



APPENDIX 7-1

SITE-SPECIFIC FLOOD RISK ANALYSIS

Project

Knocknacarra District Centre, Ragoon, Galway

Report Title

Site Specific Flood Risk Assessment

Client

Glenveagh Living Limited

INFRASTRUCTURE



DBFL CONSULTING ENGINEERS



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1.0 INTRODUCTION

1.1 Background

DBFL Consulting Engineers were commissioned by the applicant to prepare a Site Specific Flood Risk Assessment (SSFRA) for the proposed mixed-use development Knocknacarra District Centre, Ragoon, Galway.

1.2 Objectives

The objectives of this report are to inform the planning authority regarding flood risk for the potential development of the lands. The report will assess the site and development proposals in accordance the requirements of “*The Planning System and Flood Risk Management Guidelines for Planning Authorities*”.

The report will provide the following;

- The site’s flood zone category.
- Information to allow an informed decision of the planning application in the context of flood risk.
- Appropriate flood risk mitigation and management measures for any residual flood risk

1.3 Flood Risk Assessment Scope

This SSFRA relates only to the proposed development, Knocknacarra District Centre and its immediate surroundings. This report uses information obtained from various sources, together with an assessment of flood risk for the existing land and proposed development. The report follows the requirements of ‘*The Planning System & Flood Risk Management – Guidelines for Planning Authorities*’, (referred to as the *Guidelines* for the remainder of this report).

1.4 Approach

Chapter 2 of this report considers ‘*The Planning System & Flood Risk Management – Guidelines for Planning Authorities*’ as they relate to the proposed application.

Flood risk identification is presented in Chapter 3 and initial flood risk assessment in Chapter 4. A more detailed assessment of specific flood risk and residual risk relating to the proposed development is presented in Chapter 5.

Conclusions and recommendations are presented in Chapter 6.

1.5 Existing Site

The subject site is located to the North of the Western Distributor Road and is bounded to the west by the existing Gateway Retail Park, which is approximately 2.6 Km from Galway City Centre. The site's southern boundary immediately bounds an Aldi supermarket. The primary school Gaelscoil Mhic Amhlaigh is to the north and residential developments are to the east. Refer to Figure 1.1 for site location.

The site is approximately 2.43Ha and is currently greenfield, however a construction compound is located in the southern end.

The site is within the Specific Local Objective Area of 'Enterprise, Light Industry and Commercial' in the Galway City Council Development Plan 2017-2023.



— Site Boundary

Figure 1.1 - Site Location (Site Boundary Indicative Only).

The topography of the site is generally flat with a 2m fall from the north western corner to the south eastern corner in the northern half of the site, and a 2m fall from the eastern boundary to the western boundary in the southern half of the site as shown in Figure 1.2. A topographical survey of the Site is provided as a background to the proposed site services drawing 180191-3000.



Figure 1.2 – Site Topography.

The subject site is within the Galway Bay North catchment. The Corrib River and the coast are approximately 2.7 Km to the east and 1.8 Km to the south of the subject site respectively.

1.6 Proposed Development

The proposed development consists of the construction of 332 residential units up to 7 storeys with 2667 m² of commercial space including a 174 m² creche at ground floor level. The site will be dissected into Site 1 and Site 2 by the proposed diversion of the existing access road to the Gateway Retail Park, refer to Figure 1.2. A partially under-podium car parking facility will be constructed in Site 2 at ground floor level supplying 85 car parking spaces. A landscaped courtyard podium and a portion of the first floor will be constructed above the car park.

The proposals include the provision of a total of 291 surface cycle stand spaces located at ground level and 386 enclosed bicycle parking stands located at ground level.

2.0 Planning System & Flood Risk Management Guidelines

2.1 General

“The Planning System and Flood Risk Management Guidelines for Planning Authorities”, November 2009 and its Technical Appendices outline the requirements for a site specific flood risk assessment.

Residential development is classified as “highly vulnerable development” according to Table 3.1 of the Guidelines. Table 3.2 of the Guidelines indicates that the Sequential Approach mechanism requires this type of development to be in Flood zone C i.e. outside the 1000 year flood extents. (It may also be compatible within flood zone categories A and B but a Justification Test for development management is then required to determine this.)

2.2 Flood Risk Assessment Stages

This site specific flood risk assessment will initially use existing flood risk information to determine the flood zone category of the Site i.e. to check if the Guidelines Sequential Approach has been applied, see Figure 2.1 below for details.

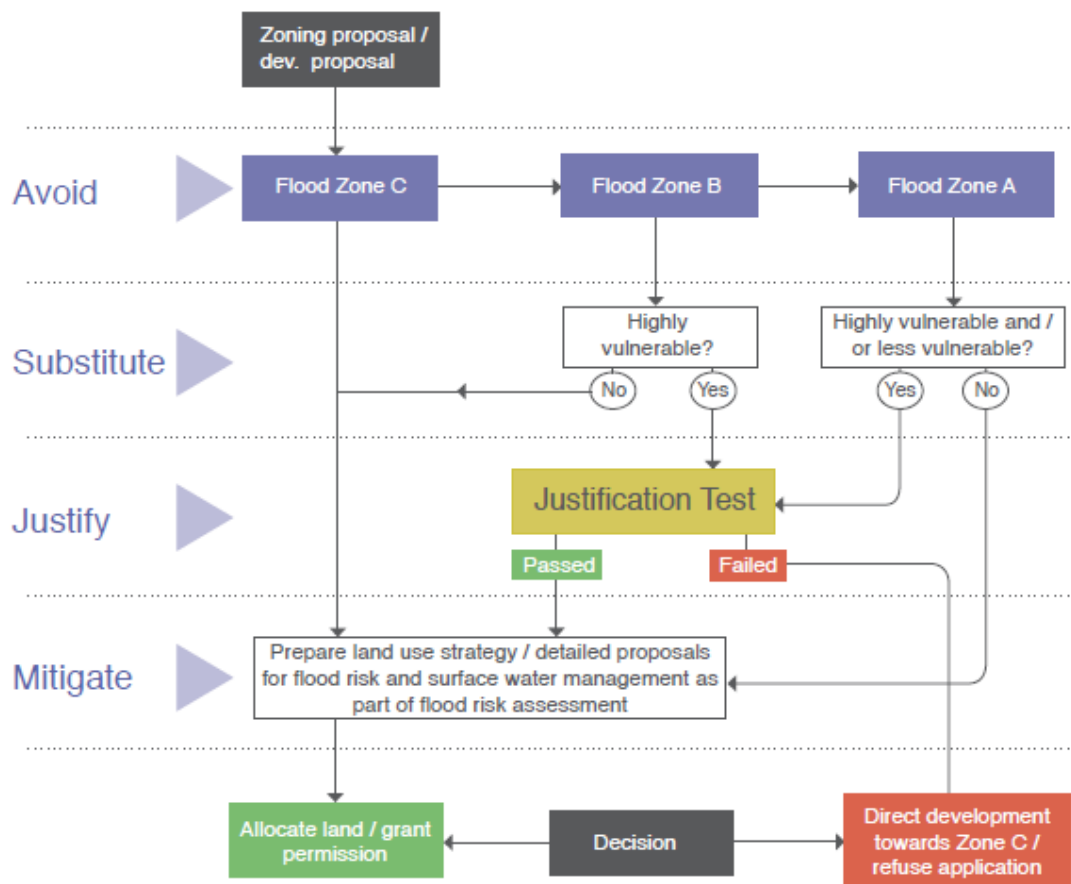


Figure 2.1 – Sequential Approach mechanism in the Planning Process

Flood risk is normally assessed by a flood risk identification stage followed by an initial flood risk assessment. A more detailed flood risk assessment stage then follows which includes an assessment of surface water management, flood risk and mitigation measures to be applied.

The following report sections outline the flood risk assessment stages for the proposed development which follow the requirements of the Guidelines' Technical Appendices.

3.0 Flood Risk Identification Stage

3.1 General

The initial flood risk identification stage uses existing information to identify and confirm whether there may be flooding or surface water management issues for the lands that may warrant further investigation.

3.2 Information Sources Consulted

Information sources consulted for the identification exercise are outlined in table 3.1 below.

Information Source	Comments
Predictive and historic flood maps, and Benefiting Lands Maps, such as those at http://www.floodmaps.ie ;	OPW www.floodmaps.ie website consulted.
Expert advice from OPW who may be able to provide reports containing the results of detailed modelling and flood-mapping studies, including critical drainage areas, and information on historic flood events, including flooding from all sources;	Historic flood hazard maps and info obtained from OPW's floodmaps.ie website
Predictive fluvial flood maps.	Draft PFRA flood extents map consulted.
Previous Strategic Flood Risk Assessments;	Western CFRAM Study.
Topographical maps, in particular digital elevation models produced by aerial survey or ground survey techniques;	OSI Maps consulted & Site topographic survey undertaken.
Information on flood defence condition and performance;	No flood defence information available.
Alluvial deposit maps of the Geological Survey of Ireland (which would allow the potential for the implementation of source control and infiltration techniques, groundwater and overland flood risk to be assessed). These maps, while not providing full coverage, can indicate areas that have flooded in the past (the source of the alluvium) and may be particularly useful at the early stages of the FRA process where no other information is available;	GSI maps consulted.
Walkover survey to assess potential sources of flooding, likely routes for flood waters and the site's key features, including flood defences;	Walkover survey conducted.
National, regional & local spatial plans, such as the National Spatial Strategy, regional planning guidelines, development plans & local area plans provide key information on existing and potential future receptors.	Galway City Council Development Plan 2017-2023 consulted.

Local Information & Local Libraries	Local landowner consulted
'Liable to flood' markings on the old '6 Inch' maps;	Historic OSI maps consulted.

Table 3.1 - Information sources consulted

3.2.1 OPW Predictive, Historic & Benefiting Lands Maps & Flood Hazard Information

From consultation of the OPW website www.floodmaps.ie there were no OPW land commission schemes or benefitting lands zones within the development boundary (see Appendix A for website report).

The OPW floodmaps.ie report shows no previous flood events within 2.5km of the subject site.

3.2.2 Previous Strategic Flood Risk Assessments & Predictive Flood Maps

As part of the EU Floods Directive, the OPW is undertaking a Catchment Flood Risk Assessment and Management (CFRAM) Study. An initial part of this Study was a national Preliminary Flood Risk Assessment (PFRA) to identify areas at risk of significant flooding. The PFRA report and maps are available at www.floodinfo.ie and identify areas deemed to be at risk of flooding (referred to as Areas for Further Assessment, or 'AFAs'), as they require more detailed assessment on the extent and degree of flood risk by the later CFRAM Studies.

The PFRA map for the subject site is reproduced in Appendix B. The flood extents maps indicates that the eastern area of the subject site could be impacted by a potential fluvial flood risk zone. No risk of pluvial or coastal flooding is highlighted on the subject site. It should be noted the OPW PFRA mapping was a high level preliminary flood risk assessment which as outlined in the PFRAM report was based on 'dropping' various depths and intensities of rainfall over a range of durations, and modelling how that rainfall would flow over the land and, in particular, pond in low-lying areas. It is noted in the PFRAM report that due to the level of the analysis undertaken, it did not take into account local drainage structures such as culverts through embankments or other local drainage that would not be resolved in the DTM (digital terrain model) at a national scale.

The Western Catchment Flood Risk Assessment and Management (CFRAM) study provides further assessment of areas identified in the PFRA for further investigation. The subject site's catchment area was not identified in the PFRA for further investigation therefore it is outside the Western CFRAM "Area of Further Assessment" boundary for Galway City.

The Galway City Development Plan Strategic Flood Risk Assessment, 2017-2023 (SFRA) was also consulted to review flood risk. The SFRA was undertaken by JBA Consulting and the scope of the FRA was to provide a broad (wide area) assessment of all types of flood risk to inform strategic land-use planning decisions. The SFRA flood map, provided in Appendix C, indicates that the subject site may be impacted by a potential flood risk zone. It should be noted that the school recently constructed under Reg Ref 15/11 and the school recently granted planning permission under Reg Ref 18/134 to the north of the subject site are within the same potential SFRA flood zone area. From Inspection of the survey levels the area of potential flood risk does not appear to correspond with the existing site levels / topography. We would also note from the SFRA that no further investigative works / revisions were undertaken for this area within Section 8 “Specific Development Site Review” of the SFRA and the site has been zoned CI, “Enterprise, Light Industry and Commercial”.

3.2.3 Tidal Flood Maps

Tidal flooding is not relevant as the subject site is approximately 1.8 Km from the coast and more than 28m above sea level.

3.2.4 Other Sources

Other information sources were consulted to determine if there was any additional flood risk to the subject site, these included:

- Topographical surveys of the area – no evidence based on topography.
- Flood defences Information – no flood defence information available.
- Soil data from EPA and GSI – Soils identified as ‘Mineral poorly drained (Mainly acidic)’ in the central area of the site and as ‘Shallow, rocky, peaty/non-peatymineral complexes (Mainly acidic)’ in the majority of the site. Subsoils identified as ‘Karstified bedrock outcrop or subcrop’ in the south and part of the northern area of the site, and as ‘Till derived from granites’ in the central and northern areas of the site.
- Groundwater information from GSI – Groundwater vulnerability is classified as ‘extreme’ in the central area and north eastern end of the site. The groundwater vulnerability in the rest of the site is classified as ‘Rock at or near surface or Karst’. The bedrock aquifer is identified as ‘Generally unproductive except for Local Zones’.
- Walkover survey – No evidence of flooding within the development lands.
- Development Plan & Local Area plan – lands are within the Specific Local Objective Area of ‘Enterprise, light industry and commercial’.

- EPA Website Watercourse Data – according to this source there are two watercourses adjacent to the subject site. According to the EPA website, one watercourse flows within the site and one watercourse flows to the east of the site, named by the EPA Database as ‘Knocknacarragh’ (see Figure 3.1 below). The location and extents of these watercourses correlate with the fluvial flood risk represented in the PFRA Maps and the Galway City Council Development Plan 2017-2023.

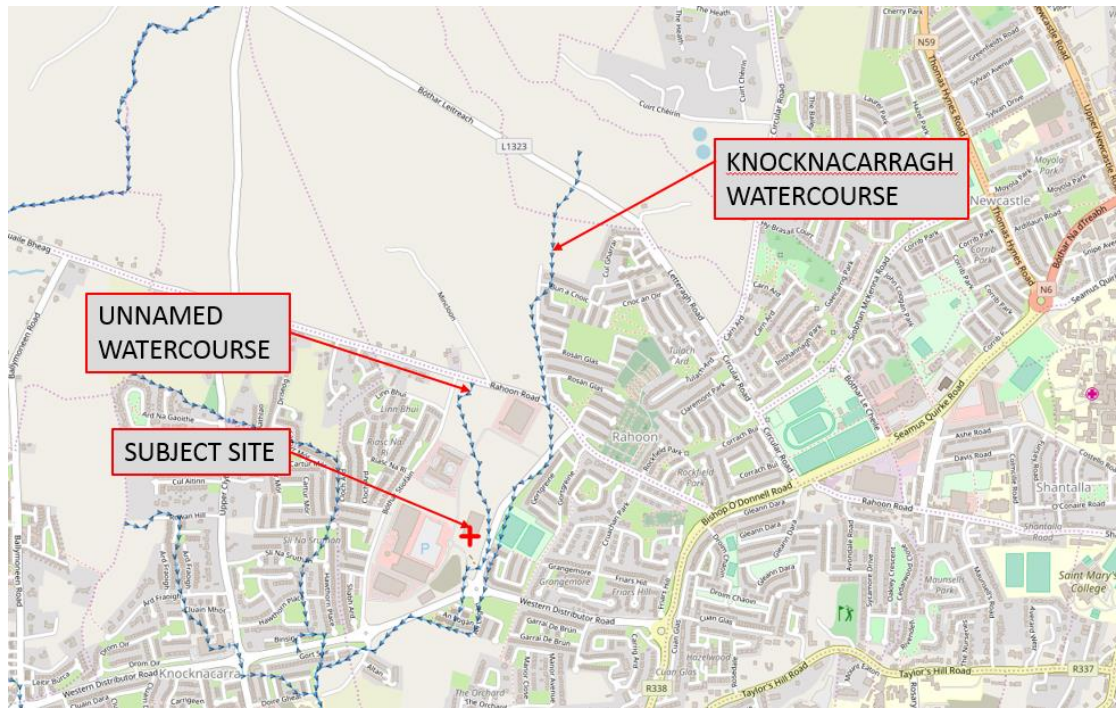


Figure 3.1 - EPA Watercourse

- Existing Local Authority Drainage Records – existing 375mm and 450mm diameter surface water sewers are located to the west of the subject site, which ultimately discharge to the existing 1500mm diameter surface water sewer along the ‘Gort Na Bró’ road to the east of the site. The location of the Knocknacarragh Stream correlates with the location of the 1500mm diameter surface water sewer which appears to have culverted this stream.
- N6 Galway City Ring Road Flood Risk Assessment Study prepared by Hydro Environmental Ltd for the Galway City outer bypass was also consulted. A link road from the proposed ring road is proposed adjacent to the site therefore the flood risk assessment encompasses the potential fluvial flood risk identified in the PFRA Maps and the Galway City Council Development Plan 2017-2023. The study concludes that this fluvial flood risk is not realistic as the EPA historic watercourses no longer exist having been replaced and realigned by a surface water network as part of development in 1996. Hydro Environmental Ltd

modelled the existing storm network shown in Figure 3.2 to confirm that the area is not at risk of flooding. The modelling was carried out using the Microdrainage software program and applying the estimated design flows from the OPW Flood Studies Update (FSU) for the 1000-year storm event at five nodal points (FSU Nodal Point 1 to FSU Nodal Point 5 as shown below). As a result of the modelling the study concluded that the surface water sewer installations have a broad capacity for the 100 year event and there is no existing risk of flooding in the area.

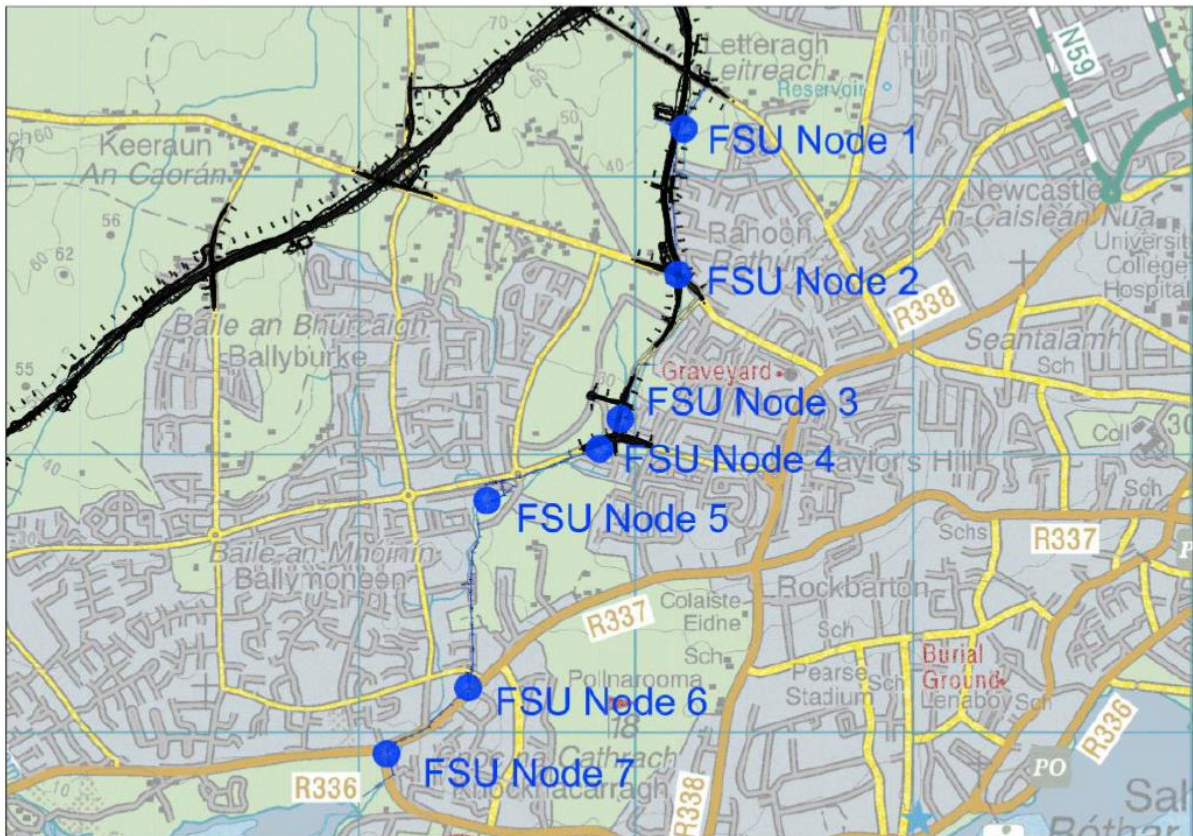


Figure 3.2 – Existing SW drainage modelled by Hydro Environmental Ltd and FSU nodal points.

- Local Information & Local Authority Consultation – a meeting was held by Galway City Council with DBFL Consulting Engineers on the 30th November 2018 to discuss the proposed development in relation to drainage and potential flood risks in the subject site based on the information available. Galway City Council concluded that the PFRA mapping and the SFRA mapping did not take account of the site-specific features and therefore the site is not considered to be at risk of fluvial flooding.
- Historic Maps – no evidence of flooding or marsh areas within the Site.

From a review of the 'other sources' above there does not appear to be evidence of flood risk to the development lands.

3.3 Source-Pathway-Receptor Model

A Source-Pathway-Receptor model was produced to summarize the possible sources of floodwater, the people and assets (receptors) that could be affected by potential flooding (with specific reference to the proposals) and the pathways by which flood water for a 0.1%AEP (Annual Exceedance Probability) and 1%AEP storms could reach the receptors, see table 3.1. It provides the probability and magnitude of the sources, the performance and response of pathways and the consequences to the receptors in the context of the LAP development proposals. These sources, pathways and receptors will be assessed further by the initial flood risk assessment stage.

Source	Pathway	Receptor	Likelihood	Consequence	Risk
Tidal	Tidal flooding from coast (1.8 Km away from subject site).		Remote		
Fluvial	Overbank existing streams and rivers.	Future development.	Low	Medium	Low
Surface Water Drainage (Pluvial)	Flooding from development's surcharging drainage systems	Future development.	Possible	Medium	Moderate
Groundwater flooding	Rising GWL on the site		Remote		
Human or Mechanical Error (Pluvial)	New drainage network blocks	Development draining to the surface water network	Possible	Medium	Moderate

Table 3.2 - Source-pathway-receptor analysis

4.0 Initial Flood Risk Assessment Stage

The only flood risks to the proposed development at Knocknacarra identified from Stage 1 are;

- A low risk of fluvial flooding;
- Pluvial flood risk following development.

4.1 Initial Fluvial Flood Risk Assessment

The PFRA flood extents map and the Galway City Council Development Plan 2017-2023 identified a potential fluvial flooding risk on the eastern area of the site. The flood risk extents correlate with two watercourses represented within the subject site in the EPA Maps, including the Knocknacarragh Watercourse to the east of the site.

Following a similar approach as in the N6 Galway City Ring Road Flood Risk Assessment Study carried out by Hydro Environmental Ltd, DBFL Consulting Engineers have modelled the existing surface water drainage to demonstrate that there is no fluvial flood risk within or in the immediate surroundings of the subject site. See Appendix D for extent of drainage modelling.

The drainage modelling was completed using the Microdrainage software programme and utility records obtained from Galway City Council, which included invert and cover levels of the surface water sewer network. The design flows inputted into the model for the 100 year event were calculated using the Qmed and growth factors estimation tool from the OPW Flood Studies Update (FSU) Web Portal, similar to the N6 Galway City Ring Road Flood Risk Assessment Study. Figure 4.1 and Table 4.1 below summarize the growth factors and Qmed values obtained from the OPW FSU Web Portal, and the design flows calculated for various return periods respectively.

It is noted that two sewer lines within the surface water drainage model have a capacity lower than the design flows calculated for 100 year return period. However, a simulation of the drainage modelled for the critical storm, accounting for an additional 10% flow for climate change, indicate that the water levels in the two sewers do not surpass the existing cover levels. The Microdrainage modelling and simulation results (refer to Appendix D) show that the existing surface water drainage adjacent to the subject site have sufficient capacity to accommodate the 100 year critical storm event. Therefore, it can be concluded that the surface water sewer installations have capacity for the 100 year storm event and the potential flood risk identified by the PFRAM mapping and the Galway City Council Development Plan can be discounted.

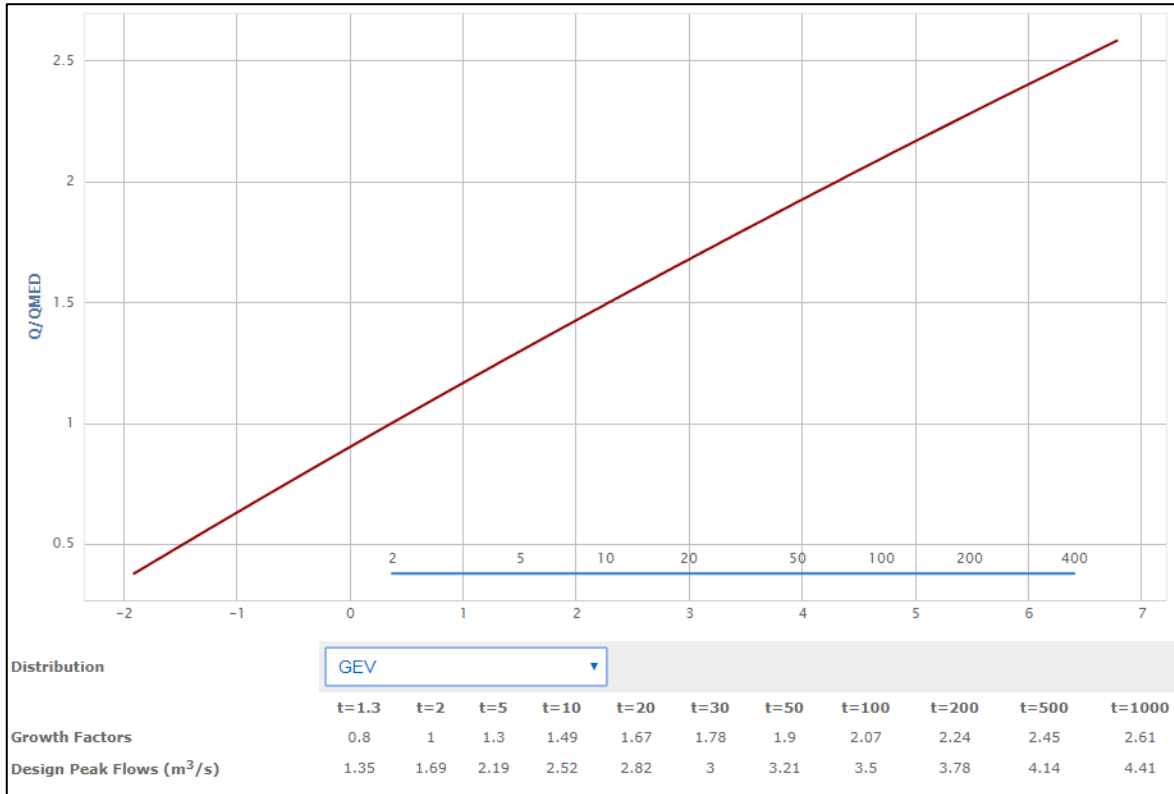


Figure 4.1 – Growth factors from FSU Web Portal.

Return Period	Growth Factor	Design Flow (m ³ /s)				
		Node 1	Node 2	Node 3	Node 4	Node 5
Qmed (Urban Estimate)	-	0.315	0.426	0.741	0.931	1.998
Q5	1.3	0.41	0.553	0.964	1.211	2.598
Q10	1.49	0.47	0.635	1.104	1.39	2.98
Q20	1.67	0.53	0.711	1.24	1.55	3.34
Q50	1.9	0.6	0.81	1.41	1.77	3.8
Q100	2.07	0.652	0.882	1.533	1.93	4.14

Table 4.1 – Design flows.

4.2 Initial Pluvial Flood Risk Assessment

The Source-Pathway-Receptor model identified that there could be potential for pluvial flood risk within the development related to future drainage networks to serve the proposed development. These have potential to cause local flooding unless they are designed in accordance with the regulations e.g. GDSDS and to take account of flood exceedance e.g. for storms return periods over 1%AEP.

The Source-Pathway-Receptor model also identified that the proper operation and maintenance of the drainage system is necessary to reduce the risk of human or mechanical error causing pluvial flood risk from blockages etc.

4.3 Flood Zone Category

Following assessment of the flood risks to the Site and available flood data it is considered that the Site is within Flood Zone Category C as defined by the Guidelines. The type of development proposed is therefore appropriate for this flood zone category. The Guidelines Sequential Approach is therefore met and the 'Avoid' principal achieved.

5.0 Detailed Flood Risk Assessment Stage

5.1 General

Since the type of development proposed is appropriate for the Flood zone category of the Site, the detailed flood risk assessment stage will only consider pluvial flood risk in relation to the following;

- Proposed Surface Water Management measures.
- Flood Exceedance.
- Impact of proposals on flood risk to adjacent areas.
- Effects of climate change.
- Sustainable Urban Structure.
- Residual risks.
- Effectiveness of any flood mitigation measures.

5.2 Surface Water Management

The proposed storm-water proposals and drainage design for the development are designed in accordance with the GDSDS. The proposals include SUDS measures to reduce the runoff for the development including a landscaped podium with planting in Site 2, and part of the civic plaza paved with porous asphalt in Site 1. One Stormtech attenuation tank and one concrete storage tank are proposed for Site 1 and Site 2 respectively to accommodate the 100 year critical storm plus a 10% climate change provision. The concrete tank storage system accommodating surface water from Site 2 will be located under the ground floor car park.

5.2.1 Sustainable Urban Drainage System Proposals

The SUDS proposals for the development include;

- One concrete attenuation tank under the ground floor car park in Site 2 to provide storage (172 m³).
- One Stormtech attenuation tank in Site 1 to provide storage (361m³).
- A landscaped courtyard with green areas and raised planters in Site 2 to provide interception storage and treatment.
- An area within the civic plaza in Site 1 paved with porous asphalt to provide interception storage and treatment.
- A Class 1 Bypass Separators to be provided on the outfall from each network.

5.2.2 Surface Water Attenuation and Storage

Storm-water attenuation for the development has been sized in accordance with the requirements of the GDSDS. Run-off rates from the proposed development to the public system are in accordance with the GDSDS.

5.3 Flood Exceedance

For storms greater than the 1%AEP pluvial event, the development's drainage network design will be exceeded. The falls of the ground floor car park in Site 2 and the proposed diverted access road to the development will be designed to route flood water away from building core entry points in direction to the drainage outfall. The falls within the pedestrian and civic amenities areas in Site 1 will also divert the flood water to the drainage outfall. Refer to Appendix E for overland flow routes.

Building floor levels are set a minimum of 0.5m above 100-year flood level in accordance with recommended minimum freeboards.

5.4 Impact on Adjacent Areas

Adjacent areas will not be impacted by the development for up to the 1%AEP flood event, however if larger storms >1%AEP exceed the capacity of the development's drainage system then overland flood routes may be directed towards existing and proposed roads.

5.5 Climate Change

The potential impact of climate change has been allowed for as follows;

- Pluvial flood risk - drainage system and attenuation storage design allow for a 10% increase in rainfall intensities, as recommended by the GDSDS.

5.6 Sustainable Urban Structure

5.6.1 Access & egress during flood events

The access and egress arrangements for the development are via the proposed diversion of the existing access road to the retail park. Based on relevant flood modelling undertaken above, it is anticipated that for a 0.1% AEP flood event the development can be safely accessed and exited through the proposed vehicular entrance.

5.7 Residual Risks

Remaining residual flood risks, following the detailed assessment include the following;

1. Pluvial flooding from the private drainage system related to a pipe blockage or from flood exceedance.
2. Pluvial flooding from the development's drainage system for storms in excess of the 100 year design capacity.

5.8 Mitigation Measures

Proposed mitigation measures to address residual flood risks are summarized below;

M1. Proposed drainage system to be maintained on a regular basis to reduce the risk of a blockage.

M2. In the event of storms exceeding the 100-year design capacity of the drainage system, flood water will be routed away from buildings.

5.8.1 Effectiveness of Mitigation Measures

It is considered that the flood risk mitigation measures if implemented are sufficient to provide a suitable level of protection to the proposed development. A regularly maintained drainage system will ensure that it remains effective and in good working order should a large pluvial storm occur.

Should extreme pluvial flooding occur that is in excess of the development's drainage capacity i.e. probability less than 1%AEP, then overland flood routes to the drainage outfall should protect the development. Refer to Appendix E for overland flow routes.

6.0 Conclusions

The Site Specific Flood Risk Assessment for the proposed development at Knocknacarra was undertaken in accordance with the requirements of the Planning System and Flood Risk Management Guidelines for Planning Authorities”, November 2009.

Following the flood risk assessment stages it was determined that the Site is within Flood Zone C as defined by the Guidelines.

It is concluded that the;

- Residential development proposed is appropriate for the Site’s flood zone category.
- Planning System and Flood Risk Management Guidelines Sequential Approach is met and the ‘Avoid’ principal achieved.
- A Justification Test is not required as the site is in Flood Zone C.

The development was concluded as having a good level of flood protection up to the 100 year return event. For pluvial floods exceeding the 100 year capacity of the drainage system then the proposed flood routing mitigation measures should protect the areas with lower finish floor levels by directing flood water to the drainage outfall.

Appendix A

OPW FLOOD HAZARD WEBSITE REPORT

Summary Local Area Report

This Flood Report summarises all flood events within 2.5 kilometres of the map centre.

The map centre is in:

County: Galway

NGR: M 270 250

This Flood Report has been downloaded from the Web site www.floodmaps.ie. The users should take account of the restrictions and limitations relating to the content and use of this Web site that are explained in the Disclaimer box when entering the site. It is a condition of use of the Web site that you accept the User Declaration and the Disclaimer.



Map Scale 1:13,976

Map Legend	
	Flood Points
	Multiple / Recurring Flood Points
	Areas Flooded
	Hydrometric Stations
	Rivers
	Lakes
	River Catchment Areas
	Land Commission *
	Drainage Districts *
	Benefiting Lands *

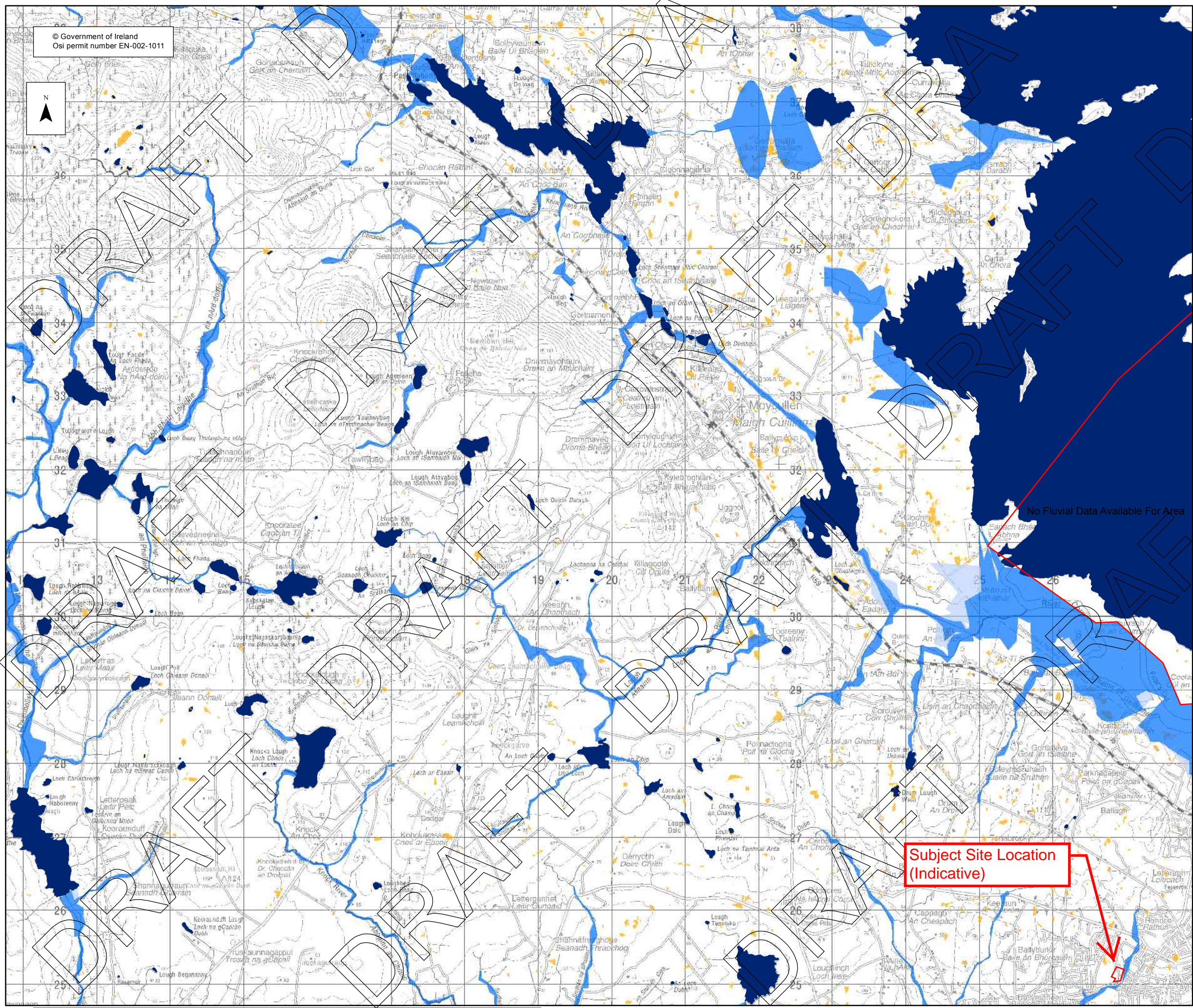
* Important: These maps do not indicate flood hazard or flood extent. Their purpose and scope is explained in the Glossary.

0 Results

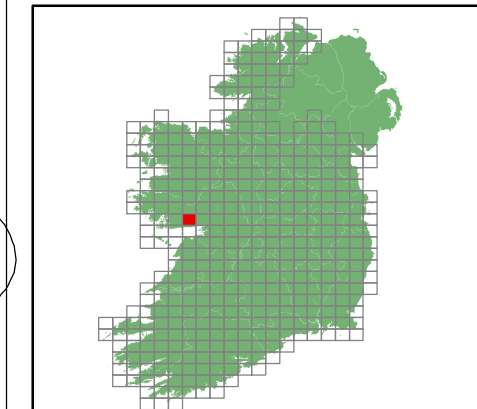
Appendix B

PRELIMINARY FLOOD RISK ASSESSMENT MAP

© Government of Ireland
Osi permit number EN-002-1011



Location Plan :



Legend:

Flood Extents

- Fluvial - Indicative 1% AEP (100-yr) Event
- Fluvial - Extreme Event
- Coastal - Indicative 0.5% AEP (200-yr) Event
- Coastal - Extreme Event
- Pluvial - Indicative 1% AEP (100-yr) Event
- Pluvial - Extreme Event
- Groundwater Flood Extents
- Lakes / Turloughs

PFRA Outcomes

- Probable Area for Further Assessment
- Possible Area for Further Assessment

Important User Note:

The flood extents shown on these maps are based on broad-scale simple analysis and may not be accurate for a specific location. Information on the purpose, development and limitations of these maps is available in the relevant reports (see www.cfram.ie). Users should seek professional advice if they intend to rely on the maps in any way.

If you believe that the maps are inaccurate in some way please forward full details by contacting the OPW (refer to PFRA Information leaflets or 'Have Your Say' on www.cfram.ie).

Office of Public Works
Jonathon Swift Street
Trim
Co Meath
Ireland



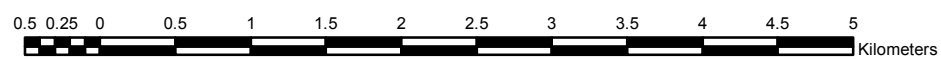
Project :
PRELIMINARY FLOOD RISK ASSESSMENT (PFRA)

Map :
PFRA Indicative extents and outcomes
- Draft for Consultation

Figure By : PJW Date : July 2011
Checked By : MA Date : July 2011

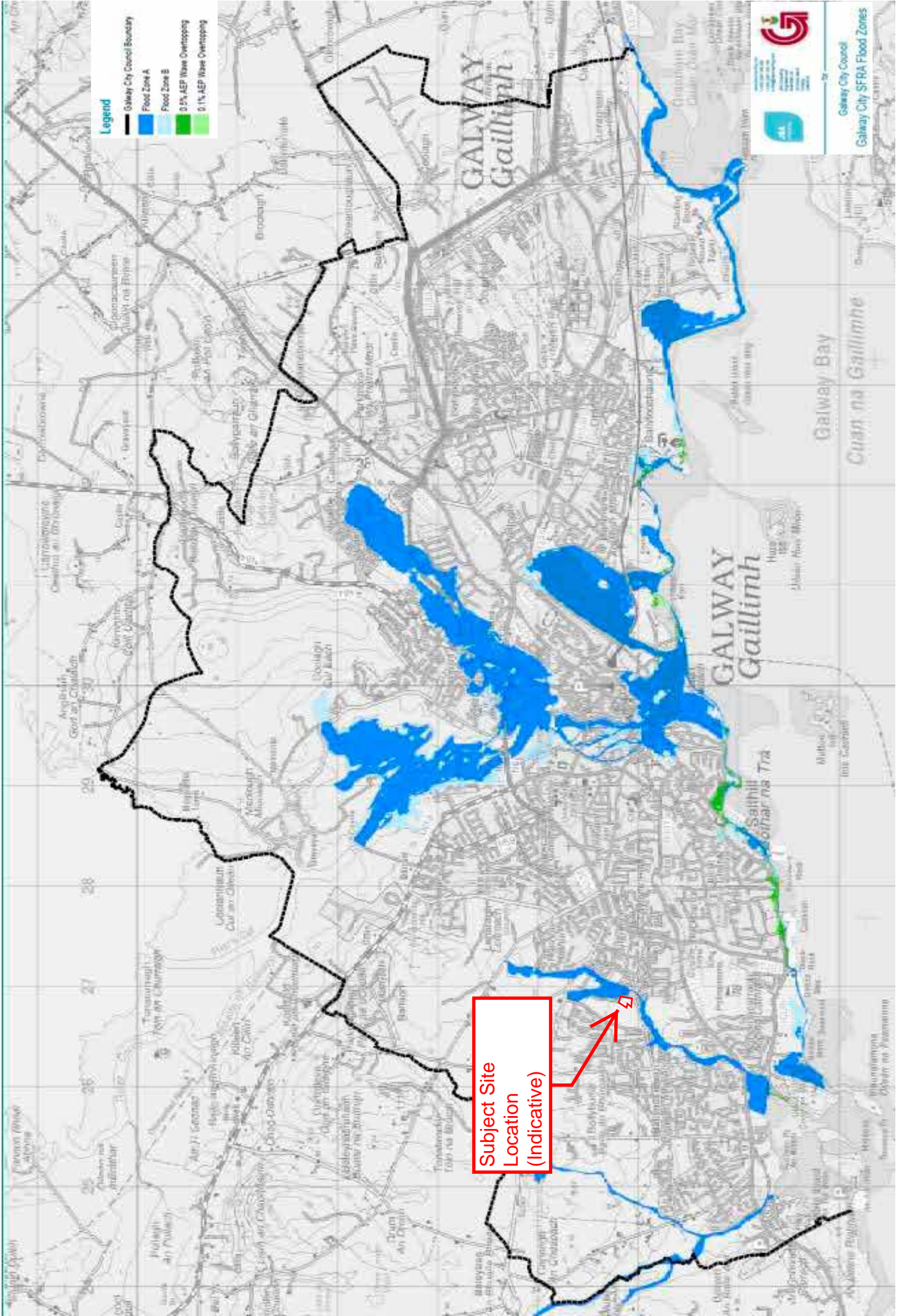
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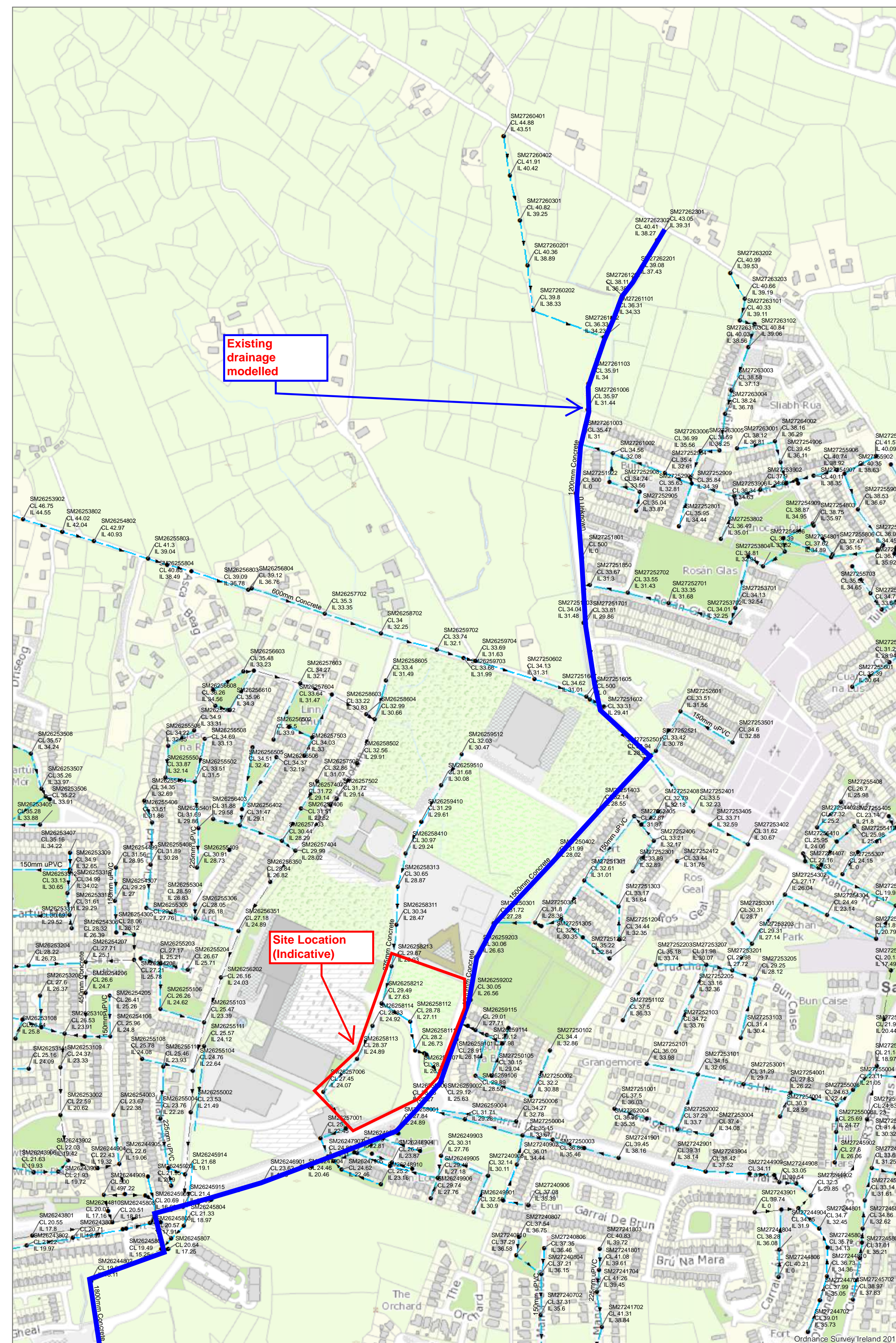
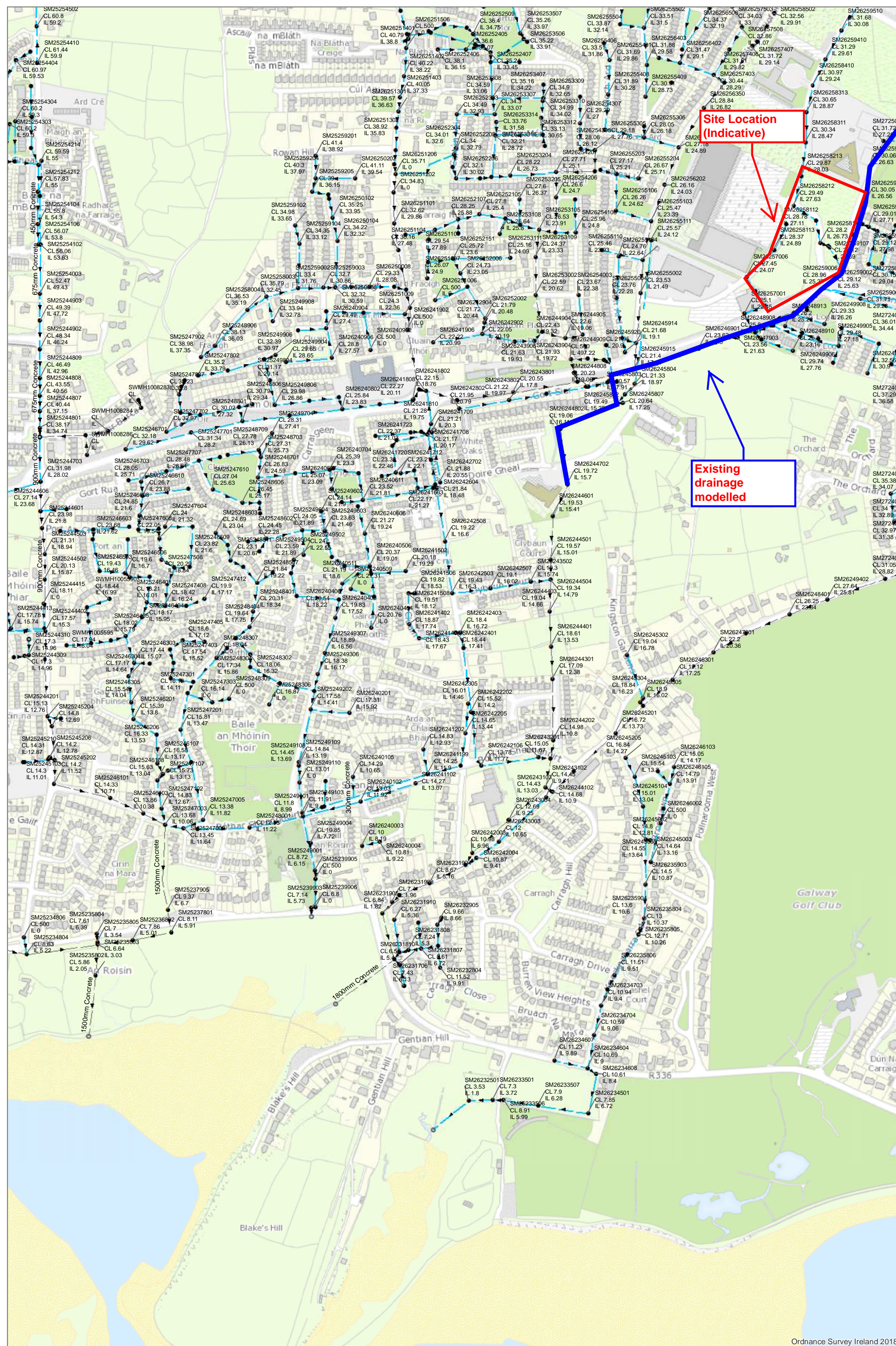
Appendix C

GALWAY CITY COUNCIL DEVELOPMENT PLAN 2017-2023 FLOOD MAP



Appendix D

MICRODRAINAGE EXISTING DRAINAGE MODELLING AND SIMULATION FOR THE 100 YEAR STORM EVENT



Legend

Storm Manholes

Manhole Type

- Standard
- Backdrop
- Cascade
- Catchpit
- Bifurcation
- Hatchbox
- Lampole
- Hydrobrake
- Other; Unknown

Storm Discharge Points

Discharge Type

- Outfall
- Overflow
- Soakaway
- Other; Unknown

Surface Gravity Mains

Surface Gravity Mains Private

Surface Water Pressurised Mains

Surface Water Pressurised Mains Private

Storm Inlets

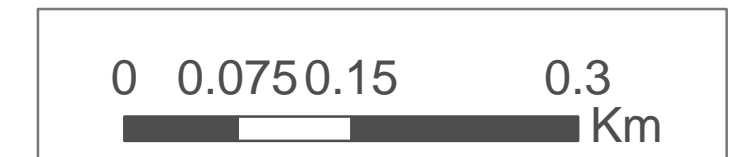
Inlet Type

- Gully
- Standard
- Other; Unknown

Storm Culverts

Storm Open Drains

Storm Detention Areas




Coordinate System: TM65 Irish Grid
Projection: Transverse Mercator

Scale @ A1:	1:5,000
Drawing No.:	DBLF-0119
Drawn By:	JS
Checked By:	.
Approved By:	.
Drawn Date	14/01/2019
Checked Date:	.
Approved Date:	.

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

Stormwater Sewers Knocknacarra Area Information Request DBLF Consulting

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD












FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	16.000	Add Flow / Climate Change (%)	0
Ratio R	0.261	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	100	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits


Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	14.180	1.038	13.7	0.000	4.00	652.0	0.600	o	600	Pipe/Conduit	
1.001	65.230	0.844	77.3	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.002	29.600	1.046	28.3	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.003	36.800	2.050	18.0	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.004	33.064	0.100	330.6	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.005	67.380	0.230	293.0	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.006	29.600	1.960	15.1	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.007	62.000	0.440	140.9	0.000	0.00	0.0	0.600	o	1200	Pipe/Conduit	
1.008	68.200	0.316	215.8	0.000	0.00	0.0	0.600	o	1200	Pipe/Conduit	
1.009	93.600	0.444	210.8	0.000	0.00	0.0	0.600	o	1200	Pipe/Conduit	
1.010	95.700	0.080	1196.3	0.000	0.00	0.0	0.600	o	1500	Pipe/Conduit	























Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E I.Area (ha)	E Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.39	4.04	39.308	0.000	652.0	0.0	0.0	6.61	1869.3	652.0
1.001	48.86	4.43	38.270	0.000	652.0	0.0	0.0	2.77	783.8	652.0
1.002	48.46	4.54	37.426	0.000	652.0	0.0	0.0	4.59	1297.7	652.0
1.003	48.07	4.64	36.380	0.000	652.0	0.0	0.0	5.77	1630.2	652.0
1.004	46.64	5.06	34.330	0.000	652.0	0.0	0.0	1.33	377.1«	652.0
1.005	44.17	5.85	34.230	0.000	652.0	0.0	0.0	1.42	400.8«	652.0
1.006	43.94	5.93	34.000	0.000	652.0	0.0	0.0	6.29	1777.7	652.0
1.007	43.03	6.25	31.440	0.000	652.0	0.0	0.0	3.15	3562.6	652.0
1.008	41.85	6.70	31.000	0.000	652.0	0.0	0.0	2.54	2875.8	652.0
1.009	40.38	7.31	30.684	0.000	652.0	0.0	0.0	2.57	2910.0	652.0
1.010	37.64	8.60	29.940	0.000	652.0	0.0	0.0	1.23	2176.0	652.0

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.011	87.600	0.120	730.0	0.000	0.00	0.0	0.600	o	1500	Pipe/Conduit	
1.012	40.720	0.330	123.4	0.000	0.00	230.0	0.600	o	1500	Pipe/Conduit	
1.013	94.300	0.460	205.0	0.000	0.00	0.0	0.600	o	1500	Pipe/Conduit	
1.014	99.500	0.400	248.8	0.000	0.00	0.0	0.600	o	1500	Pipe/Conduit	
1.015	99.000	0.530	186.8	0.000	0.00	0.0	0.600	o	1500	Pipe/Conduit	
1.016	123.900	0.740	167.4	0.000	0.00	0.0	0.600	o	1500	Pipe/Conduit	
1.017	55.500	0.650	85.4	0.000	0.00	0.0	0.600	o	1500	Pipe/Conduit	
1.018	62.400	0.070	891.4	0.000	0.00	0.0	0.600	o	1500	Pipe/Conduit	
1.019	40.800	0.260	156.9	0.000	0.00	0.0	0.600	o	1500	Pipe/Conduit	
1.020	20.000	0.160	125.0	0.000	0.00	0.0	0.600	o	1500	Pipe/Conduit	
1.021	63.800	0.510	125.1	0.000	0.00	651.0	0.600	o	1500	Pipe/Conduit	
1.022	48.470	0.360	134.6	0.000	0.00	0.0	0.600	o	1500	Pipe/Conduit	
1.023	46.780	0.380	123.1	0.000	0.00	0.0	0.600	o	1500	Pipe/Conduit	
1.024	109.500	3.720	29.4	0.000	0.00	397.0	0.600	o	1500	Pipe/Conduit	
1.025	40.000	0.710	56.3	0.000	0.00	0.0	0.600	o	1500	Pipe/Conduit	
1.026	58.700	0.960	61.1	0.000	0.00	0.0	0.600	o	1500	Pipe/Conduit	
1.027	80.300	1.180	68.1	0.000	0.00	0.0	0.600	o	1500	Pipe/Conduit	
1.028	42.000	0.730	57.5	0.000	0.00	0.0	0.600	o	1500	Pipe/Conduit	
1.029	40.800	0.610	66.9	0.000	0.00	0.0	0.600	o	1500	Pipe/Conduit	
1.030	4.034	0.020	201.7	0.000	0.00	0.0	0.600	o	1800	Pipe/Conduit	
1.031	50.000	0.410	122.0	0.000	0.00	0.0	0.600	o	1800	Pipe/Conduit	
1.032	111.200	0.140	794.3	0.000	0.00	2210.0	0.600	o	1800	Pipe/Conduit	


Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E I.Area (ha)	E Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.011	35.95	9.53	29.860	0.000	652.0	0.0	0.0	1.58	2791.6	652.0
1.012	35.65	9.70	29.740	0.000	882.0	0.0	0.0	3.86	6822.3	882.0
1.013	34.79	10.23	29.410	0.000	882.0	0.0	0.0	2.99	5287.9	882.0
1.014	33.86	10.84	28.950	0.000	882.0	0.0	0.0	2.72	4798.3	882.0
1.015	33.10	11.36	28.550	0.000	882.0	0.0	0.0	3.14	5540.7	882.0
1.016	32.26	11.99	28.020	0.000	882.0	0.0	0.0	3.31	5853.5	882.0
1.017	32.00	12.19	27.280	0.000	882.0	0.0	0.0	4.64	8206.1	882.0
1.018	31.10	12.92	26.630	0.000	882.0	0.0	0.0	1.43	2524.2	882.0
1.019	30.86	13.11	26.560	0.000	882.0	0.0	0.0	3.42	6047.1	882.0
1.020	30.76	13.20	26.300	0.000	882.0	0.0	0.0	3.84	6778.2	882.0
1.021	30.44	13.48	26.140	0.000	1533.0	0.0	0.0	3.83	6775.5	1533.0
1.022	30.20	13.70	25.630	0.000	1533.0	0.0	0.0	3.70	6530.2	1533.0
1.023	29.98	13.90	25.270	0.000	1533.0	0.0	0.0	3.87	6830.3	1533.0
1.024	29.73	14.13	24.890	0.000	1930.0	0.0	0.0	7.92	13992.6	1930.0
1.025	29.61	14.25	21.170	0.000	1930.0	0.0	0.0	5.72	10107.8	1930.0
1.026	29.42	14.42	20.460	0.000	1930.0	0.0	0.0	5.49	9701.3	1930.0
1.027	29.16	14.68	19.500	0.000	1930.0	0.0	0.0	5.20	9194.8	1930.0
1.028	29.03	14.80	18.320	0.000	1930.0	0.0	0.0	5.66	10001.9	1930.0
1.029	28.90	14.93	17.590	0.000	1930.0	0.0	0.0	5.25	9274.7	1930.0
1.030	28.89	14.95	16.680	0.000	1930.0	0.0	0.0	3.37	8581.3	1930.0
1.031	28.70	15.15	16.660	0.000	1930.0	0.0	0.0	4.34	11045.5	1930.0
1.032	27.68	16.24	16.250	0.000	4140.0	0.0	0.0	1.69	4308.2	4140.0

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.033	98.840	0.410	241.1	0.000	0.00	0.0	0.600	o	1800	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.033	27.22	16.78	16.110	0.000	4140.0	0.0	0.0	3.08	7846.5	4140.0

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

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.261
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 16.000 Cv (Winter) 0.840

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600,
720, 960, 1440, 2160, 2880, 4320, 5760, 7200,
8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 10, 10, 10


PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	S1	10080 Winter	1	+10%					39.657
1.001	S2	10080 Winter	1	+10%					38.722
1.002	S3	10080 Winter	1	+10%					37.794
1.003	S4	10080 Winter	1	+10%					36.685
1.004	S5	10080 Winter	1	+10%	1/15 Summer				35.752
1.005	S6	10080 Winter	1	+10%	1/15 Summer				35.315
1.006	S7	10080 Winter	1	+10%					34.287
1.007	S8	10080 Winter	1	+10%					31.841
1.008	S9	10080 Winter	1	+10%					31.439
1.009	S10	10080 Winter	1	+10%					31.101
1.010	S11	5760 Winter	1	+10%					30.577
1.011	S12	5760 Winter	1	+10%					30.423
1.012	S13	5760 Winter	1	+10%					30.241
1.013	S14	5760 Winter	1	+10%					29.871
1.014	S15	5760 Winter	1	+10%					29.428
1.015	S16	5760 Winter	1	+10%					28.995
1.016	S17	5760 Winter	1	+10%					28.442

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

PN	US/MH Name	Surcharged Flooded		Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
		Depth (m)	Volume (m³)					
1.000	S1	-0.251	0.000	0.64		652.0	OK	
1.001	S2	-0.148	0.000	0.92		652.0	OK	
1.002	S3	-0.232	0.000	0.64		652.0	OK	
1.003	S4	-0.295	0.000	0.48		652.0	OK	
1.004	S5	0.822	0.000	2.09		652.0	SURCHARGED	
1.005	S6	0.485	0.000	1.80		652.0	SURCHARGED	
1.006	S7	-0.313	0.000	0.46		652.0	OK	
1.007	S8	-0.799	0.000	0.25		652.0	OK	
1.008	S9	-0.761	0.000	0.29		652.0	OK	
1.009	S10	-0.783	0.000	0.26		652.0	OK	
1.010	S11	-0.863	0.000	0.33		652.0	OK	
1.011	S12	-0.937	0.000	0.29		652.0	OK	
1.012	S13	-0.999	0.000	0.25		882.0	OK	
1.013	S14	-1.039	0.000	0.21		882.0	OK	
1.014	S15	-1.022	0.000	0.22		882.0	OK	
1.015	S16	-1.055	0.000	0.19		882.0	OK	
1.016	S17	-1.078	0.000	0.18		882.0	OK	

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surchage	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.017	S18	5760 Winter	1	+10%					27.699
1.018	S19	5760 Winter	1	+10%					27.345
1.019	S20	5760 Winter	1	+10%					27.074
1.020	S21	5760 Winter	1	+10%					26.814
1.021	S22	5760 Winter	1	+10%					26.744
1.022	S23	5760 Winter	1	+10%					26.295
1.023	S24	5760 Winter	1	+10%					25.925
1.024	S25	5760 Winter	1	+10%					25.296
1.025	S26	5760 Winter	1	+10%					21.796
1.026	S27	5760 Winter	1	+10%					21.035
1.027	S28	5760 Winter	1	+10%					20.042
1.028	S29	5760 Winter	1	+10%					18.941
1.029	S30	5760 Winter	1	+10%					18.242
1.030	S31	10080 Summer	30	+10%					18.103
1.031	S32	8640 Summer	100	+10%					18.087
1.032	S33	1440 Winter	1	+10%	1/360 Summer				18.050
1.033	S34	8640 Summer	100	+10%					17.241

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m ³)	Flow / Cap. (l/s)	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.017	S18	-1.081	0.000	0.17		882.0	OK	
1.018	S19	-0.785	0.000	0.46		882.0	OK	
1.019	S20	-0.986	0.000	0.26		882.0	OK	
1.020	S21	-0.986	0.000	0.26		882.0	OK	
1.021	S22	-0.896	0.000	0.34		1533.0	OK	
1.022	S23	-0.835	0.000	0.41		1533.0	OK	
1.023	S24	-0.845	0.000	0.40		1533.0	OK	
1.024	S25	-1.094	0.000	0.16		1930.0	OK	
1.025	S26	-0.874	0.000	0.37		1930.0	OK	
1.026	S27	-0.925	0.000	0.31		1930.0	OK	
1.027	S28	-0.958	0.000	0.28		1930.0	OK	
1.028	S29	-0.879	0.000	0.36		1930.0	OK	
1.029	S30	-0.848	0.000	0.39		1930.0	OK	
1.030	S31	-0.377	0.000	0.90		1932.6	OK	
1.031	S32	-0.373	0.000	0.33		1932.5	OK	
1.032	S33	0.000	0.000	1.19		4143.4	SURCHARGED	
1.033	S34	-0.669	0.000	0.72		4140.1	OK	

Appendix E

OVERLAND FLOW ROUTES

