 30kph is used throughout. While 10/15kph speed limits may be warranted in housing estates in practice these are impractical to always achieve and even more difficult to enforce. Kerb radii have been kept as low as possible to limit speed and give the advantage to cyclist in the internal roads;

- 0-3 metres for 20mph speed limit
- 2-6 metres for 30mph
- 3-10 metres for more than 30mph

Sight triangles have been assessed to maximise the junctions that achieve 25m sight distance with a 9m setback, as per the guidance of *"Traffic engineering and control 1992"*

[2] c Google Earth May 2004
[3] C Google Earth April 2006

Raised table top crossings are proposed internally within the development (refer to Drg. No. 18112 - C13 for locations).

PEDESTRIAN PRIORITY VEHICLE PRIORITY

FUNCTION	CENTRE	N'HOOD	SUBURBAN	BUSINESS/ INDUSTRIAL	RURAL FRINGE
ARTERIAL	30-40 KM/H	40-50 KM/H	40-50 KM/H	50-60 KM/H	60-80 KM/H
LINK	30 KM/H	30-50 KM/H	30-50 KM/H	50-60 KM/H	60-80 KM/H
LOCAL	10-30 KM/H	10-30 KM/H	10-30 KM/H	30-50 KM/H	60 KM/H

CONTEXT

Table 4.1: Design speed selection matrix indicating the links between place, movement and speed that need to be taken into account in order to achieve effective and balanced design solutions.

6.5 National Cycle Manual (2011)

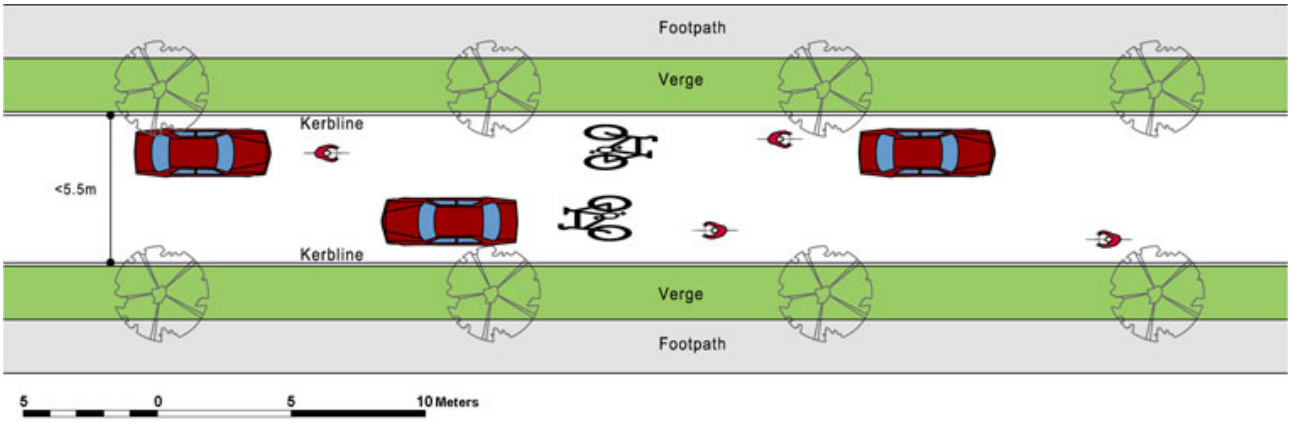
Cycle paths are provided on approach to the development in the charge of the Local Authority. The introduction of an on road / off road cycleway from the dock road interchange to the development entrance will greatly enhance the area (refer to Drg. No. 18112 - C19). Within the development the roads are mixed/shared streets in accordance with 4.3.1. There is no through traffic, low speeds and the design has been formulated to encourage shared use and respect of all road users;

6.6 Traffic Management Guidelines (2003)

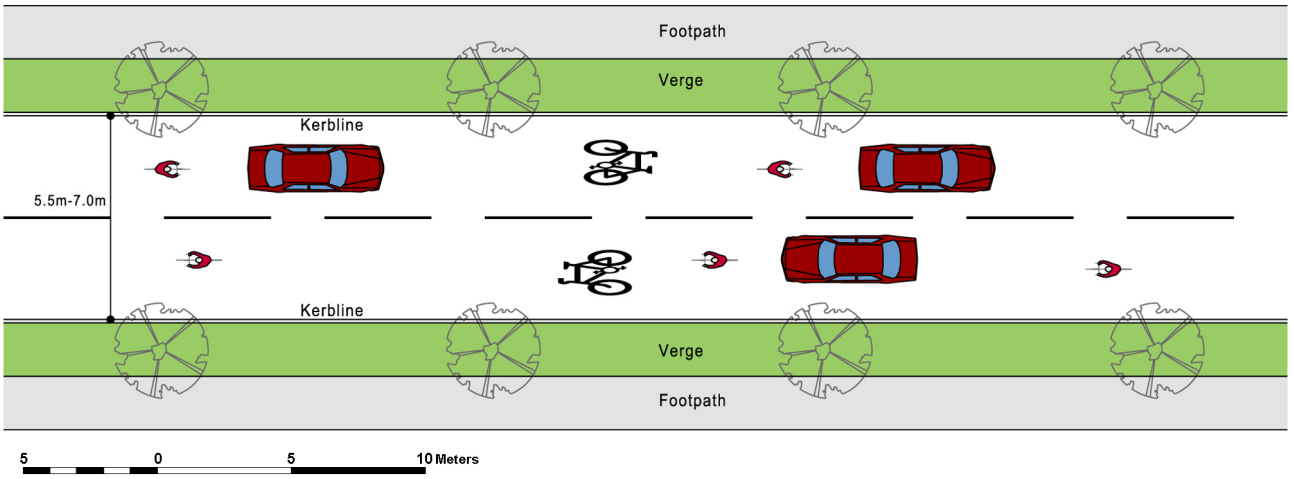
The raised crossings are proposed in accordance with the guidance (refer to Drg. No. 18112 - C17 for detail).

6.7 Road Geometry

The internal network mimics the site boundaries and while this dictates somewhat straight geometry the internal table top ramps and tight chicanes will restrict vehicle speeds. Narrow 5.5m roads have been chosen to discourage streetside parking and to encourage slower speeds see diagram from DMURS;



The main loop road is proposed at 6 m as it will link to future potential development lands to the East and would be expected to have higher volumes of cyclists as well as being the designated route for bin trucks;



The looped ring road is also proposed at 6m as it contains a substantial amount of 90 deg parking, similarly some of the other cul de sacs are widened to 6m to ensure maneuverability from spaces. Road curvature has been designed in accordance with Table 4.3 of DMURS.

HORIZONTAL CURVATURE						
Design Speed (km/h)	**10**	**20**	**30**	**40**	**50**	**60**
Minimum Radius with adverse camber of 2.5%	-	11	26	56	104	178
Minimum Radius with superelevation of 2.5 %	-	-	-	46	82	136
VERTICAL CURVATURE						
Design Speed (km/h)	**10**	**20**	**30**	**40**	**50**	**60**
Crest Curve K Value	N/A	N/A	N/A	2.6	4.7	8.2
Sag Curve K Value	N/A	N/A	2.3	4.1	6.4	9.2

Table 4.3: Carriageway geometry parameters for horizontal and vertical curvature. [4]

6.8 Road Finishes

Hierarchy

The road hierarchy is illustrated to road users by using physical geometry and a mix of finishes and colours. The following is a summary of the hard stand areas and their associated function;

- Primary road routes; Black tarmac with line marking to indicate shared area with cyclists
- Crossing points and Junctions; Red tarmac, ramped on approach with triangular markings
- Shared Area; Block Paving surface, expected to be in mauve or brown to contrast strongly.
- Cycle lanes and shared lane; Permeable paving, Block paving to match shared areas at junctions.

The design approach has been to provide separated commuting routes through green areas and away from traffic noise along the west, north and east perimeter. Dedicated cycle lanes are used parallel to the R510 as cycle commuters may be traveling more rapidly along this route, mixing the north and eastern loop with pedestrian and using rougher contrasting paving will help control cycle speed.

There is also emphasis on the shared nature of the interior of the development travel routes with narrow roads, regular bends and raised crossings employed to limit vehicular traffic and cyclist speeds.

Main road Construction

The internal roads shall be in accordance with TII Specification for Road Works Series 900;
Minimum 200mm base course
60mm AC 20 Bin 70/100
40mm AC 14 Close 70/100
PSV >60
2.5% crossfall on roads, 2% on paths.

6.9 Cycleway Construction

The main cycle routes and shared pedestrian and cycle paths shall be constructed from permeable tarmac to minimise impacts on the surrounding areas. Generally these tracks are at existing ground level or marginally above. Cross-over and junction areas shall be paved to provide colour and texture contrast to users and highlight the need to take extra caution. Similarly internal square int the development that are to be shared between all road users are to be paved.

6.9 Traffic

See EIAR Chapter 11 - Traffic and Transportation by TTRSA.

[4] Table 4.3 from DMURS provided relevant values for horizontal and vertical curvature.

6.10 Parking

National guidelines and direction in relation to parking has evolved rapidly in recent years and often these requirements need to be considered alongside the development plan guidelines. The cornerstone of recent national planning legislation states;

There should generally be no car parking requirement for new development in or near the centres of the five cities and a significantly reduced requirements in the inner suburbs.

National Planning Framework 2040

The layout has been designed on the basis of most recent guidelines; 'Sustainable Urban Housing Design Standards for New Apartments – Guidelines for Planning Authorities'. Apartment complexes shall be managed by a residents management company along with the dedicated adjacent parking areas for each block. Limerick City and County council expect a 20-30% modal shift in the coming years, this is strongly enforced in the Draft LSMATS.
The childcare unit is designed to accommodate drop-off by means of controlled parking in 17 spaces. This keeps vehicle speeds low and enables users to alight the vehicle to deliver children to the facility. Hence 7 spaces should be available for staff and 10 would be adequate for drop off.
Cycle parking for each block is managed by each apartment complex through a mix of internal complexes stores and external modular units. This is in keeping with the secure long stay parking requirements outlined in the draft LSMATS. The locations are shown on GMS drawing 1704-10-102 and space allocation is detailed in their Design Statement report.

6.11 Road Safety Audit

Road Plan completed a stage 1&2 audit RSA of the development and entrance design originally in March 2020, all recommendations were addressed and salient alterations were made. Following consultation with An Bord Pleanala amendments were made to small parts of the site and Road Plan provided a review of these areas in December 2021. Again any issues were address by modifying or clarifying the design. A mixture of textures and raised/ramped areas are integrated in the design to keep speeds limited through physical constraint rather than relying solely on signage.

6.12 Conclusion

The access point is largely dictated by the completed infrastructure. Narrow roads and raised crossings are proposed as per discussions with the road design engineers in Limerick City & County Council. These lands can utilise the existing entrance and the additional cycleway will be a substantial improvement, not only for the development and local area but finally linking the city centre and the Raheen area with a high quality cycleway.

7 Appendix A1

7.1 Global Data

7.1.1 Met Eireann

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 154681, Northing: 154404,

	Interval		Years											
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.6,	3.9,	4.6,	5.8,	6.5,	7.2,	9.2,	11.7,	13.3,	15.7,	17.9,	19.6,	22.3,	24.4,	26.2,	N/A ,
10 mins	3.6,	5.4,	6.5,	8.0,	9.1,	10.0,	12.9,	16.3,	18.6,	21.9,	24.9,	27.3,	31.0,	34.0,	36.4,	N/A ,
15 mins	4.3,	6.4,	7.6,	9.4,	10.7,	11.7,	15.1,	19.1,	21.8,	25.7,	29.3,	32.1,	36.5,	40.0,	42.9,	N/A ,
30 mins	5.5,	8.1,	9.5,	11.7,	13.2,	14.4,	18.4,	22.9,	26.0,	30.4,	34.4,	37.5,	42.4,	46.2,	49.4,	N/A ,
1 hours	7.2,	10.3,	12.0,	14.6,	16.4,	17.7,	22.3,	27.5,	31.0,	35.9,	40.4,	43.8,	49.2,	53.3,	56.8,	N/A ,
2 hours	9.3,	13.0,	15.1,	18.1,	20.2,	21.8,	27.1,	33.0,	36.9,	42.5,	47.4,	51.2,	57.1,	61.6,	65.4,	N/A ,
3 hours	10.8,	15.0,	17.2,	20.6,	22.9,	24.6,	30.3,	36.7,	40.9,	46.8,	52.0,	56.1,	62.3,	67.1,	71.0,	N/A ,
4 hours	12.0,	16.5,	19.0,	22.5,	25.0,	26.8,	32.8,	39.6,	44.0,	50.2,	55.6,	59.8,	66.2,	71.2,	75.3,	N/A ,
6 hours	13.9,	19.0,	21.7,	25.6,	28.2,	30.3,	36.8,	44.0,	48.7,	55.3,	61.1,	65.5,	72.3,	77.5,	81.8,	N/A ,
9 hours	16.2,	21.8,	24.8,	29.1,	31.9,	34.1,	41.2,	49.0,	54.0,	61.0,	67.1,	71.7,	78.8,	84.3,	88.8,	N/A ,
12 hours	18.0,	24.1,	27.2,	31.8,	34.9,	37.2,	44.6,	52.8,	58.1,	65.3,	71.7,	76.5,	83.9,	89.5,	94.1,	N/A ,
18 hours	21.0,	27.7,	31.1,	36.2,	39.5,	42.0,	50.0,	58.7,	64.3,	72.0,	78.7,	83.8,	91.5,	97.4,	102.2,	N/A ,
24 hours	23.4,	30.6,	34.2,	39.6,	43.1,	45.7,	54.2,	63.3,	69.2,	77.2,	84.1,	89.4,	97.3,	103.4,	108.4,	125.3,
2 days	29.7,	37.8,	41.9,	47.7,	51.4,	54.3,	63.2,	72.7,	78.8,	86.9,	93.9,	99.2,	107.1,	113.0,	117.9,	134.3,
3 days	35.2,	44.1,	48.5,	54.8,	58.8,	61.9,	71.3,	81.3,	87.6,	96.0,	103.2,	108.6,	116.7,	122.8,	127.7,	144.2,
4 days	40.2,	49.9,	54.6,	61.3,	65.6,	68.8,	78.7,	89.2,	95.7,	104.4,	111.9,	117.4,	125.7,	131.9,	136.9,	153.8,
6 days	49.5,	60.4,	65.7,	73.2,	77.9,	81.4,	92.3,	103.6,	110.5,	119.9,	127.7,	133.6,	142.3,	148.8,	154.1,	171.5,
8 days	58.2,	70.2,	76.0,	84.1,	89.2,	93.0,	104.7,	116.7,	124.1,	134.0,	142.3,	148.4,	157.5,	164.3,	169.8,	187.8,
10 days	66.5,	79.5,	85.7,	94.4,	99.9,	103.9,	116.3,	129.0,	136.9,	147.2,	155.9,	162.3,	171.8,	178.8,	184.5,	203.1,
12 days	74.5,	88.4,	95.1,	104.3,	110.1,	114.4,	127.4,	140.8,	149.0,	159.7,	168.8,	175.4,	185.3,	192.6,	198.4,	217.7,
16 days	89.9,	105.6,	113.0,	123.2,	129.5,	134.3,	148.5,	163.0,	171.8,	183.4,	193.1,	200.2,	210.7,	218.4,	224.6,	244.9,
20 days	104.9,	122.0,	130.1,	141.2,	148.1,	153.2,	168.6,	184.1,	193.5,	205.8,	216.0,	223.6,	234.6,	242.7,	249.2,	270.5,
25 days	123.1,	142.1,	150.9,	163.0,	170.5,	176.0,	192.6,	209.2,	219.3,	232.4,	243.3,	251.3,	263.0,	271.6,	278.4,	300.8,

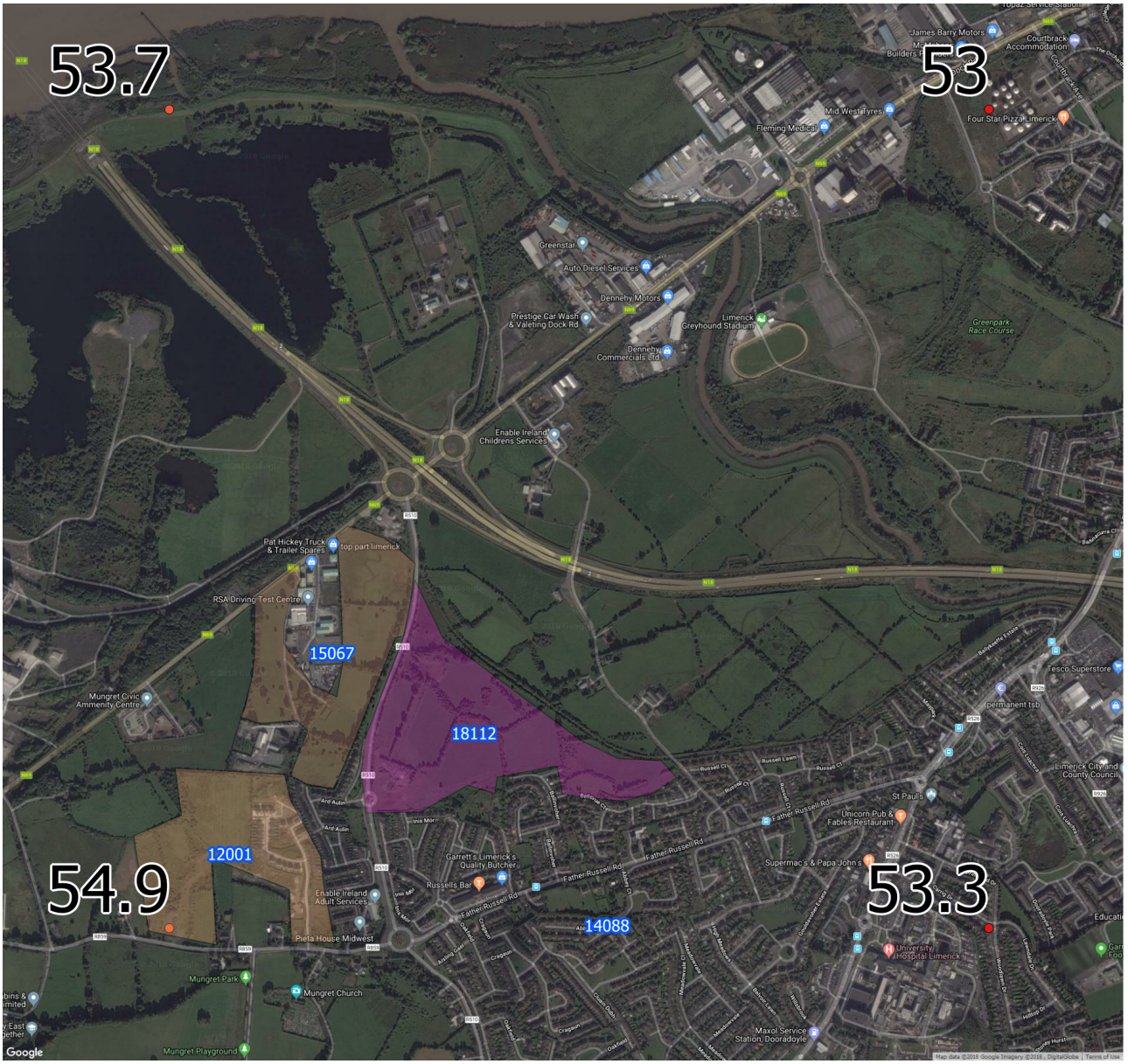
NOTES:
N/A Data not available
These values are derived from a Depth Duration Frequency (DDF) Model
For details refer to:
'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf

7.1.2 SAAR

7.1.3 M5-60


17.1
17.3
17.8
17.5
15067
18112
12001
14088
James Barry Motors
McMahons Builders Providers
Courtbrack Accommodation
Mid West Tyres
Fleming Medical
Four Star Pizza Limerick
Greenstar
Auto Diesel Services
Dennehy Motors
Prestige Car Wash & Valeting Dock Rd
Limerick Greyhound Stadium
Greenpark Race Course
Dennehy Commercials Rd
Enable Ireland Childrens Services
Pat Hickey Truck & Trailer Spares
top part limerick
RSA Driving Test Centre
Mungret Civic Ammenity Centre
Tesco Superstore
permanent tsb
Limerick City and County Council
St Paul's
Unicorn Pub & Fables Restaurant
Supermac's & Papa John's
Garrett's Limerick's Quality Butcher
Russells Bar
Enable Ireland Adult Services
Pieta House Midwest
Mungret Church
University Hospital Limerick
Maxol Service Station, Dooradoyle
Mungret Playground
Google

7.1.4 M5-2D


53.7
53
54.9
53.3
15067
18112
12001
14088
Pat Hickey Truck & Trailer Spares
top part limerick
RSA Driving Test Centre
Mungret Civic Ammenity Centre
Enable Ireland Childrens Services
Greenstar
Auto Diesel Services
Dennehy Motors
Prestige Car Wash & Valeting Dock Rd
Dennehy Commercials Ltd
Limerick Greyhound Stadium
Greenpark Race Course
James Barry Motors
Courtbrack Accommodation
Mid West Tyres
Fleming Medical
Four Star Pizza Limerick
Tesco Superstore
permanent tsb
Limerick City and County Council
St Paul's
Unicorn Pub & Fables Restaurant
Supermac's & Papa John's
University Hospital Limerick
Maxol Service Station, Dooradoyle
Garrett's Limerick's Quality Butcher
Russells Bar
Enable Ireland Adult Services
Pieta House Midwest
Mungret Park
Mungret Church
Mungret Playground
Father Russell Rd
Google

7.1.5 WRAP


149
99052
14080
Kilrush Church
River Shannon
4
Fountain
Altavilla
Loughanleigh
15067
18112
12001
14088
Barrack Road
Mungret
Mungret Soccer Club
Liskelly
The Bridge
Mount Mungret
Mungret Woods
Islanduane
Caher Road
Breska Beg
Limerick Greyhound Stadium
Greenpark Race Course
Crescent Shopping Centre
Limerick Education Centre
University Hospital Limerick
Analog Devices International
Stryker Orthopaedics
CHURCH HILL MEADOWS
GLENCAIRIN
Raheen Business Park
Google

7.2 Site Data

7.2.1 IH124 Greenfield runoff summary

IH124		Area*	SAAR	Soil		Qbarrural	l/s
Raheen	50.00	**0.5**	**967.00**	**0.45**		**0.321**	320.57
	ha	km2	mm			m3/s	l/s
			FSR Vol. V Fig. II 3.1	FSR Vol. V Fig. I 4.18 & Cunnane		Green Field Runoff Rate	
FSR vol. 1, Table 2.38							
	u	α	k	cv			
Ireland	0.87	0.21	-0.05	0.29			
FSR vol. 1, Table 2.39			**Q**	**0.32057**			
Return Period (yrs)	5	30	50	**100**			
Curve ordinate	1.20	1.64	1.77	1.96			
QT	0.38	0.53	0.57	0.63	m3/s		
QT	384.1	527.1	569.0	627.1	l/s		

Tank1

```
*****************
Hydrological Data
*****************

Location              = Ireland
SAAR                  = 968 mm/yr
WRAP                  = 4
M5-60                 = 17.6 mm
r Ratio               = 0.325
Soil runoff           = 0.45

***************
Greenfield Data
***************

Contributing area     = 0.9176 ha
Hydrologic area       = Irish

***************
Calculated Data
***************

Mean annual peak flow QBAR (rural) = 5.890 lps

***********
Peak Runoff
***********
```

Storm Return Period year(s)	Flow lps	Flow/ Unit Area lps/ha
1	5.007	5.456
2	5.596	6.098
5	7.068	7.703
10	8.070	8.794
30	9.601	10.463
50	10.426	11.362
100	11.486	12.517
500	14.137	15.406

Tank2

```
-----------------------------------------------

*****************
Hydrological Data
*****************

Location          = Ireland
SAAR              = 968 mm/yr
WRAP               = 4
M5-60             = 17.6 mm
```

r Ratio = 0.325
Soil runoff = 0.45

****
Greenfield Data
****

Contributing area = 1.4372 ha
Hydrologic area = Irish

****
Calculated Data
****

Mean annual peak flow QBAR (rural) = 9.226 lps

****
Peak Runoff
****

Storm Return Period year(s)	Flow lps	Flow/ Unit Area lps/ha
1	7.842	5.456
2	8.764	6.098
5	11.071	7.703
10	12.639	8.794
30	15.038	10.463
50	16.329	11.362
100	17.990	12.517
500	22.142	15.406

7.3 Tank3

Greenfield Runoff Calculations (reference IH 124)

****
Hydrological Data
****

Location = Ireland
SAAR = 968 mm/yr
WRAP = 4
M5-60 = 17.6 mm

r Ratio = 0.325
Soil runoff = 0.45

****
Greenfield Data
****

Contributing area = 2.2655 ha
Hydrologic area = Irish

****
Calculated Data
****

Mean annual peak flow QBAR (rural) = 14.543 lps

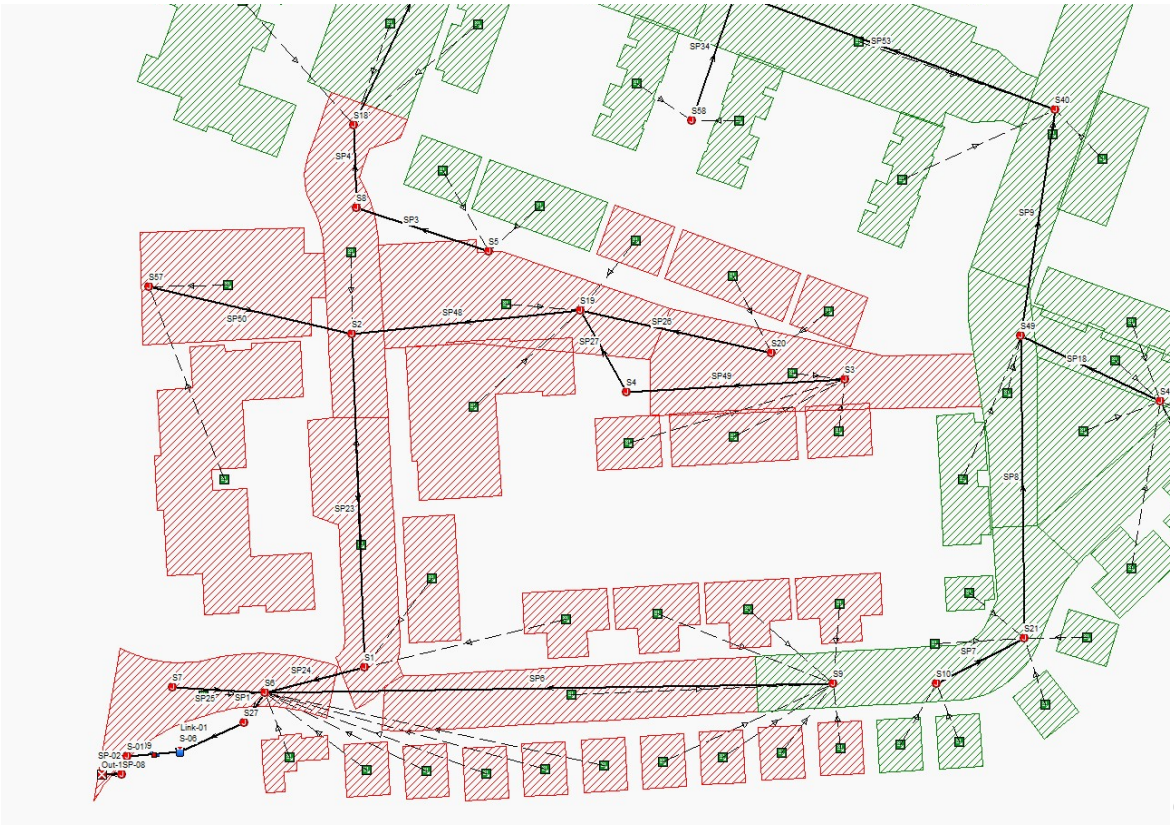
****
Peak Runoff
****

Storm Return Period year(s)	Flow lps	Flow/ Unit Area lps/ha
1	12.361	5.456
2	13.816	6.098
5	17.451	7.703
10	19.924	8.794
30	23.705	10.463
50	25.741	11.362
100	28.358	12.517
500	34.903	15.406

7.2.2 Site Catchment & Tank subdivision

5

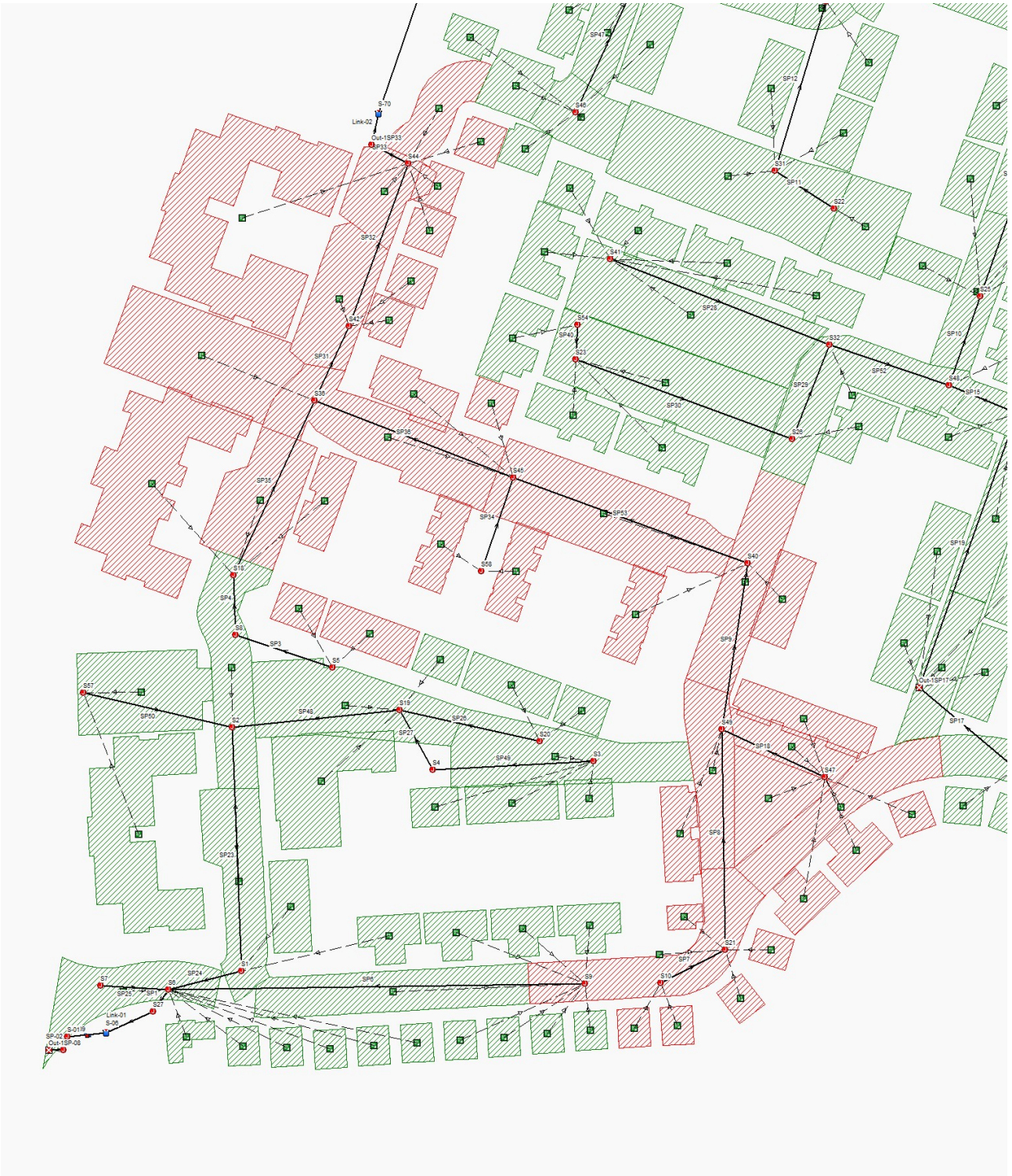
[5] Site catchments.



6

[6] Site Catchment 1 - Front of site

.



7

[7] Site Catchment 2 - Main Site middle

.

8

7.4 Initial Tank Sizing

[8] Site Catchment 3 - Main Site rear

.

IH 124 Initial Sizing

Return Period	Qbar	Tank1			Tank2			Tank3		
1:X yrs	l/s/ha	Vol. Req.	Depth	Top elev.	Vol. Req.	Depth	Top elev.	Vol. Req.	Depth	Top elev.
1	5.45	95.42	0.34	3.64	149.44	0.28	2.28	235.57	0.18	2.18
5	7.68	133.19	0.48	3.78	208.61	0.39	2.39	329	0.26	2.26
30	10.54	251	0.91	4.21	394	0.73	2.73	620.85	0.49	2.49
100	12.54	372	1.34	4.64	581.85	1.08	3.08	917.19	0.72	2.92

Empty Tank Dims

	100yr +10% vol	Width (m)	Length (m)	Depth (m)	Area (m2)	Tank Invert (m OD)	Imp. Area (ha)	1:100yr Outflow l/s	Total Area (ha)	Qbar l/s/ha Total A
Tank1	409	17	16	1.5	278	3.3	0.92	11.51	1.70	3.46
Tank2	581.85	24	16	1.5	540	2	1.44	18.03	2.30	4.01
Tank3	917.19	30	20	1.5	1275	2.2	2.27	28.41	4.40	3.30

8 Appendix A2 - Attenuation Sizing

8.1 SUDS initial Sizing 1:1yr

Catchment 1 - 1:1yr

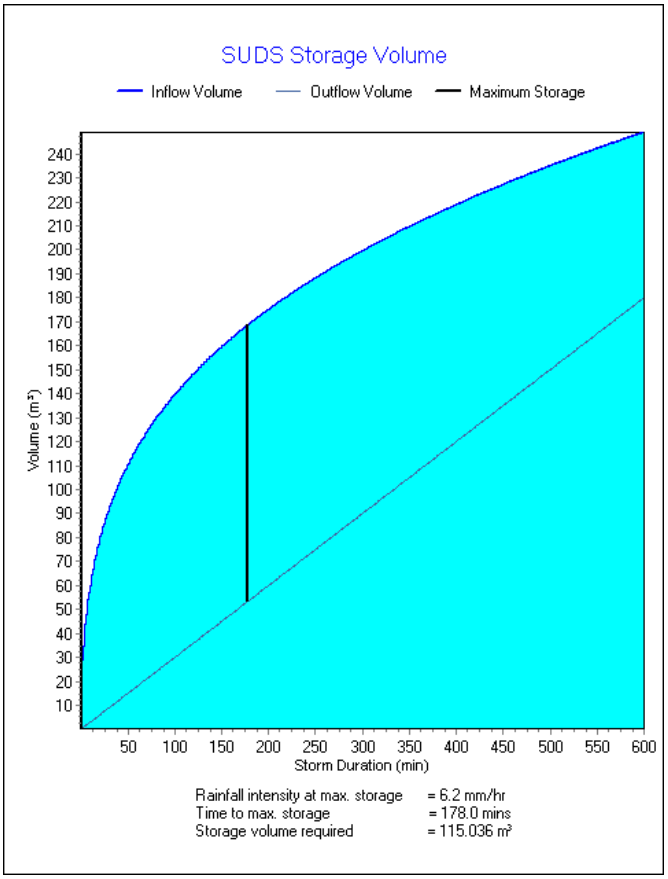
Location = Ireland
SAAR = 968 mm/yr
WRAP = 4
M5-60 = 17.6 mm
r Ratio = 0.325
Soil index = 0.45

****
Input Data
****

Contributing area = 0.917645 ha
Allowable discharge = 5.001 lps
Maximum possible storm duration = 600 min
Storm duration time step = 1 min
Storm return period = 1 year

****
Calculated Data
****

Time to max. storage = 178 mins
Rainfall at max. storage = 6.2 mm/hr
Storage volume = 115.036 m³



Catchment 2 - 1:1yr

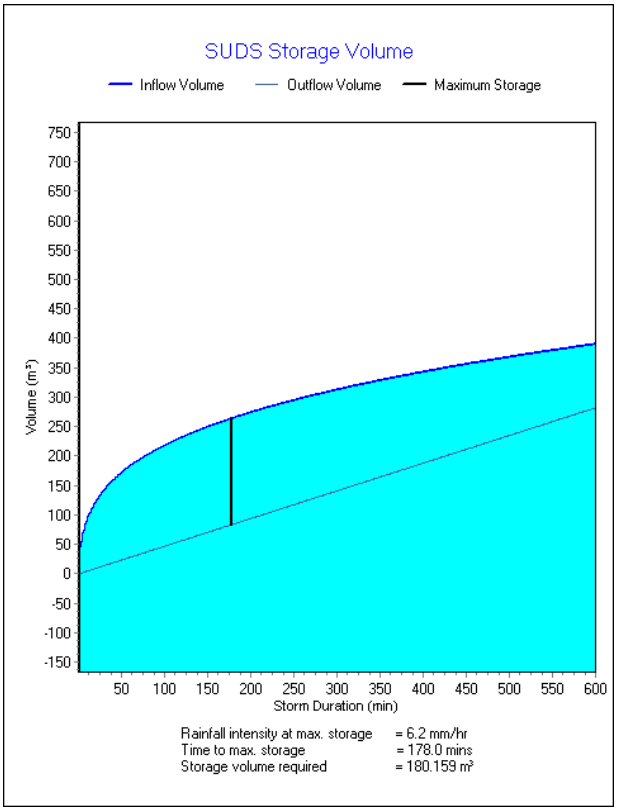
Location = Ireland
SAAR = 968 mm/yr
WRAP = 4
M5-60 = 17.6 mm
r Ratio = 0.325
Soil index = 0.45

****
Input Data
****

Contributing area = 1.437186 ha
Allowable discharge = 7.833 lps
Maximum possible storm duration = 600 min
Storm duration time step = 1 min
Storm return period = 1 year

****
Calculated Data
****

Time to max. storage = 178 mins
Rainfall at max. storage = 6.2 mm/hr
Storage volume = 180.159 m³



Catchment 3 - 1:1yr

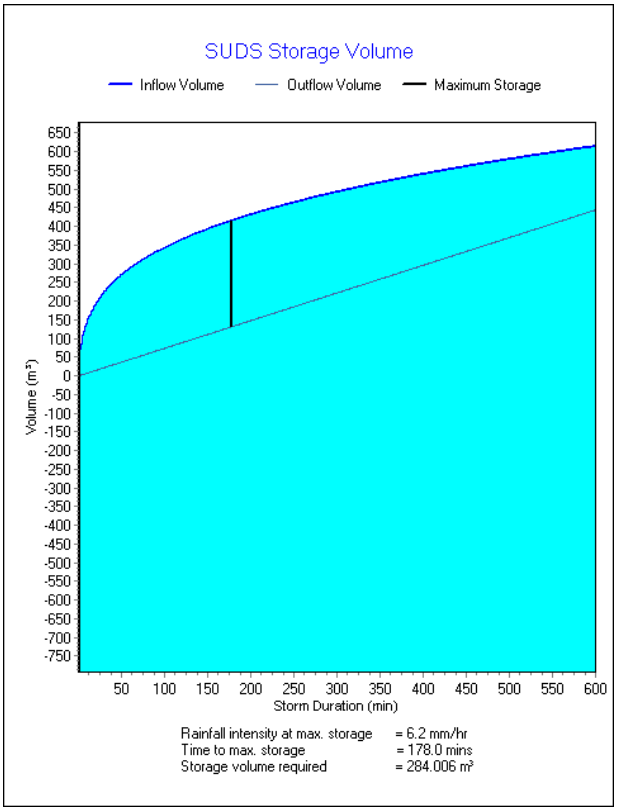
Location = Ireland
SAAR = 968 mm/yr
WRAP = 4
M5-60 = 17.6 mm
r Ratio = 0.325
Soil index = 0.45

****
Input Data
****

Contributing area = 2.265542 ha
Allowable discharge = 12.347 lps
Maximum possible storm duration = 600 min
Storm duration time step = 1 min
Storm return period = 1 year

****
Calculated Data
****

Time to max. storage = 178 mins
Rainfall at max. storage = 6.2 mm/hr
Storage volume = 284.006 m³



8.2 SUDS initial Sizing 1:100yr

Catchment 1 - 1:100yr

SUDS Storage Calculations

****
Global Variables
****

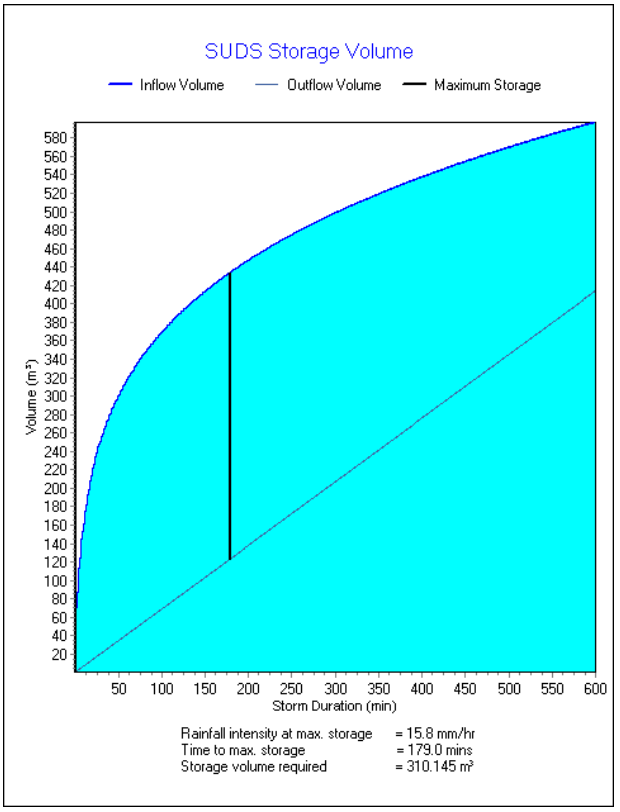
Location = Ireland
SAAR = 968 mm/yr
WRAP = 4
M5-60 = 17.6 mm
r Ratio = 0.325
Soil index = 0.45

****
Input Data
****

Contributing area = 0.917645 ha
Allowable discharge = 11.507 lps
Maximum possible storm duration = 600 min
Storm duration time step = 1 min
Storm return period = 100 years

****
Calculated Data
****

Time to max. storage = 179 mins
Rainfall at max. storage = 15.8 mm/hr
Storage volume = 310.145 m³



Catchment 2 - 1:100yr

SUDS Storage Calculations

****
Global Variables
****

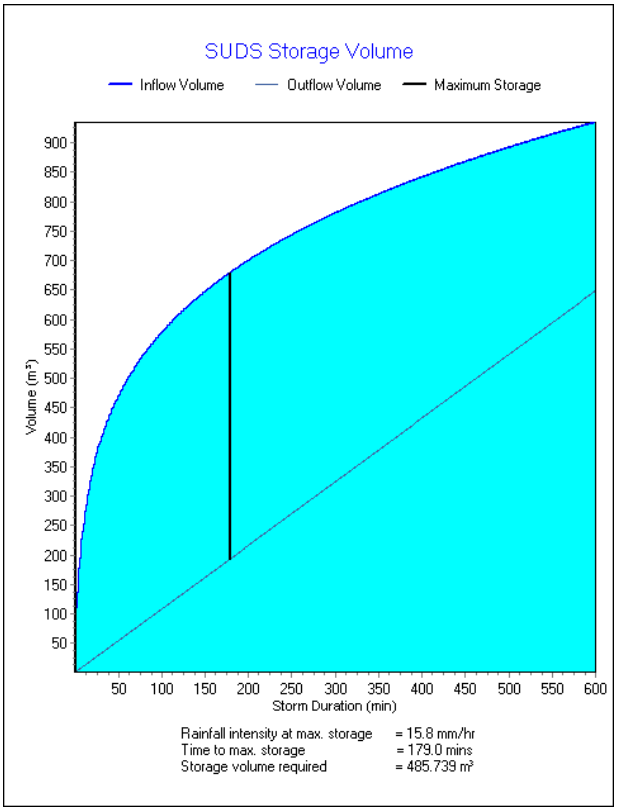
Location = Ireland
SAAR = 968 mm/yr
WRAP = 4
M5-60 = 17.6 mm
r Ratio = 0.325
Soil index = 0.45

****
Input Data
****

Contributing area = 1.437186 ha
Allowable discharge = 18.022 lps
Maximum possible storm duration = 600 min
Storm duration time step = 1 min
Storm return period = 100 years

****
Calculated Data
****

Time to max. storage = 179 mins
Rainfall at max. storage = 15.8 mm/hr
Storage volume = 485.739 m³



Catchment 3 - 1:100yr

SUDS Storage Calculations

****
Global Variables
****

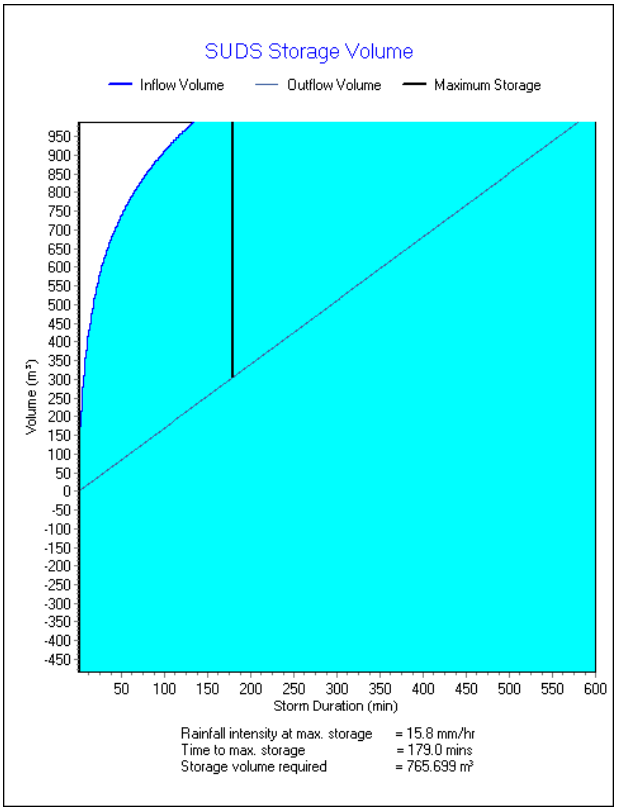
Location = Ireland
SAAR = 968 mm/yr
WRAP = 4
M5-60 = 17.6 mm
r Ratio = 0.325
Soil index = 0.45

****
Input Data
****

Contributing area = 2.265542 ha
Allowable discharge = 28.410 lps
Maximum possible storm duration = 600 min
Storm duration time step = 1 min
Storm return period = 100 years

****
Calculated Data
****

Time to max. storage = 179 mins
Rainfall at max. storage = 15.8 mm/hr
Storage volume = 765.699 m³



8.3 Stormtech Initial Sizing

Unit	Length (m)	Width + 6"	ft3	Footprint (m2)	Height			
SC-740	2.30	1.45	45.90	3.34	0.76			
SC-310	2.17	1.02	14.70	2.20				
Store 1	SC-740	Base (m)	Cover (m)	Void %	Capacity (m3)	Pipe Size	Inlet Level	Top Level
		0.30	1.20	0.35	3.20	300	3.62	5.26
Return Period	Vol. Req. (m3)	Vol. Prov. (m3)	No. Units	Available Width (m)	No. Rows	Width (m)	Units/row	Length (m)
100yr +10% vol	**409**	409.23	128	**17.00**	11	15.93	12	27.65
Store 2	SC-740	Base (m)	Cover (m)	Void %	Capacity (m3)	Pipe Size	Inlet Level	Top Level
		0.25	0.70	0.35	2.55	375.00	2.38	3.61
Return Period	Vol. Req. (m3)	Vol. Prov. (m3)	No. Units	Available Width (m)	No. Rows	Width (m)	Units/row	Length (m)
100yr +10% vol	**640**	641.30	251	**24.00**	16	23.16	16	36.86
Store 3	SC-740	Base (m)	Cover (m)	Void %	Capacity (m3)	Pipe Size	Inlet Level	Top Level
		0.10	0.20	0.35	1.80	450.00	2.23	3.06
Return Period	Vol. Req. (m3)	Vol. Prov. (m3)	No. Units	Available Width (m)	No. Rows	Width (m)	Units/row	Length (m)
100yr +10% vol	**1009**	1009.41	562	**30.00**	20	28.96	28	64.51
Total	2058	m3	941	Units				

9 Appendix A3 - Full Network Design

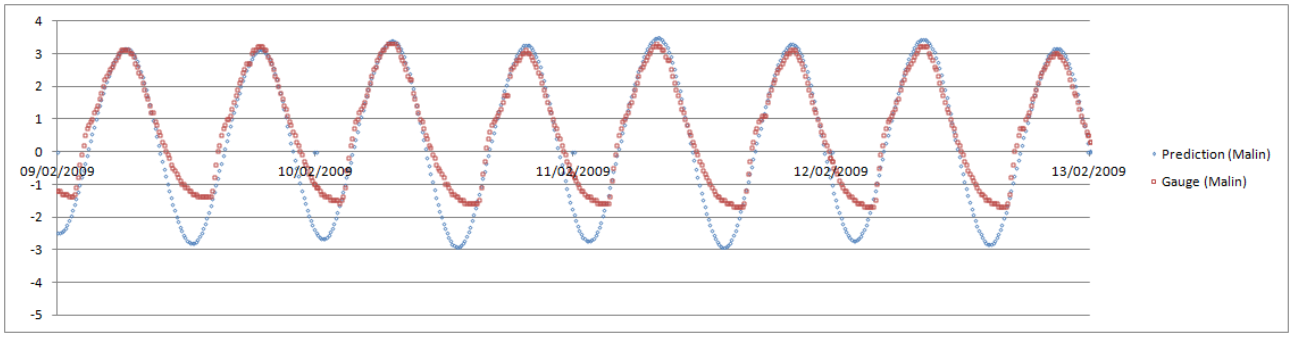
9.1 TIdal Surge model

The CFRAM levels are interpolated from the IPPC report by the OPW. We have compared the methodology in this report with the tidal data from SFPC and reviewed the prediction vs recorded data;

November/December 2009

Substantial flooding occurred in Limerick City in 2009, the graph below shows the significant fluvial influence on low tide levels during the period between 14/10/2009 and 31/12/2009. Flooding due to coastal inundation was not an issue in the Raheenarea during this period but as the graph shows the fluvial flows had a noticeable effect on high tides.

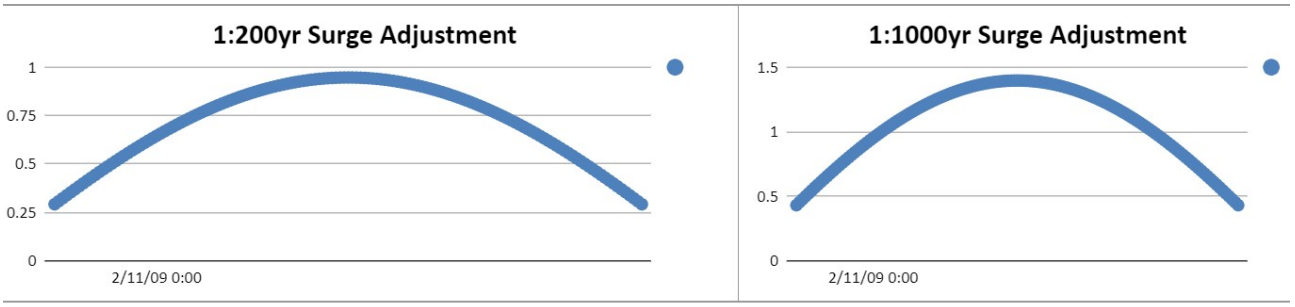
*Gauge data in **Red**, Prediction data in **Blue***

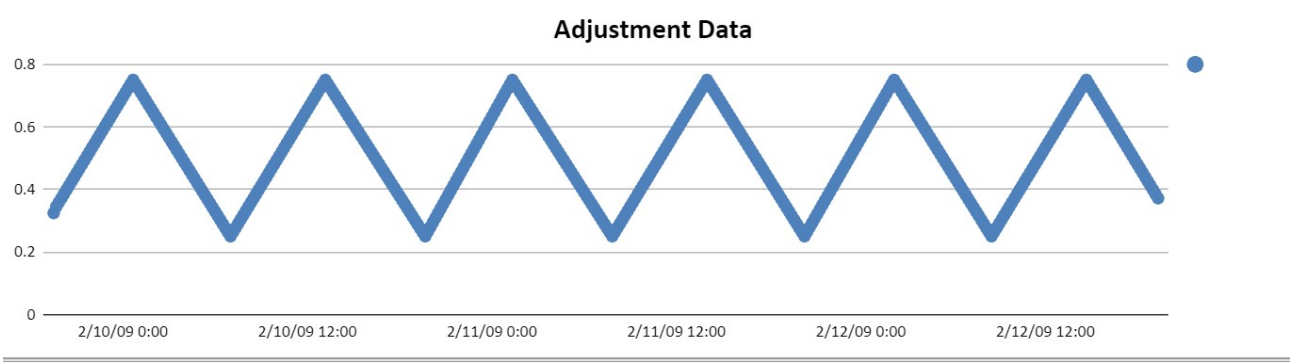


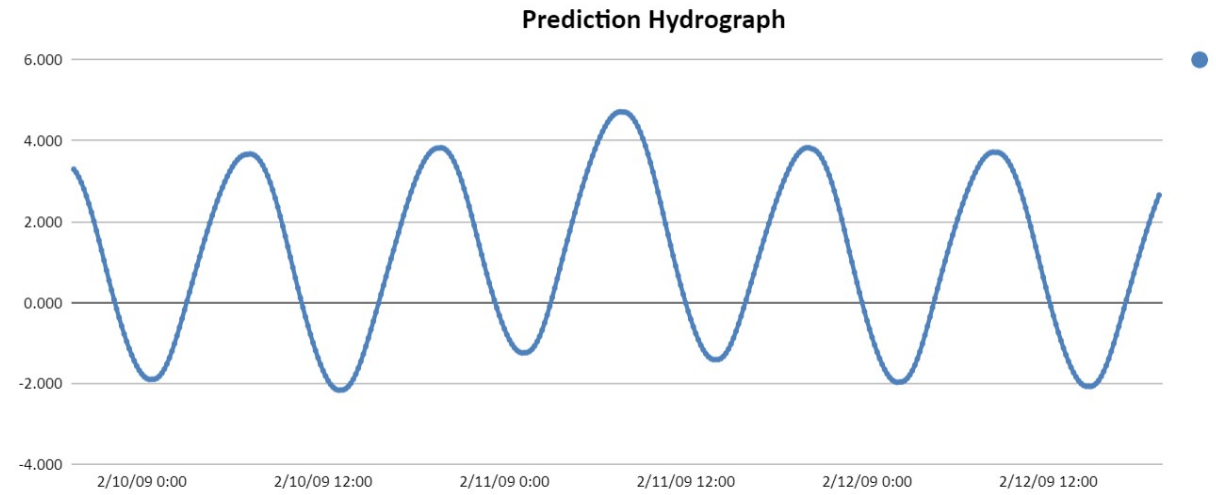
9

The OPW approach has been to include a surge in the model and match the peak of this surge with a peak high tide, this has been re-constructed as follows;

[9] Extract of comparison data.







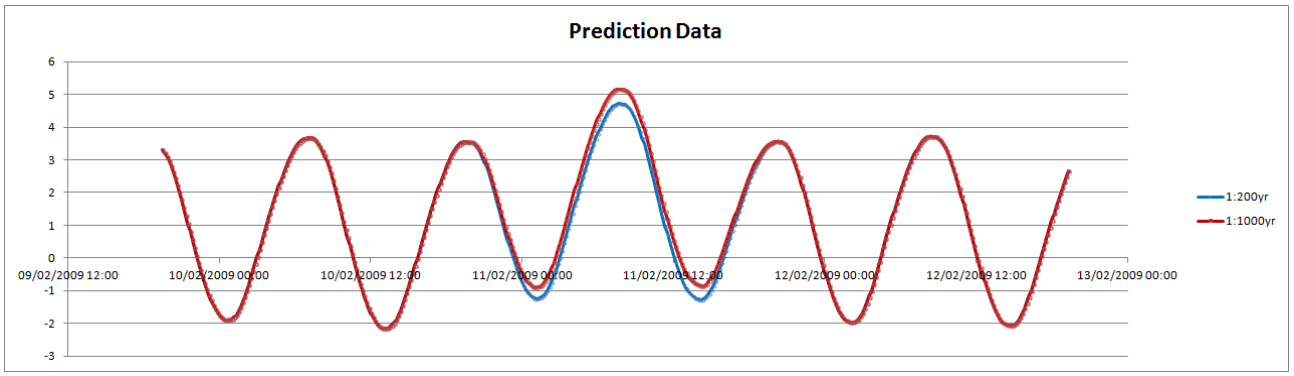
10

The final design tidal graph was formulated as follows;

- Based on a 5 day period of predictive data for a typical (non-perigean) February spring tide at Limerick dock.
- Low tide level adjusted upwards by 1m to allow for typical winter fluvial flow and high tide increased by .25m
- Surge influence to be imposed on the peak spring tide to provide the 1:200yr and 1:1000yr scenarios.

The resultant adjusted hydrograph is as follows;

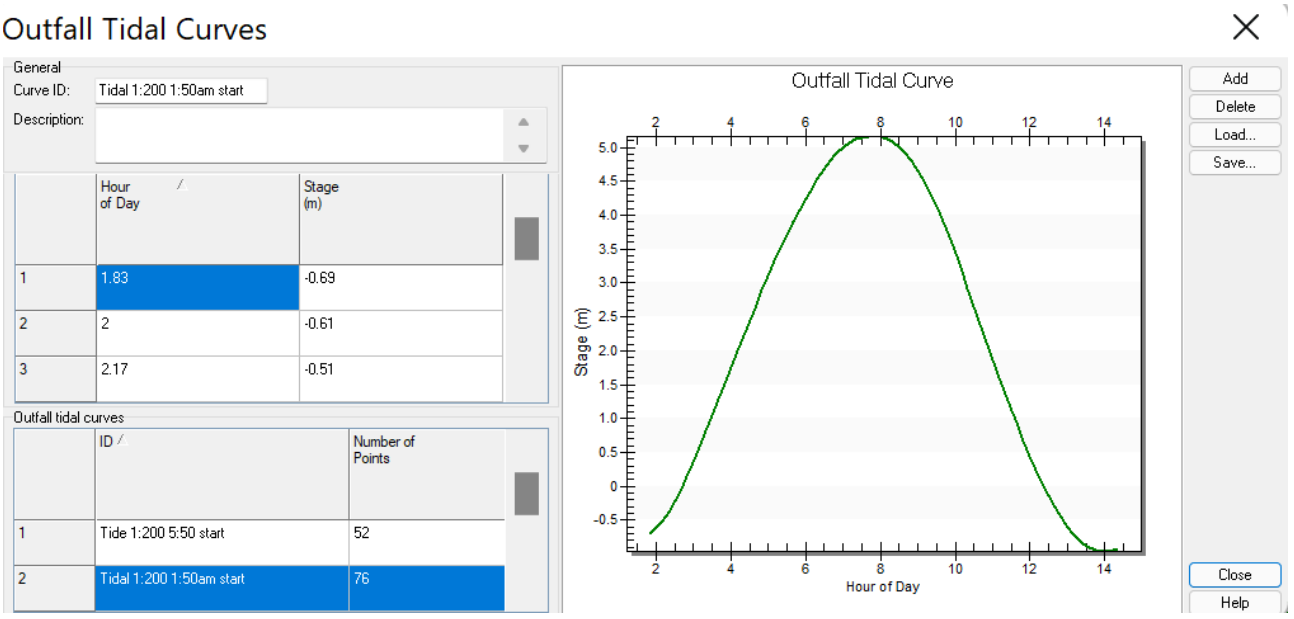
[10] Limerick Gauge and admiral prediction data for period 14/10/09 to 31/12/09 (x-axis = Level in m, y-axis = Time)



11

As there are protection measures the low tide levels may not be achieved, in any case the peak level of the prediction is critical for the outfall.

The worst case scenario outfall curve was applied with peak tide at close to peak runoff;



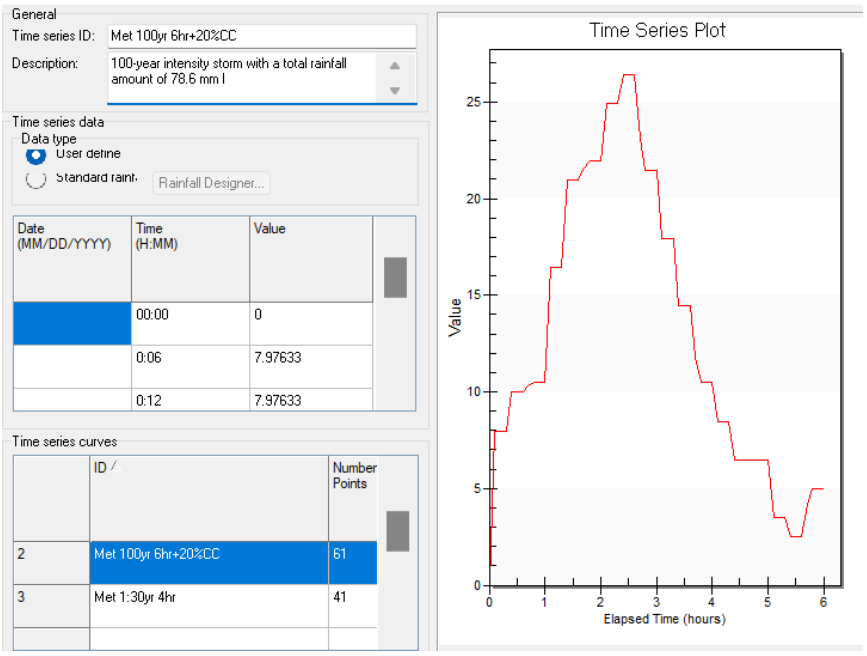
[11] Graph of synthetic coastal surge hydrographs.

9.2 Total Site 1:100yr rainfall & 1:200yr tidal surge Calculations

Input Data

Rainfall data synthetic storm

Time Series




```
FLOW_UNITS              LPS
SUBBASIN_HYDROGRAPH     SCS TR-55
TIME_OF_CONCENTRATION   User-Defined
LINK_ROUTING            Hydrodynamic
START_TIME              00:00:00
REPORT_START_DATE       10/09/2019
REPORT_START_TIME       00:00:00
END_DATE                10/10/2019
END_TIME                00:01:00
SWEEP_START             01/01
SWEEP_END               12/31
REPORT_STEP             00:00:30
DRY_STEP                00:00:30
ALLOW_PONDING           YES
INERTIAL_DAMPING        PARTIAL
VARIABLE_STEP           0.75
LENGTHENING_STEP        0
MIN_SURFAREA            0
NORMAL_FLOW_LIMITED     BOTH
SKIP_STEADY_STATE       NO
FORCE_MAIN_EQUATION     H-W
LINK_OFFSETS            DEPTH
MIN_SLOPE               0.2
```

.

```
[JUNCTIONS]
;;               Invert     Max.       Init.      Surcharge  Ponded
;;Name            Elev.      Depth      Depth      Depth      Area
;;--------------------------------------------------------------------
  Out-1SP33      2.19426792 6          0          0          0
  S-07           3.2        3.34185838 0          0          0
  S1             3.5        6          0          0          10
  S10            5.25       1.54820005 0          0          10
  S11            2.9        4.29121701 0          0          10
  S12            6.0707056  0.92929441 0          0          10
  S13            2.8        4.2        0          0          10
  S15            4.2        2.77169349 0          0          10
  S16            6.21717353 0.7        0          0          10
  S17            5.50495329 1.39504671 0          0          10
  S18            3.2        3.7        0          0          10
  S19            4.37619832 2.28270902 0          0          10
  S2             3.95       2.77783862 0          0          0
  S20            5          1.63436655 0          0          10
  S21            5          1.75       0          0          10
  S22            4.2        2.36963353 0          0          10
  S23            4.5        1.05852231 0          0          10
  S24            4.5625     1.71283041 0          0          10
  S25            3.35       2.84988771 0          0          10
  S26            3.9125     1.652221   0          0          10
  S27            3.3        2.7702015  0          0          0
  S28            4.1        1.95332637 0          0          10
  S3             5          0.92378389 0          0          10
  S30            4.4        1.53690569 0          0          10
  S31            3.80044413 2.08720121 0          0          10
  S32            3.70098645 2.09901355 0          0          10
  S33            3.65       2.02131956 0          0          10
  S34            4.9625     0.707      0          0          10
  S35            5          0.58987356 0          0          10
  S36            2.75692956 2.79672106 0          0          10
  S37            2.6        2.94699199 0          0          10
  S38            2.4        3.1        0          0          10
  S4             4.5630181  1.87433904 0          0          10
  S40            3.84605264 1.64873686 0          0          10
  S41            4.4        1.05130203 0          0          10
  S42            2.5513048  2.84981017 0          0          10
  S44            2.28975408 3.04773353 0          0          10
  S45            2.98       1.376      0          0          10
  S46            3.55569012 1.64430988 0          0          10
  S47            4.5        0.7        0          0          10
  S48            3.5        3.232      0          0          0
  S49            4.33719898 0.7        0          0          10
  S5             4.5        2.5        0          0          10
  S54            4.6        1.20650422 0          0          10
  S55            5          4.39789376 0          0          10
  S56            3.25387877 2.46745435 0          0          10
  S57            4.4        2.35796431 0          0          0
  S58            4          2          0          0          10
  S59            2.2        3.8        0          0          0
  S6             3.35       4.16727345 0          0          10
  S-67           1.925      3.775      0          0          0
  S7             4.5        2.99512206 0          0          10
  S8             3.5        3.79236849 0          0          10
  S9             6.15047157 1.13697699 0          0          10
```

```
[OUTFALLS]
;;               Invert     Outfall    Stage/Table      Tide
;;Name            Elev.      Type       Time Series      Gate
;;--------------------------------------------------------------
  Out-1SP-08     3.1        FREE                        NO
  Out-1SP-77     1.65       TIDAL      Tide 1:200 5:50 start NO

[STORAGE]
;;               Invert   Max.     Init.    Shape      Shape      Ponded   Evap.
;;Name            Elev.    Depth    Depth    Curve      Parameters Area     Frac.
;;-----------------------------------------------------------------------------------------------
  S-06           3.2      3.5606763  0          TABULAR    SC-740 - 134              0        0
;Tank2Outlet
  S-70           2.1      2.65       0          TABULAR    SC-740-260                0        0

Storage Node Exfiltration Details
;;               Exfiltration       Exfiltration
;;Name            At                 Rate
;;-----------------------------------------------
  S-06           No exfiltration    -
  S-70           No exfiltration    -
  S-71           No exfiltration    -
  S-71           2.2      3.35       0          TABULAR    SC-740-580                0        0
```

```
[CONDUITS]
;;               Inlet           Outlet                      Manning    Inlet      Outlet     Init.      Maximum
;;Name           Node            Node            Length      N          Height     Height     Flow       Flow
;;-------------------------------------------------------------------------------------------------------------------
-
  Link-02        Out-1SP33       S-70            8.10        0.015      0          0          0          0
  SP-08          S-07            Out-1SP-08      3.86        0.012      0          0          0          0
  SP1            S6              S27             6.93        0.012      0          0          0          0
  SP10           S48             S25             24.37       0.015      0          0          0          0
  SP11           S22             S31             18.25       0.012      0          0          0          0
  SP12           S31             S38             45.57       0.012      0          0.8        0          0
  SP13           S38             S59             26.09       0.015      0          0          0          0
  SP14           S17             S24             20.02       0.012      5.55653613398821E-18 0.075      0          0
  SP15           S33             S48             18.81       0.012      0          0          0          0
  SP16           S35             S30             58.30       0.012      0          0          0          0
  SP17           S30             S28             32.54       0.012      0          0          0          0
  SP18           S47             S49             29.31       0.012      0          0          0          0
  SP19           S28             S33             75.28       0.012      0          0          0          0
  SP20           S15             S33             39.84       0.012      0          0          0          0
  SP21           S12             S15             52.40       0.012      0          1.15866133 0          0
  SP22           S16             S17             16.11       0.012      0          0          0          0
  SP23           S2              S1              62.96       0.015      0          0          0          0
  SP24           S1              S6              19.51       0.012      0          0          0          0
  SP25           S7              S6              17.50       0.012      0          0.65       0          0
  SP26           S20             S19             37.17       0.012      0          0.00380167999999959 0          0
  SP27           S4              S19             17.74       0.012      0          0          0          0
  SP28           S41             S32             60.78       0.012      0          0.09901355 0          0
  SP29           S26             S32             26.14       0.012      0          0.0750000000000002 0          0
  SP3            S5              S8              26.52       0.012      0          0          0          0
  SP30           S23             S26             59.59       0.012      0          0          0          0
  SP31           S36             S42             21.16       0.012      0          0          0          0
  SP32           S42             S44             44.72       0.012      0          0          0          0
  SP33           S44             Out-1SP33       10.63       0.012      0          0          0          0
  SP34           S58             S45             25.57       0.012      0          0.52       0          0
  SP35           S18             S36             49.67       0.012      0          0          0          0
  SP36           S45             S36             55.11       0.012      0          0.019      0          0
  SP38           S24             S15             23.27       0.012      0          0          0          0
  SP39           S34             S24             50.54       0.012      0          0          0          0
  SP4            S8              S18             15.50       0.012      0          0          0          0
  SP40           S54             S23             9.01        0.012      0          0          0          0
  SP41           S25             S11             63.13       0.012      0          0          0          0
  SP42           S11             S13             18.01       0.012      0          0          0          0
  SP43           S55             S11             40.18       0.012      0          1.6        0          0
  SP44           S13             S37             56.03       0.012      0          0          0          0
  SP45           S37             S59             24.28       0.012      0          0          0          0
  SP46           S56             S59             48.51       0.012      0          0          0          0
  SP47           S46             S56             39.87       0.012      0          0          0          0
  SP48           S19             S2              43.49       0.012      0          0          0          0
  SP49           S3              S4              41.51       0.012      0          0          0          0
  SP50           S57             S2              39.33       0.012      0          0          0          0
  SP52           S32             S48             32.68       0.012      0          0          0          0
  SP53           S40             S45             64.40       0.012      0          0.21145657 0          0
  SP6            S9              S6              107.51      0.012      0          1.65       0          0
  SP7            S10             S21             18.61       0.012      0          0          0          0
  SP-77          S-67            Out-1SP-77      54.99       0.012      0          0          0          0
  SP8            S21             S49             57.08       0.012      0          0          0          0
  SP9            S49             S40             43.31       0.012      0          0.0655000000000001 0          0
  TANK1          S27             S-06            13.34       0.015      0          0          0          0
  Tank3          S59             S-71            24.15       0.015      0          -0.2       0          0

[OUTLETS]
;;               Inlet           Outlet          Outflow     Discharge  Qcoeff/              Flap
;;Name           Node            Node            Height      Curve      Qtable     Qexpon    Gate
;;-------------------------------------------------------------------------------------------------
  HydorBrake-T1  S-06            S-07            0           TABULAR/DEPTH Tank1-Rev2           NO
  HydroBrake2_rev2 S-70          S-67            0           TABULAR/DEPTH Tank2_rev2           NO
  HydroBrake3_rev2 S-71          S-67            0           TABULAR/DEPTH Tank3_rev2           NO
```

.

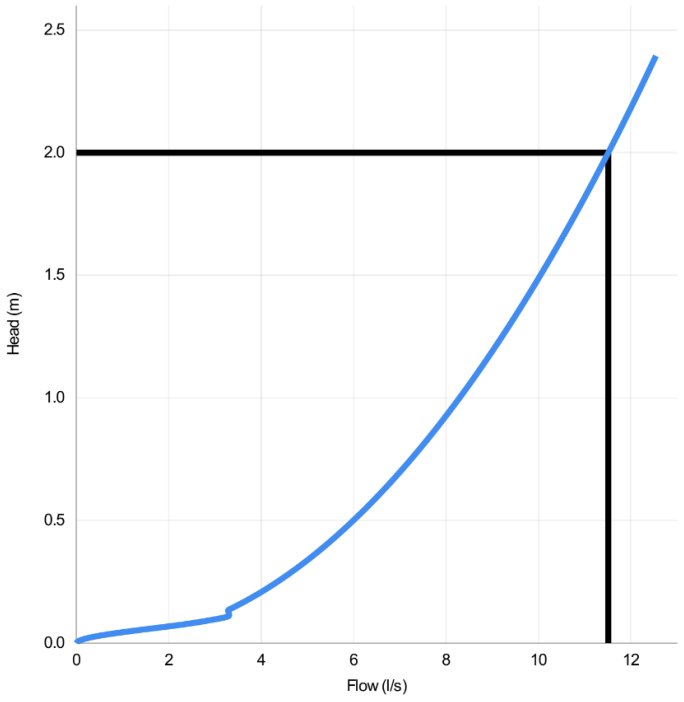
Hydrobrake Tank1-Rev2;

Technical Specification		
Control Point	Head (m)	Flow (l/s)
Primary Design	2.000	11.510
Flush-Flo	0.114	3.305
Kick-Flo®	0.134	3.269
Mean Flow		7.807

BBA APPROVAL INSPECTION TESTING CERTIFICATION
CERTIFICATE No 08/4596

WRc APPROVED
PT/329/0412

hydro-int.com/patents



Head (m)	Flow (l/s)
0.000	0.000
0.069	2.027
0.138	3.314
0.207	3.986
0.276	4.549
0.345	5.042
0.414	5.487
0.483	5.894
0.552	6.272
0.621	6.627
0.690	6.962
0.759	7.280
0.828	7.583
0.897	7.874
0.966	8.154
1.034	8.423
1.103	8.683
1.172	8.935
1.241	9.180
1.310	9.418
1.379	9.649
1.448	9.875
1.517	10.095
1.586	10.310
1.655	10.520
1.724	10.726
1.793	10.927
1.862	11.125
1.931	11.319
2.000	11.510

DESIGN ADVICE

The head/flow characteristics of this SCU-0090-1151-2000-1151 Hydro-Brake Optimum® Flow Control are unique. Dynamic hydraulic modelling evaluates the full head/flow characteristic curve.

! **The use of any other flow control will invalidate any design based on this data and could constitute a flood risk.**

Hydro International

DATE	12/12/2021 14:03
Site	Raheen
DESIGNER	David O'Malley
Ref	18112-T1-rev3 / 21_21_7345

SCU-0090-1151-2000-1151

Hydro-Brake Optimum®

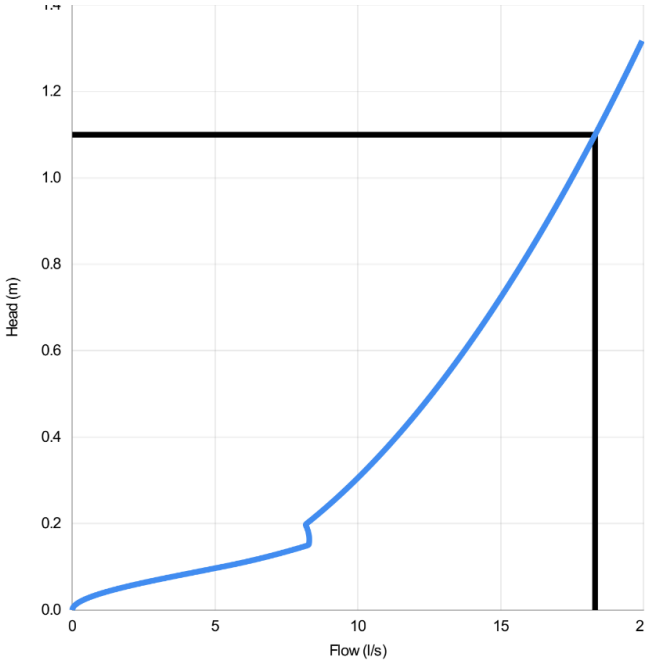
Hydrobrake Tank2-Rev2;

Technical Specification		
Control Point	Head (m)	Flow (l/s)
Primary Design	1.100	18.300
Flush-Flo	0.163	8.295
Kick-Flo®	0.198	8.162
Mean Flow		12.292

BBA APPROVAL INSPECTION TESTING CERTIFICATION
CERTIFICATE No 08/4596

WRc APPROVED
PT/329/0412

hydro-int.com/patents



Head (m)	Flow (l/s)
0.000	0.000
0.038	0.972
0.076	3.388
0.114	6.210
0.152	8.280
0.190	8.217
0.228	8.706
0.266	9.355
0.303	9.957
0.341	10.522
0.379	11.055
0.417	11.561
0.455	12.045
0.493	12.508
0.531	12.953
0.569	13.382
0.607	13.796
0.645	14.198
0.683	14.587
0.721	14.966
0.759	15.334
0.797	15.694
0.834	16.044
0.872	16.387
0.910	16.722
0.948	17.050
0.986	17.371
1.024	17.686
1.062	17.995
1.100	18.299

DESIGN ADVICE

The head/flow characteristics of this SCU-0132-1830-1100-1830 Hydro-Brake Optimum® Flow Control are unique. Dynamic hydraulic modelling evaluates the full head/flow characteristic curve.

! **The use of any other flow control will invalidate any design based on this data and could constitute a flood risk.**

Hydro International

DATE	12/12/2021 14:05
Site	Raheen
DESIGNER	David O'Malley
Ref	18112-2

SCU-0132-1830-1100-1830

Hydro-Brake Optimum®

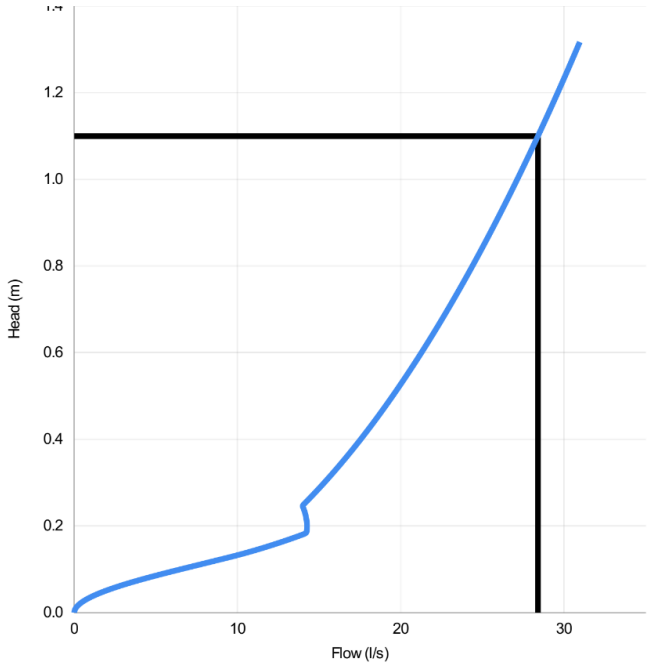
Hydrobrake Tank3-Rev2;

Technical Specification		
Control Point	Head (m)	Flow (l/s)
Primary Design	1.100	28.400
Flush-Flo	0.200	14.253
Kick-Flo®	0.247	13.973
Mean Flow		18.979

BBA APPROVAL INSPECTION TESTING CERTIFICATION
CERTIFICATE No 08/4596

WRc APPROVED
PT/329/0412

hydro-int.com/patents



Head (m)	Flow (l/s)
0.000	0.000
0.038	1.116
0.076	4.044
0.114	7.980
0.152	11.750
0.190	14.239
0.228	14.152
0.266	14.455
0.303	15.393
0.341	16.273
0.379	17.103
0.417	17.892
0.455	18.645
0.493	19.367
0.531	20.060
0.569	20.729
0.607	21.375
0.645	22.001
0.683	22.609
0.721	23.199
0.759	23.774
0.797	24.334
0.834	24.881
0.872	25.415
0.910	25.938
0.948	26.449
0.986	26.950
1.024	27.442
1.062	27.924
1.100	28.398

DESIGN ADVICE

The head/flow characteristics of this SCU-0165-2840-1100-2840 Hydro-Brake Optimum® Flow Control are unique. Dynamic hydraulic modelling evaluates the full head/flow characteristic curve.

! **The use of any other flow control will invalidate any design based on this data and could constitute a flood risk.**

Hydro International

DATE	12/12/2021 14:29
Site	Raheen
DESIGNER	David O'Malley
Ref	18112-T3

SCU-0165-2840-1100-2840

Hydro-Brake Optimum®

9.3 Results

```
********************
  Project Description
  ********************
  File Name ................. 18112-All-REV4.SPF


  ****************
  Analysis Options
  ****************
  Flow Units ................ LPS
  Subbasin Hydrograph Method. SCS TR-55
  Time of Concentration...... User-Defined
  Link Routing Method ....... Hydrodynamic
  Storage Node Exfiltration.. Constant rate, wetted area
  Starting Date ............. OCT-09-2019 00:00:00
  Ending Date ............... OCT-10-2019 00:01:00
  Report Time Step .......... 00:00:30


  *************************        Volume         Depth
  Runoff Quantity Continuity     hectare-m            mm
  *************************     ---------       -------
  Total Precipitation ......         0.363       78.483
  Surface Runoff ...........         9.468     2049.241
  Continuity Error (%) .....         0.000


  *************************        Volume        Volume
  Flow Routing Continuity        hectare-m       Mliters
  *************************     ---------     ---------
  External Inflow ..........         0.067         0.668
  External Outflow .........         0.337         3.366
  Initial Stored Volume ....         0.000         0.004
  Final Stored Volume ......         0.068         0.677
  Continuity Error (%) .....        -0.006
```

****
Subbasin Runoff Summary
****

Subbasin ID	Total Precip mm	Total Runoff mm	Peak Runoff LPS	Weighted Curve Number	Time of Concentration days	Time of Concentration hh:mm:ss
1	78.48	72.49	0.57	98.000	0	00:04:56
2	78.48	72.49	0.57	98.000	0	00:04:56
3	78.48	72.49	0.57	98.000	0	00:04:56
4	78.48	72.49	0.57	98.000	0	00:04:56
5	78.48	72.49	0.57	98.000	0	00:04:56
6	78.48	72.49	0.57	98.000	0	00:04:56
7	78.48	72.49	0.57	98.000	0	00:04:56
8	78.48	72.49	0.57	98.000	0	00:04:56
10	78.48	72.57	1.13	98.000	0	00:04:56
11	78.48	72.49	0.57	98.000	0	00:04:56
12	78.48	72.49	0.57	98.000	0	00:04:56
13	78.48	72.57	1.70	98.000	0	00:04:56
14	78.48	72.59	6.80	98.000	0	00:04:56
15	78.48	72.57	1.13	98.000	0	00:04:56
16	78.48	72.49	0.57	98.000	0	00:04:56
17	78.48	72.57	1.13	98.000	0	00:04:56
18	78.48	72.57	1.13	98.000	0	00:04:56
19	78.48	72.59	7.93	98.000	0	00:04:56
20	78.48	72.49	0.57	98.000	0	00:04:56
21	78.48	72.49	0.57	98.000	0	00:04:56
22	78.48	72.54	0.85	98.000	0	00:04:56
23	78.48	72.42	0.28	98.000	0	00:04:56
24	78.48	72.59	4.53	98.000	0	00:04:56
25	78.48	72.57	1.70	98.000	0	00:04:56
26	78.48	72.57	1.42	98.000	0	00:04:56
27	78.48	72.49	0.57	98.000	0	00:04:56
28	78.48	72.57	1.42	98.000	0	00:04:56
29	78.48	72.57	1.42	98.000	0	00:04:56
30	78.48	72.49	0.57	98.000	0	00:04:56
31	78.48	72.57	1.42	98.000	0	00:04:56
32	78.48	72.59	9.91	98.000	0	00:04:56
33	78.48	72.49	0.57	98.000	0	00:04:56
34	78.48	72.57	1.42	98.000	0	00:04:56
35	78.48	72.54	0.85	98.000	0	00:04:56
36	78.48	72.57	1.70	98.000	0	00:04:56
37	78.48	72.49	0.57	98.000	0	00:04:56
38	78.48	72.49	0.57	98.000	0	00:04:56
39	78.48	72.57	1.42	98.000	0	00:04:56
40	78.48	72.54	0.85	98.000	0	00:04:56
41	78.48	72.54	0.85	98.000	0	00:04:56
42	78.48	72.54	0.85	98.000	0	00:04:56
43	78.48	72.54	0.85	98.000	0	00:04:56
44	78.48	72.57	1.13	98.000	0	00:04:56
45	78.48	72.49	0.57	98.000	0	00:04:56
46	78.48	72.57	2.27	98.000	0	00:04:56
47	78.48	72.57	1.70	98.000	0	00:04:56
48	78.48	72.57	1.70	98.000	0	00:04:56
49	78.48	72.54	0.85	98.000	0	00:04:56
50	78.48	72.57	2.27	98.000	0	00:04:56
51	78.48	72.54	0.85	98.000	0	00:04:56
52	78.48	72.57	1.42	98.000	0	00:04:56
53	78.48	72.57	1.13	98.000	0	00:04:56
54	78.48	72.57	1.42	98.000	0	00:04:56
55	78.48	72.54	0.85	98.000	0	00:04:56
56	78.48	72.57	1.42	98.000	0	00:04:56
57	78.48	72.57	1.42	98.000	0	00:04:56
58	78.48	72.57	1.70	98.000	0	00:04:56
59	78.48	72.57	1.42	98.000	0	00:04:56
60	78.48	72.49	0.57	98.000	0	00:04:56
61	78.48	72.57	1.70	98.000	0	00:04:56
62	78.48	72.57	1.42	98.000	0	00:04:56
63	78.48	72.54	0.85	98.000	0	00:04:56
64	78.48	72.57	2.27	98.000	0	00:04:56
65	78.48	72.57	1.70	98.000	0	00:04:56
66	78.48	72.57	1.42	98.000	0	00:04:56
67	78.48	72.57	1.70	98.000	0	00:04:56
68	78.48	72.57	1.70	98.000	0	00:04:56
69	78.48	72.49	0.57	98.000	0	00:04:56
70	78.48	72.49	0.57	98.000	0	00:04:56
71	78.48	72.57	1.70	98.000	0	00:04:56
73	78.48	72.57	1.70	98.000	0	00:04:56
74	78.48	72.54	0.85	98.000	0	00:04:56

75	78.48	72.54	0.85	98.000	0	00:04:56
76	78.48	72.57	1.42	98.000	0	00:04:56
77	78.48	72.57	1.42	98.000	0	00:04:56
78	78.48	72.54	0.85	98.000	0	00:04:56
79	78.48	72.54	0.85	98.000	0	00:04:56
80	78.48	72.57	1.42	98.000	0	00:04:56
81	78.48	72.57	1.70	98.000	0	00:04:56
82	78.48	72.57	1.42	98.000	0	00:04:56
83	78.48	72.54	0.85	98.000	0	00:04:56
84	78.48	72.57	1.70	98.000	0	00:04:56
85	78.48	72.57	1.70	98.000	0	00:04:56
86	78.48	72.57	1.70	98.000	0	00:04:56
87	78.48	72.54	0.85	98.000	0	00:04:56
88	78.48	72.57	1.70	98.000	0	00:04:56
89	78.48	72.57	1.70	98.000	0	00:04:56
90	78.48	72.54	0.85	98.000	0	00:04:56
91	78.48	72.57	1.42	98.000	0	00:04:56
92	78.48	72.57	1.70	98.000	0	00:04:56
93	78.48	72.57	1.42	98.000	0	00:04:56
94	78.48	72.57	1.42	98.000	0	00:04:56
95	78.48	72.54	0.85	98.000	0	00:04:56
96	78.48	72.57	1.70	98.000	0	00:04:56
97	78.48	72.57	1.70	98.000	0	00:04:56
98	78.48	72.57	1.70	98.000	0	00:04:56
99	78.48	72.57	1.42	98.000	0	00:04:56
100	78.48	72.57	1.70	98.000	0	00:04:56
Sub-104	78.48	72.54	0.57	98.000	0	00:01:18
Sub-56	78.48	72.59	7.08	98.000	0	00:04:56
Sub-57	78.48	72.59	7.08	98.000	0	00:04:56
Sub-58	78.48	72.59	3.96	98.000	0	00:04:56
Sub-59	78.48	72.59	4.53	98.000	0	00:04:56
Sub-60	78.48	72.59	4.81	98.000	0	00:04:56
Sub-61	78.48	72.59	5.10	98.000	0	00:04:56
Sub-62	78.48	72.59	4.81	98.000	0	00:04:56
Sub-64	78.48	72.59	5.38	98.000	0	00:04:56
Sub-65	78.48	72.59	5.66	98.000	0	00:04:56
Sub-66	78.48	72.59	6.23	98.000	0	00:04:56
Sub-67	78.48	72.59	6.23	98.000	0	00:04:56
Sub-68	78.48	72.59	8.50	98.000	0	00:04:56
Sub-69	78.48	72.57	2.83	98.000	0	00:04:56
Sub-70	78.48	72.57	2.27	98.000	0	00:04:56
Sub-71	78.48	72.57	1.70	98.000	0	00:04:56
Sub-72	78.48	72.57	2.55	98.000	0	00:04:56
Sub-73	78.48	72.57	2.27	98.000	0	00:04:56
Sub-74	78.48	72.59	4.53	98.000	0	00:04:56
Sub-75	78.48	72.59	8.78	98.000	0	00:04:56
Sub-76	78.48	72.57	2.83	98.000	0	00:04:56
Sub-77	78.48	72.59	3.96	98.000	0	00:01:18
Sub-78	78.48	72.54	0.85	98.000	0	00:04:56
Sub-79	78.48	72.57	2.55	98.000	0	00:04:56
Sub-80	78.48	72.59	5.38	98.000	0	00:04:56
Sub-81	78.48	72.59	4.53	98.000	0	00:04:56
Sub-82	78.48	72.57	3.11	98.000	0	00:04:56
Sub-83	78.48	72.59	6.51	98.000	0	00:04:56
Sub-84	78.48	72.59	6.23	98.000	0	00:04:56
Sub-85	78.48	72.59	6.51	98.000	0	00:04:56
Sub-86	78.48	72.59	7.08	98.000	0	00:04:56
Sub-87	78.48	72.57	2.55	98.000	0	00:04:56
Sub-88	78.48	72.59	4.25	98.000	0	00:04:56
Sub-89	78.48	72.57	3.11	98.000	0	00:04:56
Sub-90	78.48	72.57	3.68	98.000	0	00:04:56
Sub-91	78.48	72.57	1.98	98.000	0	00:04:56
Sub-92	78.48	72.57	3.11	98.000	0	00:04:56
Sub-93	78.48	72.59	5.10	98.000	0	00:04:56
Sub-94	78.48	72.59	5.95	98.000	0	00:04:56
Sub-95	78.48	72.57	2.83	98.000	0	00:04:56
Sub-96	78.48	72.57	1.42	98.000	0	00:04:56
Sub-97	78.48	72.59	8.21	98.000	0	00:04:56
Sub-98	78.48	72.59	8.50	98.000	0	00:04:56

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Node Depth Summary
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Node ID	Average Depth Attained m	Maximum Depth Attained m	Maximum HGL Attained m	Time of Max Occurrence days	hh:mm	Total Flooded Volume ha-mm	Total Time Flooded minutes	Retention Time hh:mm:ss

Out-1SP33	0.04	0.05	2.24	0	02:37	0	0	0:00:00
S-07	0.05	0.06	3.26	0	05:10	0	0	0:00:00
S1	0.05	0.18	3.68	0	02:37	0	0	0:00:00
S10	0.01	0.02	5.27	0	02:34	0	0	0:00:00
S11	0.11	0.63	3.53	0	02:39	0	0	0:00:00
S12	0.02	0.07	6.14	0	02:36	0	0	0:00:00
S13	0.11	0.67	3.47	0	02:39	0	0	0:00:00
S15	0.04	0.11	4.31	0	02:36	0	0	0:00:00
S16	0.01	0.02	6.23	0	02:30	0	0	0:00:00
S17	0.01	0.02	5.53	0	02:33	0	0	0:00:00
S18	0.03	0.09	3.29	0	02:36	0	0	0:00:00
S19	0.04	0.13	4.51	0	02:34	0	0	0:00:00
S2	0.03	0.10	4.05	0	02:36	0	0	0:00:00
S20	0.01	0.04	5.04	0	02:36	0	0	0:00:00
S21	0.02	0.06	5.06	0	02:36	0	0	0:00:00
S22	0.01	0.03	4.23	0	02:31	0	0	0:00:00
S23	0.03	0.08	4.58	0	02:36	0	0	0:00:00
S24	0.02	0.07	4.64	0	02:30	0	0	0:00:00
S25	0.07	0.27	3.62	0	02:39	0	0	0:00:00
S26	0.04	0.11	4.02	0	02:36	0	0	0:00:00
S27	0.04	0.04	3.34	0	02:36	0	0	0:00:00
S28	0.04	0.12	4.22	0	02:34	0	0	0:00:00
S3	0.03	0.09	5.09	0	02:32	0	0	0:00:00
S30	0.03	0.10	4.50	0	02:31	0	0	0:00:00
S31	0.03	0.08	3.88	0	02:36	0	0	0:00:00
S32	0.04	0.13	3.83	0	02:37	0	0	0:00:00
S33	0.06	0.19	3.84	0	02:37	0	0	0:00:00
S34	0.02	0.07	5.03	0	02:29	0	0	0:00:00
S35	0.02	0.06	5.06	0	02:36	0	0	0:00:00
S36	0.06	0.20	2.96	0	02:36	0	0	0:00:00
S37	0.14	0.75	3.35	0	02:39	0	0	0:00:00
S38	0.03	0.11	2.51	0	02:36	0	0	0:00:00
S4	0.02	0.07	4.63	0	02:33	0	0	0:00:00
S40	0.05	0.18	4.03	0	02:37	0	0	0:00:00
S41	0.03	0.09	4.49	0	02:36	0	0	0:00:00
S42	0.06	0.19	2.74	0	02:37	0	0	0:00:00
S44	0.08	0.29	2.58	0	02:37	0	0	0:00:00
S45	0.07	0.21	3.19	0	02:37	0	0	0:00:00
S46	0.02	0.06	3.61	0	02:36	0	0	0:00:00
S47	0.03	0.10	4.60	0	02:36	0	0	0:00:00
S48	0.08	0.27	3.77	0	02:37	0	0	0:00:00
S49	0.04	0.13	4.47	0	02:37	0	0	0:00:00
S5	0.01	0.03	4.53	0	02:35	0	0	0:00:00
S54	0.01	0.03	4.63	0	02:35	0	0	0:00:00
S55	0.01	0.03	5.03	0	02:37	0	0	0:00:00
S56	0.03	0.08	3.34	0	02:36	0	0	0:00:00
S57	0.05	0.16	4.56	0	02:36	0	0	0:00:00
S58	0.01	0.03	4.03	0	02:35	0	0	0:00:00
S59	0.02	0.02	2.22	0	02:37	0	0	0:00:00
S6	0.07	0.24	3.59	0	02:36	0	0	0:00:00
S-67	1.46	3.23	5.15	0	05:50	0	0	0:00:00
S7	0.00	0.00	4.50	0	00:00	0	0	0:00:00
S8	0.01	0.03	3.53	0	02:36	0	0	0:00:00
S9	0.02	0.07	6.22	0	02:36	0	0	0:00:00
Out-1SP-08	0.04	0.05	3.15	0	05:10	0	0	0:00:00
Out-1SP-77	1.65	3.52	5.17	0	05:50	0	0	0:00:00
S-06	1.07	1.51	4.71	0	05:10	0	0	0:00:00
S-70	1.33	2.01	4.11	0	07:40	0	0	0:00:00
S-71	0.91	1.35	3.55	0	08:05	0	0	0:00:00

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Node Flow Summary
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Node ID	Element Type	Maximum Lateral Inflow LPS	Peak Inflow LPS	Time of Peak Inflow Occurrence days	Time of Peak Inflow Occurrence hh:mm	Maximum Flooding Overflow LPS	Time of Peak Flooding Occurrence days	Time of Peak Flooding Occurrence hh:mm
Out-1SP33	JUNCTION	0.00	104.19	0	02:37	0.00		
S-07	JUNCTION	0.00	10.07	0	05:10	0.00		
S1	JUNCTION	2.83	48.28	0	02:36	0.00		
S10	JUNCTION	1.13	1.13	0	02:23	0.00		
S11	JUNCTION	5.80	118.68	0	02:38	0.00		
S12	JUNCTION	10.14	10.14	0	02:31	0.00		
S13	JUNCTION	7.53	125.65	0	02:39	0.00		
S15	JUNCTION	9.57	33.92	0	02:36	0.00		
S16	JUNCTION	0.93	0.93	0	02:23	0.00		

S17	JUNCTION	1.30	2.24	0	02:32	0.00
S18	JUNCTION	13.90	16.54	0	02:36	0.00
S19	JUNCTION	11.64	24.04	0	02:33	0.00
S2	JUNCTION	9.57	45.45	0	02:34	0.00
S20	JUNCTION	2.63	2.63	0	02:28	0.00
S21	JUNCTION	7.14	8.27	0	02:34	0.00
S22	JUNCTION	2.80	2.80	0	02:25	0.00
S23	JUNCTION	11.67	13.37	0	02:36	0.00
S24	JUNCTION	1.30	14.22	0	02:29	0.00
S25	JUNCTION	8.44	111.83	0	02:37	0.00
S26	JUNCTION	1.30	14.67	0	02:36	0.00
S27	JUNCTION	0.00	66.52	0	02:36	0.00
S28	JUNCTION	9.60	26.90	0	02:32	0.00
S3	JUNCTION	9.77	9.77	0	02:31	0.00
S30	JUNCTION	11.10	17.30	0	02:36	0.00
S31	JUNCTION	11.84	14.64	0	02:34	0.00
S32	JUNCTION	6.00	36.84	0	02:36	0.00
S33	JUNCTION	4.50	65.33	0	02:36	0.00
S34	JUNCTION	10.68	10.68	0	02:29	0.00
S35	JUNCTION	6.20	6.20	0	02:29	0.00
S36	JUNCTION	7.14	80.76	0	02:36	0.00
S37	JUNCTION	2.44	127.99	0	02:39	0.00
S38	JUNCTION	2.24	16.88	0	02:36	0.00
S4	JUNCTION	0.00	9.77	0	02:32	0.00
S40	JUNCTION	16.71	44.53	0	02:36	0.00
S41	JUNCTION	16.17	16.17	0	02:28	0.00
S42	JUNCTION	5.80	86.56	0	02:37	0.00
S44	JUNCTION	17.66	104.20	0	02:36	0.00
S45	JUNCTION	9.57	57.10	0	02:37	0.00
S46	JUNCTION	7.53	7.53	0	02:32	0.00
S47	JUNCTION	14.50	14.50	0	02:36	0.00
S48	JUNCTION	1.30	103.46	0	02:37	0.00
S49	JUNCTION	5.07	27.84	0	02:36	0.00
S5	JUNCTION	2.63	2.63	0	02:28	0.00
S54	JUNCTION	1.70	1.70	0	02:28	0.00
S55	JUNCTION	2.27	2.27	0	02:32	0.00
S56	JUNCTION	9.03	16.57	0	02:36	0.00
S57	JUNCTION	11.84	11.84	0	02:33	0.00
S58	JUNCTION	3.00	3.00	0	02:25	0.00
S59	JUNCTION	0.00	161.24	0	02:37	0.00
S6	JUNCTION	7.33	66.53	0	02:36	0.00
S-67	JUNCTION	0.00	47.52	0	03:23	0.00
S7	JUNCTION	0.00	0.00	0	00:00	0.00
S8	JUNCTION	0.00	2.63	0	02:35	0.00
S9	JUNCTION	10.93	10.93	0	02:36	0.00
Out-1SP-08	OUTFALL	0.00	10.07	0	05:10	0.00
Out-1SP-77	OUTFALL	0.00	52.22	0	09:00	0.00
S-06	STORAGE	0.00	66.52	0	02:36	0.00
S-70	STORAGE	0.00	104.19	0	02:37	0.00
S-71	STORAGE	0.00	161.24	0	02:37	0.00

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Storage Node Summary
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Storage Node ID	Maximum Ponded Volume 1000 m³	Maximum Ponded Volume (%)	Time of Max Ponded Volume days hh:mm	Average Ponded Volume 1000 m³	Average Ponded Volume (%)	Maximum Storage Node Outflow LPS	Maximum Exfiltration Rate cmm	Time of Max. Exfiltration Rate hh:mm:ss	Total Exfiltrated Volume 1000 m³
S-06	0.511	48	0 05:10	0.374	35	10.07	0.00	0:00:00	0.000
S-70	1.249	79	0 07:40	0.863	55	18.21	0.00	0:00:00	0.000
S-71	2.033	47	0 08:05	1.408	32	28.40	0.00	0:00:00	0.000

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Outfall Loading Summary
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Outfall Node ID	Flow Frequency (%)	Average Flow LPS	Peak Inflow LPS
Out-1SP-08	99.78	8.29	10.07
Out-1SP-77	99.71	37.94	52.22
System	99.75	46.23	61.03

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Link Flow Summary
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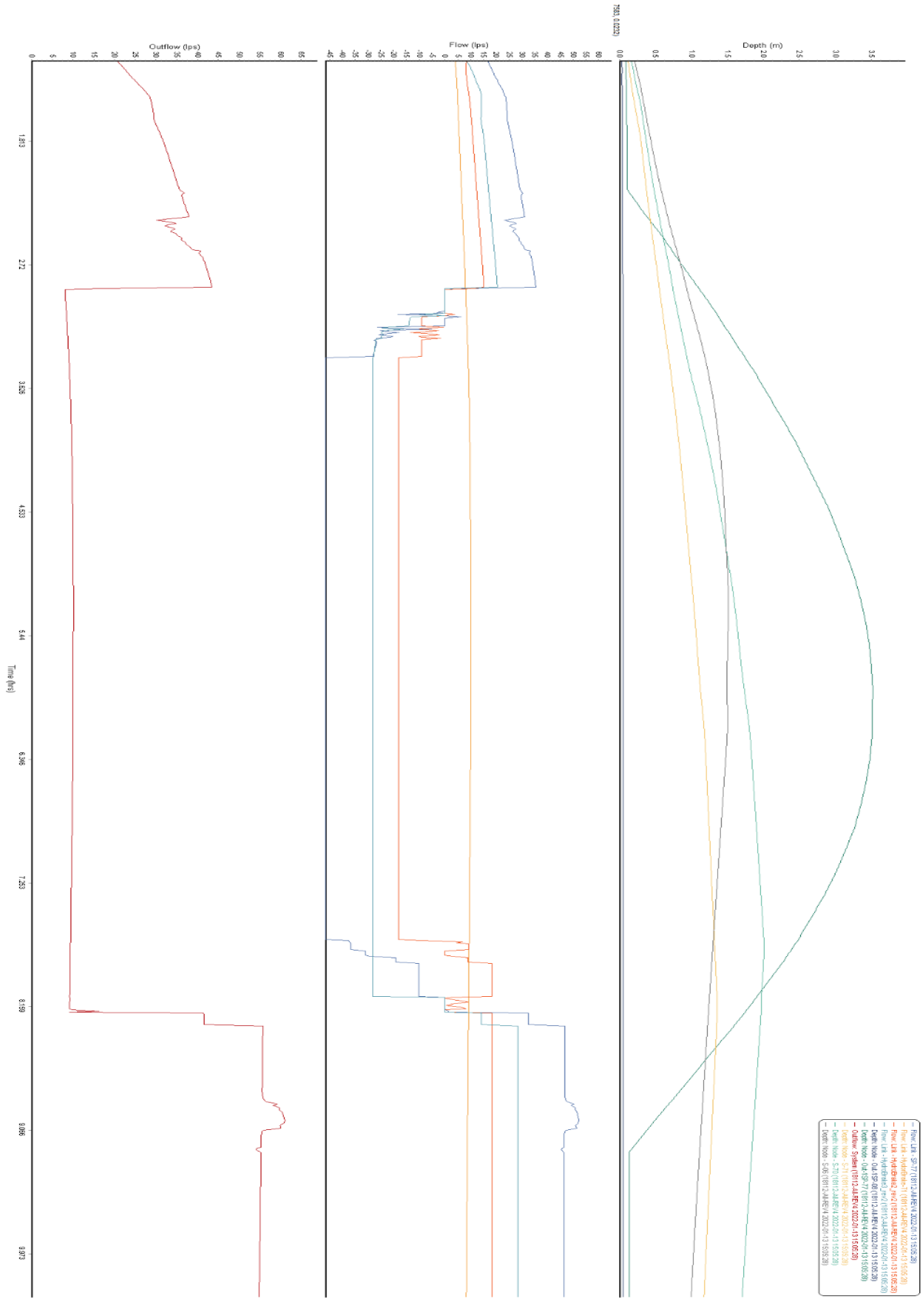
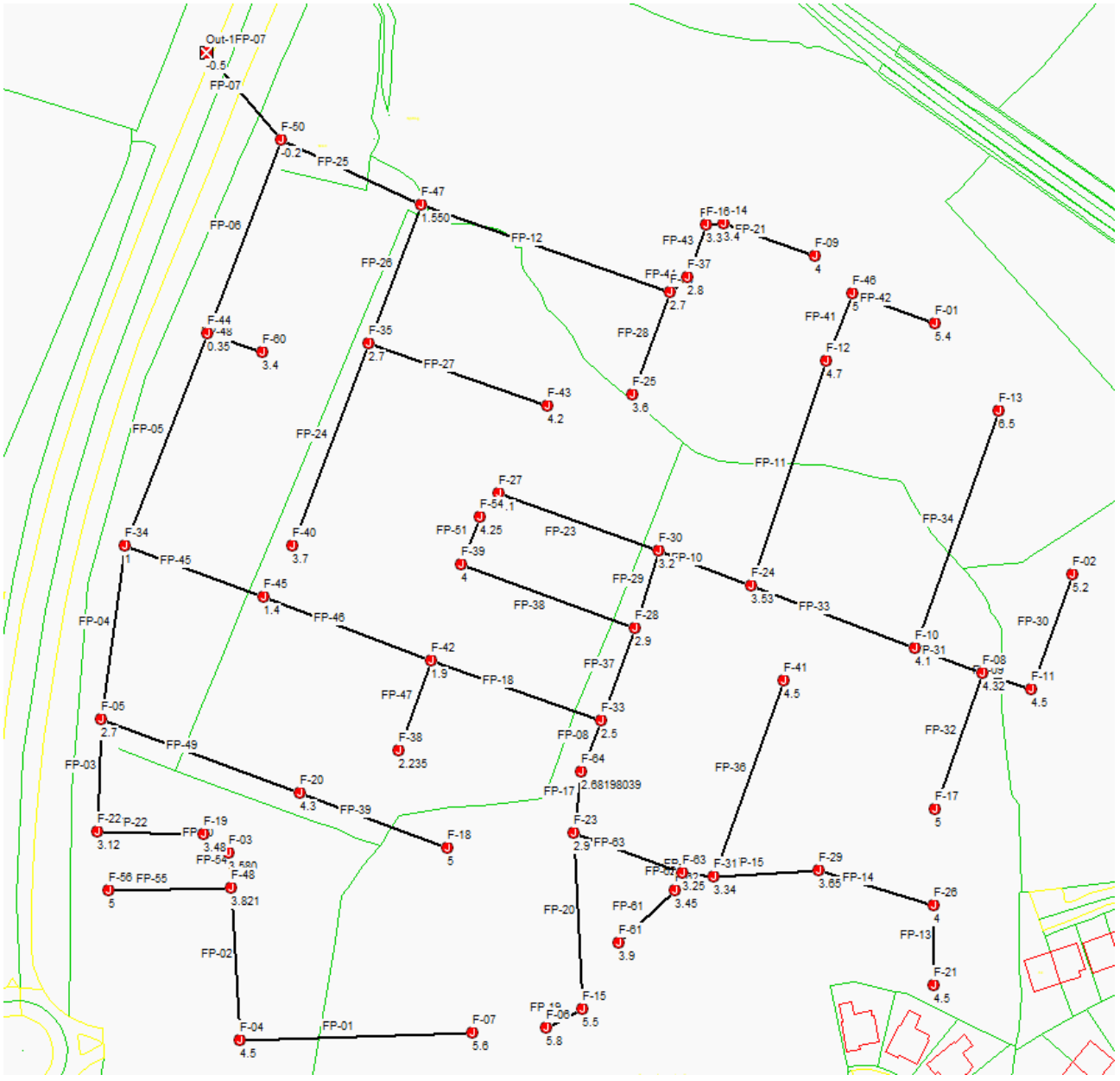
Link ID	Element Type	Time of Peak Flow Occurrence days hh:mm	Maximum Velocity Attained m/sec	Length Factor	Peak Flow during Analysis LPS	Design Flow Capacity LPS	Ratio of Maximum /Design Flow	Ratio of Maximum Flow Depth	Total Time Surcharged minutes	Reported Condition
Link-02	DIRECT	0 02:37			104.19					
SP-08	CONDUIT	0 05:10	1.13	1.00	10.07	168.63	0.06	0.18	0	Calculated
SP1	CONDUIT	0 02:36	1.70	1.00	66.52	161.35	0.41	0.38	0	Calculated
SP10	CONDUIT	0 02:37	1.24	1.00	103.39	193.87	0.53	0.60	0	Calculated
SP11	CONDUIT	0 02:31	0.37	1.00	2.80	71.98	0.04	0.25	0	Calculated
SP12	CONDUIT	0 02:36	1.15	1.00	14.64	55.84	0.26	0.36	0	Calculated
SP13	CONDUIT	0 02:36	1.25	1.00	16.88	216.35	0.08	0.14	0	Calculated
SP14	CONDUIT	0 02:33	1.00	1.00	2.24	101.26	0.02	0.11	0	Calculated
SP15	CONDUIT	0 02:37	0.94	1.00	65.32	169.63	0.39	0.62	0	Calculated
SP16	CONDUIT	0 02:36	0.64	1.00	6.20	16.74	0.37	0.54	0	Calculated
SP17	CONDUIT	0 02:32	0.91	1.00	17.30	46.71	0.37	0.48	0	Calculated
SP18	CONDUIT	0 02:36	0.71	1.00	14.50	36.26	0.40	0.51	0	Calculated
SP19	CONDUIT	0 02:34	0.72	1.00	26.90	81.00	0.33	0.52	0	Calculated
SP20	CONDUIT	0 02:36	0.96	1.00	33.92	123.09	0.28	0.50	0	Calculated
SP21	CONDUIT	0 02:36	1.06	1.00	10.14	56.71	0.18	0.29	0	Calculated
SP22	CONDUIT	0 02:30	0.57	1.00	0.93	102.28	0.01	0.09	0	Calculated
SP23	CONDUIT	0 02:36	0.56	1.00	45.45	5179.67	0.01	0.09	0	Calculated
SP24	CONDUIT	0 02:37	0.91	1.00	48.27	91.86	0.53	0.71	0	Calculated
SP25	CONDUIT	0 00:00	0.00	1.00	0.00	82.23	0.00	0.00	0	Calculated
SP26	CONDUIT	0 02:36	0.26	1.00	2.63	21.31	0.12	0.55	0	Calculated
SP27	CONDUIT	0 02:33	0.57	1.00	9.77	49.92	0.20	0.45	0	Calculated
SP28	CONDUIT	0 02:36	1.07	1.00	16.17	48.33	0.33	0.40	0	Calculated
SP29	CONDUIT	0 02:37	0.81	1.00	14.67	35.15	0.42	0.46	0	Calculated
SP3	CONDUIT	0 02:35	0.92	1.00	2.63	94.46	0.03	0.12	0	Calculated
SP30	CONDUIT	0 02:36	0.84	1.00	13.37	48.30	0.28	0.42	0	Calculated
SP31	CONDUIT	0 02:37	1.37	1.00	80.75	187.25	0.43	0.53	0	Calculated
SP32	CONDUIT	0 02:37	0.99	1.00	86.55	236.22	0.37	0.54	0	Calculated
SP33	CONDUIT	0 02:37	1.89	1.00	104.19	292.75	0.36	0.38	0	Calculated
SP34	CONDUIT	0 02:35	0.80	1.00	3.00	231.23	0.01	0.08	0	Calculated
SP35	CONDUIT	0 02:36	0.60	1.00	16.53	45.94	0.36	0.66	0	Calculated
SP36	CONDUIT	0 02:37	1.01	1.00	57.09	100.62	0.57	0.55	0	Calculated
SP38	CONDUIT	0 02:31	0.94	1.00	14.22	60.72	0.23	0.41	0	Calculated
SP39	CONDUIT	0 02:29	0.82	1.00	10.68	93.20	0.11	0.24	0	Calculated
SP4	CONDUIT	0 02:37	0.30	1.00	2.63	67.68	0.04	0.27	0	Calculated
SP40	CONDUIT	0 02:35	0.28	1.00	1.70	17.38	0.10	0.38	0	Calculated
SP41	CONDUIT	0 02:38	1.15	1.00	110.72	260.79	0.42	0.80	0	Calculated
SP42	CONDUIT	0 02:40	1.01	1.00	118.59	230.16	0.52	1.00	31	SURCHARGED
SP43	CONDUIT	0 02:37	0.63	1.00	2.27	116.87	0.02	0.10	0	Calculated
SP44	CONDUIT	0 02:39	0.88	1.00	125.65	184.54	0.68	1.00	37	SURCHARGED
SP45	CONDUIT	0 02:39	1.90	1.00	127.99	396.46	0.32	0.52	0	Calculated
SP46	CONDUIT	0 02:36	2.06	1.00	16.57	154.42	0.11	0.17	0	Calculated
SP47	CONDUIT	0 02:36	0.60	1.00	7.53	91.15	0.08	0.23	0	Calculated
SP48	CONDUIT	0 02:34	1.28	1.00	24.04	34.25	0.70	0.59	0	Calculated
SP49	CONDUIT	0 02:32	1.06	1.00	9.77	16.93	0.58	0.52	0	Calculated
SP50	CONDUIT	0 02:36	0.75	1.00	11.84	17.65	0.67	0.83	0	Calculated
SP52	CONDUIT	0 02:37	0.64	1.00	36.84	148.97	0.25	0.53	0	Calculated
SP53	CONDUIT	0 02:37	1.35	1.00	44.52	49.04	0.91	0.78	0	Calculated
SP6	CONDUIT	0 02:36	1.00	1.00	10.93	50.32	0.22	0.32	0	Calculated
SP7	CONDUIT	0 02:34	0.28	1.00	1.13	19.12	0.06	0.28	0	Calculated
SP-77	CONDUIT	0 09:00	1.05	1.00	52.22	218.43	0.24	1.00	375	SURCHARGED
SP8	CONDUIT	0 02:36	0.52	1.00	8.27	52.42	0.16	0.42	0	Calculated
SP9	CONDUIT	0 02:37	1.21	1.00	27.83	48.23	0.58	0.56	0	Calculated
TANK1	DIRECT	0 02:36			66.52					
Tank3	DIRECT	0 02:37			161.24					
HydorBrake-T1	OUTLET	0 05:10			10.07					
HydroBrake2_rev2	OUTLET	0 03:23			18.21					
HydroBrake3_rev2	OUTLET	0 03:23			28.40					

9.4 Graphs


Outflow (lps)
Flow (lps)
Depth (m)
Time (hrs)
1.813
2.72
3.626
4.533
5.44
6.346
7.253
8.159
9.066
9.973

10 Appendix B - Foul Network Design



11 Irish Water Approvals

11.1 Pre-connection COF

Lawlor Burns and Associates C/O, Dylan Casey
HUTCH OMALLEY MCBEATH
THE RAILWAY STATION
PATRICKSWELL
CO LIMERICK

UISCE ÉIREANN : IRISH WATER
Uisce Éireann
Bosca OP 6000
Baile Átha Cliath 1
Éire

Irish Water
PO Box 6000
Dublin 1
Ireland

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

20 September 2018

Dear Sir/Madam,

Re: Customer Reference No 0587989218 pre-connection enquiry - Subject to contract | Contract denied
Connection for 400 no. house units at Raheen, Co. Limerick

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

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

Strategic Housing Development
Irish Water notes that the scale of this development dictates that it is subject to the Strategic Housing Development planning process. Therefore:

A. In advance of submitting your full application to An Bord Pleanala for assessment, you must have reviewed this development with Irish Water and received a Statement of Design Acceptance in relation to the layout of water and wastewater services.
B. You are advised that this correspondence does not constitute an offer in whole or in part to provide a connection to any Irish Water infrastructure and is provided subject to a connection agreement being signed and appropriate connection fee paid at a later date.

This Confirmation of Feasibility to connect to the Irish Water infrastructure also does not extend to your fire flow requirements. In order to determine the potential flow that could be delivered during normal operational conditions, an on site assessment of the existing network is required. Please note that Irish Water cannot guarantee a flow rate to meet fire flow requirements and in order to guarantee a flow to meet the Fire Authority
requirements, you should provide adequate fire storage capacity within your development.

All infrastructure should be designed and installed in accordance with the Irish Water Codes of Practice and Standard Details. A design proposal for the water and/or wastewater infrastructure should be submitted to Irish Water for assessment. Prior to submitting your planning application, you are required to submit these detailed design proposals to Irish Water for review.

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

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

If you have any further questions, please contact John Hennessy from the design team on 022-52256 or email jhennessy@water.ie. For further information, visit **www.water.ie/connections**

Yours sincerely,

Maria O'Dwyer
Connections and Developer Services

11.2 Design Approval

UISCE ÉIREANN | IRISH WATER

Cillian Clair
The Railway Station,
Attyflin Patrickswell,
Co Limerick

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

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

www.water.ie

3 September 2020

Re: Design Submission for SHD Development at Raheen Development (the "Development") (the "Design Submission") / 0587989218.

Dear Cillian Clair,

Many thanks for your recent Design Submission.

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

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

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

If you have any further questions, please contact your Irish Water Representative

Name: Alvaro Garcia
Phone: 022 54623
Email: agarcia@water.ie

Yours sincerely,

Maria O'Dwyer

Connections and Developer Services