AMIL PROPERTIES LTD

PROPOSED RESIDENTIAL DEVELOPMENT AT

CREAGH DEMENSE, GOREY, CO WEXFORD

SITE SPECIFIC FLOOD RISK ASSESSMENT

IE CONSULTING
WATER-ENVIRONMENTAL-CIVIL
Integrated Engineering Consulting

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1 Introduction

IE Consulting was requested by Strutec Ltd, on behalf of AMIL Properties Ltd., to undertake a Site Specific Flood Risk Assessment (SSFRA) for a proposed development site at Creagh Demesne, Gorey, Co. Wexford. It is proposed to construct a 297 unit residential development, crèche and all associated infrastructure works at the site.

The purpose of this SSFRA is to assess the potential flood risk to the proposed development site and to assess the impact that development of the site may or may not have on the hydrological regime of the area.

A hydrological engineer from IE Consulting undertook a survey of the site area and surrounding catchment on the 31st January 2018.

Quoted ground levels or estimated flood levels relate to Ordnance Datum (Malin) unless stated otherwise.

This flood risk assessment study has been undertaken in consideration of the following guidance document:-

'The Planning System and Flood Risk Management – Guidelines for Planning Authorities' DOEHLG 2009.

1.1 An Bord Pleanála Inspector's Report and Opinion

Following the Pre-Application Consultation with An Bord Pleanála on the 28th of May 2018 the Inspector's Report and the Board's Opinion was provided. In relation to flood risk the following was included under Point 5:

5. Surface Water Management and Risk of Flooding

Further consideration of documents as they relate to the potential for increased risk of flooding in the wider area having particular regard to the potential for displaced waters due to any infrastructural network upgrade works required to facilitate the development. Any surface water management proposals should be considered in tandem with any Flood Risk Assessment, which should In turn accord with the requirements of 'The Planning System and Flood Risk Management Guidelines' (including the associated 'Technical Appendices'). Further consideration of these issues may require an amendment to the documents and/or design proposals submitted. The prospective applicant is advised to liaise with the planning authority regarding surface/storm water proposals prior to making an application.

In response to the above statement the proposed storm and foul infrastructure upgrades located outside the applicant's lands have been incorporated into the Site Specific Flood Risk Assessment herein. In addition, the potential hydrological impact of the surface water management proposals for the site has also been considered as part of this assessment. The design proposals have been amended to take account of the potential impact of flood risk on the foul infrastructure proposed.

The planning authority has been consulted in relation to the surface water proposals for the site. They have confirmed that they are satisfied with the surface water management proposals. These proposals are discussed in further detail in the Engineering Report.

2 Proposed Site Description

2.1 General

The proposed development site is located at Creagh Demense, Gorey, Co. Wexford. The total area of the site is 13.236 hectares, which is divided into three areas as follows:

- Main Development Site area = 10.376 ha
- Area zoned for Community and Education = 1.818 ha
- Area for proposed foul and storm pipes outside applicant lands = 1.034 ha

The main development site area is bounded to the north by zoned residential land (currently used as agricultural lands), to the south by residential properties, to the west by Fort Road and to the east by Coillte forestry lands. The area of the main development site area excludes the area zoned for 'Community and Education' as shown in *Figure 1 below.*

The location of the proposed development site is illustrated on *Figure 1* below and shown on *Drawing Number IE1544-001-B* in *Appendix A*.

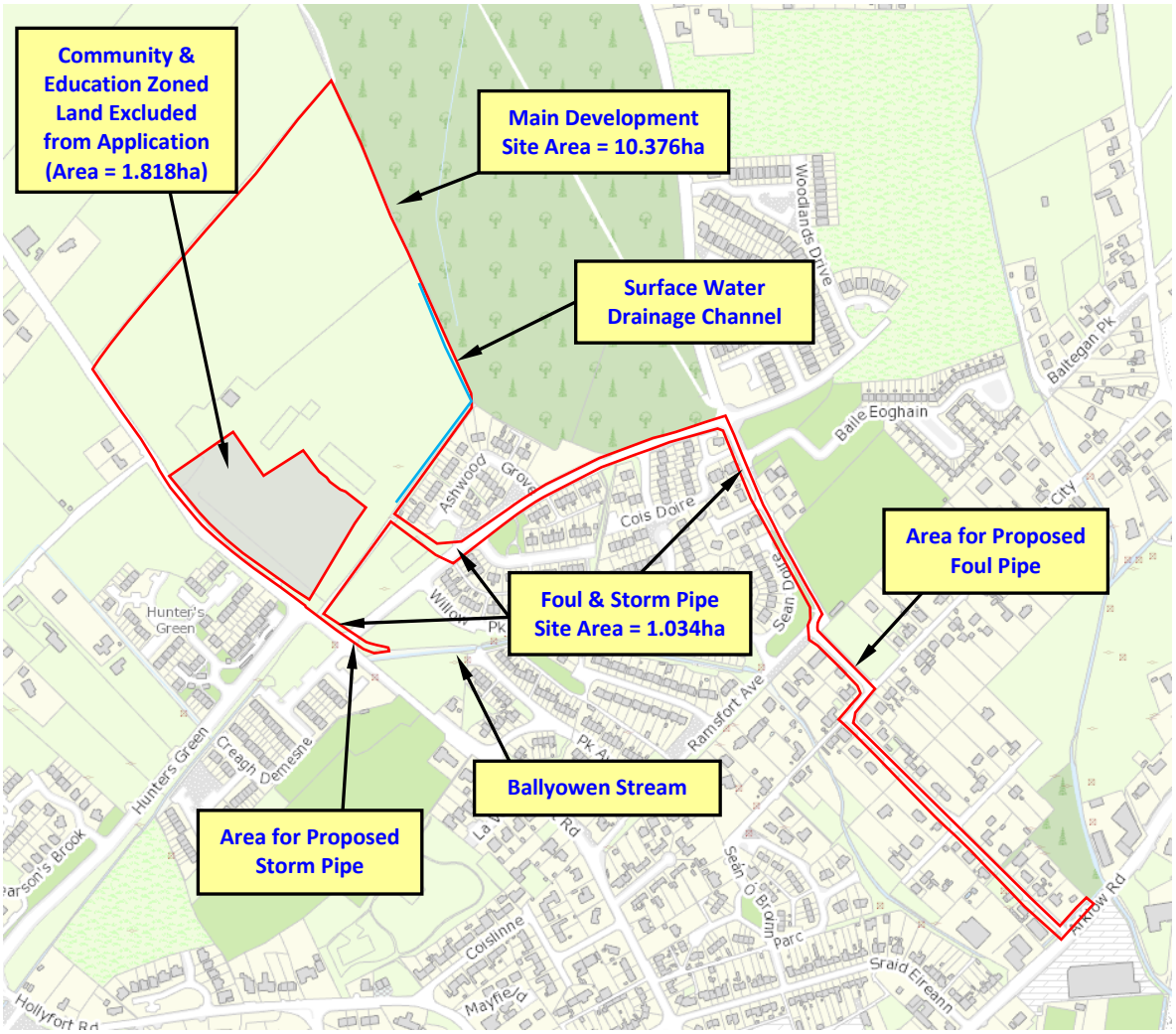


Figure 1 - Site Location

2.2 Existing Topography Levels at Site

The main development area site slopes moderately from the northern boundary of the site to the southern boundary of the site at an average gradient of approximately 3.2% (1 in 31).

Existing ground elevations range from approximately 71.85mOD (Malin) in the northern area of the site to 54.16mOD (Malin) in the southern area of the site.

2.3 Local Hydrology, Landuse & Existing Drainage

The most immediate mapped hydrological feature in the vicinity of the proposed site is the Ballyowen Stream that flows from west to east approximately 130m beyond the southern boundary of the main development site area.

The catchment area of the Ballyowen Stream watercourse was delineated and found to be approximately **2.588km^2** to a point downstream of the site. An assessment of the catchment area indicates that the catchment is predominately rural in nature with urban development accounting for approximately 18% of the total catchment area.

An existing open surface water drainage channel is located adjacent to the eastern boundary of the proposed development site. This drainage channel is discussed in more detail in *Section 6* below.

3 Initial Flood Risk Assessment

The flood risk assessment for the proposed development site is undertaken in three principal stages, these being *'Step 1 – Screening', 'Step 2 – Scoping'* and *'Step 3 – Assessing'*.

3.1 Possible Flooding Mechanisms

Table 1 below summarises the possible flooding mechanisms in consideration of the proposed development site:-

Source/Pathway	Significant?	Comment/Reason
Tidal/Coastal	No	The site is not located within a coastal region.
Fluvial	Yes	The Ballyowen Stream is located 130m beyond the southern boundary of the main area of the proposed development site. The proposed foul pipe crosses the Ballyowen Stream at one location.
Pluvial (urban drainage)	Possible	There is existing urban drainage network located in the vicinity of site.
Pluvial (overland flow)	No	The site is not surrounded by significantly elevated lands and does not provide an important surface water discharge point to adjacent lands
Blockage	No	There are no hydraulic structures near the main area of the proposed development site. There is one bridge/culvert located close to the proposed foul pipe.
Groundwater	No	There are no significant springs or groundwater discharges mapped or recorded in the immediate vicinity of the site

Table 1

The primary potential flood risk to the proposed development site can be attributed to an extreme fluvial flood event in the Ballyowen Stream located 130m beyond the southern boundary of the site. Secondary flood risk can be attributed to a potential surcharge due to a blockage of the urban drainage network in the vicinity of the site or to a potential surcharge due to a blockage in the bridge/culvert on the Ballyowen Stream in the vicinity of the proposed foul pipe.

In accordance with 'The Planning System and Flood Risk Management – Guidelines for Planning Authorities - DOEHLG 2009' these potential flood risks are analysed in the subsequent 'Screening Assessment' and ''Scoping Assessment'' section of this study report.

4 Screening Assessment

The purpose of the screening assessment is to establish the level of flooding risk that may or may not exist for a particular site and to collate and assess existing current or historical information and data which may indicate the level or extent of any flood risk.

If there is a potential flood risk issue then the flood risk assessment procedure should move to *'Step 2 – Scoping Assessment'* or if no potential flood risk is identified from the screening stage then the overall flood risk assessment can end at *'Step 1'*.

The following information and data was collated as part of the flood risk screening assessment for the proposed development site:-

4.1 OPW/EPA/Local Authority Hydrometric Data

Existing sources of OPW, EPA and local authority hydrometric data were investigated. As illustrated in *Figure 2* below, this assessment has determined that there are no hydrometric gauging stations located in the vicinity of the proposed development site. The closest station is 4km south of the site on the Owenavorragh River, which is too far away from the site to be of any assistance in the prediction of extreme flood volumes and flood levels at the location of the proposed development site.

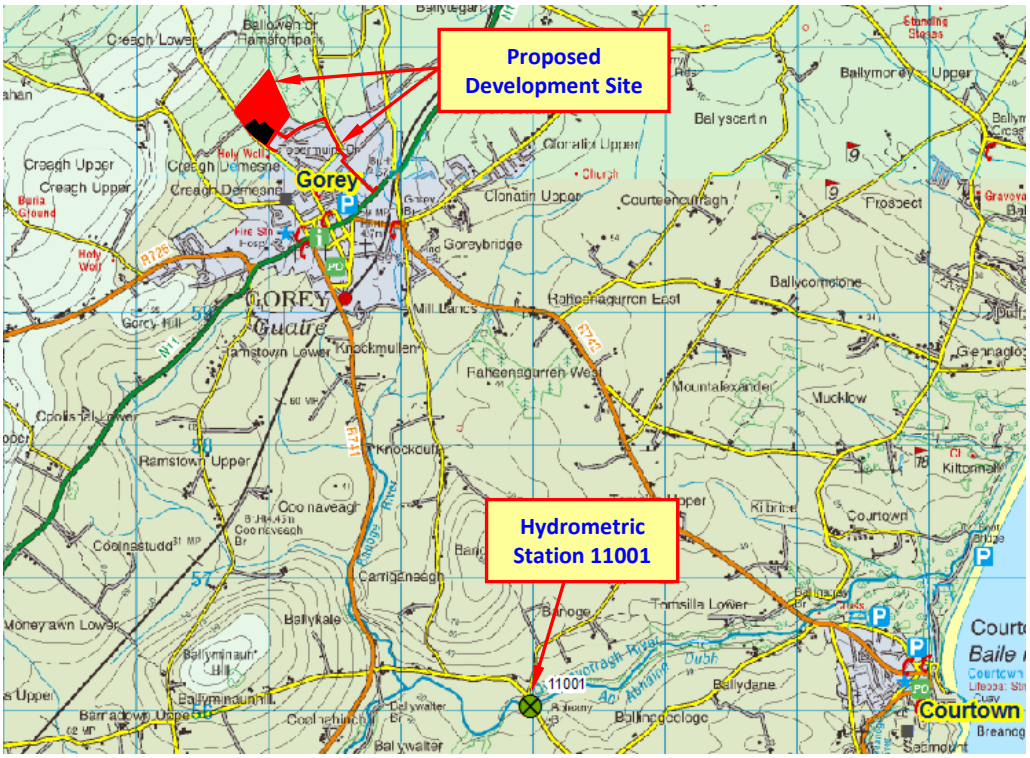


Figure 2 – Hydrometric Gauging Stations

4.2 OPW PFRA Indicative Flood Mapping

Preliminary Flood Risk Assessment (PFRA) Mapping for Ireland was produced by the OPW in 2011. OPW PFRA indicative flood map number 2019/MAP/157/A illustrates indicative flood zones within this area of County Wexford.

Figure 3 below illustrates an extract from the above indicative flood map in the vicinity of the proposed development site.

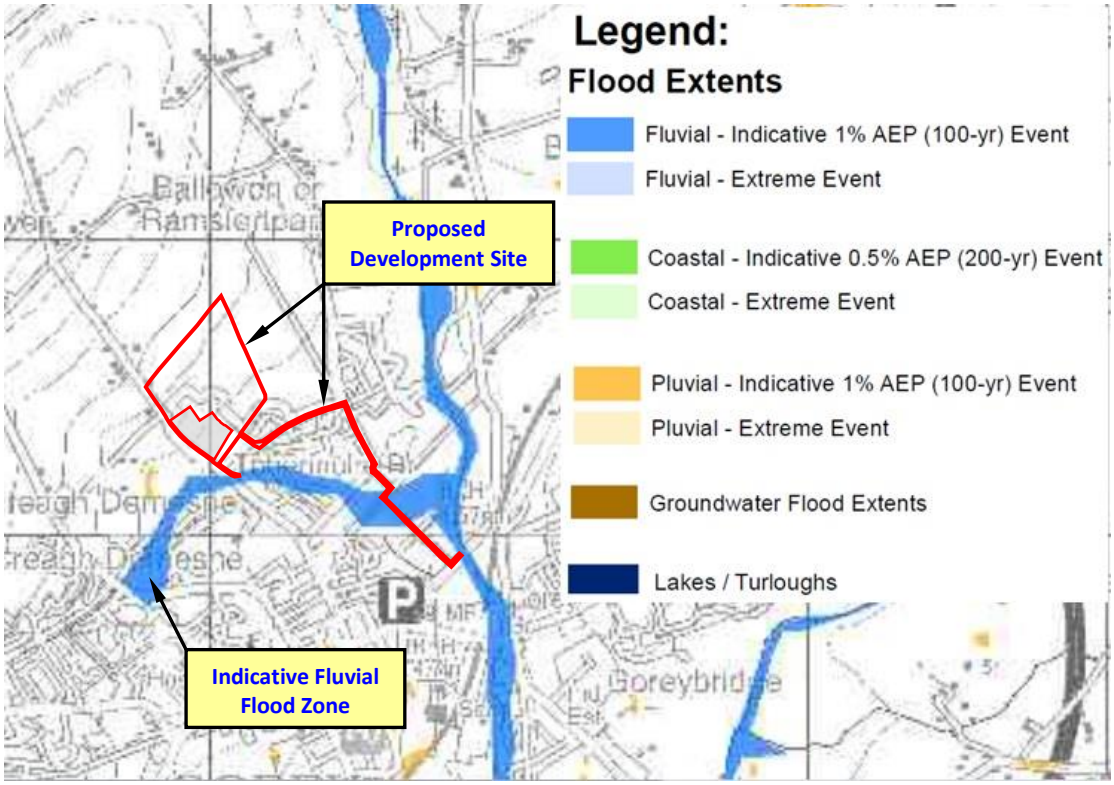


Figure 3 – PFRA Mapping

The PFRA indicative flood mapping indicates that a small portion of the route of the proposed foul sewer may be located within an indicative fluvial flood zone associated with the Ballyowen Stream. The proposed residential area of the site is however not located within an indicative fluvial flood zone. No indicative pluvial or groundwater flood zones are mapped within the boundary of the site or along the route of the proposed foul sewer pipe.

Figure 4 below illustrates the PFRA indicative flood zones from *Figure 3* overlaid onto higher resolution background mapping. It should be noted that the extent of flooding illustrated on these maps was developed using a low resolution digital terrain model (DTM) and illustrated flood extents are intended

to be indicative only. The flood extents mapped on the PFRA maps are not intended to be used on a site specific basis.

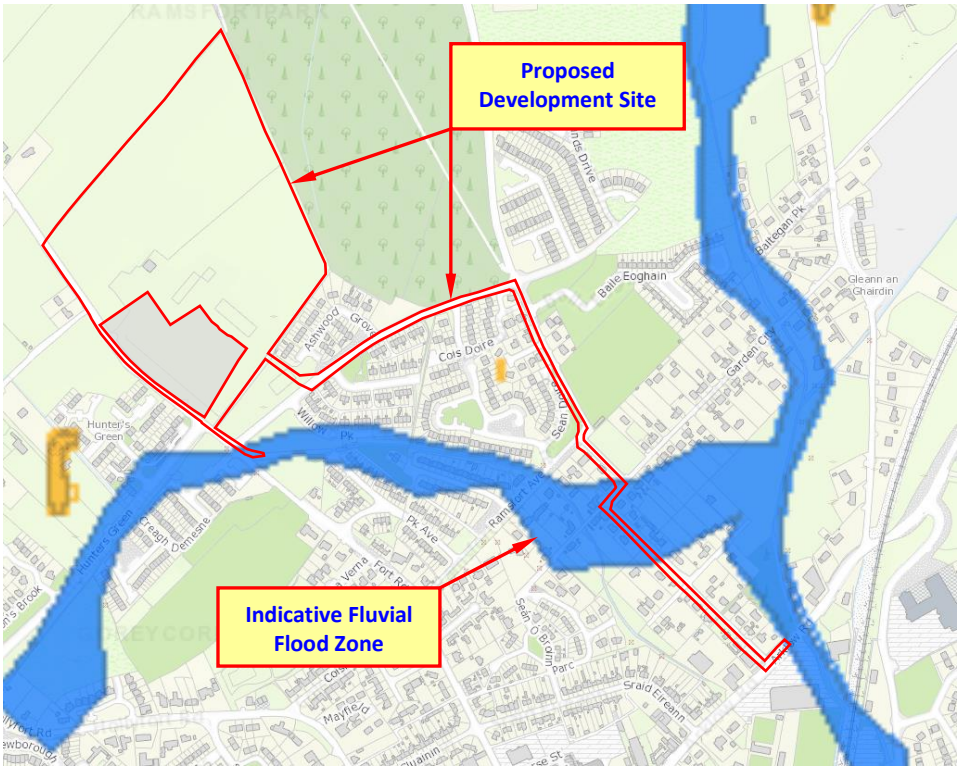


Figure 4 – PFRA Flood Mapping

4.3 OPW Flood Maps Website

The OPW Flood Maps Website (www.floods.ie) was consulted in relation to available historical or anecdotal information on any flooding incidences or occurrences in the vicinity of the proposed development site. *Figure 5* below illustrates mapping from the Flood Maps website in the vicinity of the site.

OPW National Flood Hazard Mapping

Summary Local Area Report

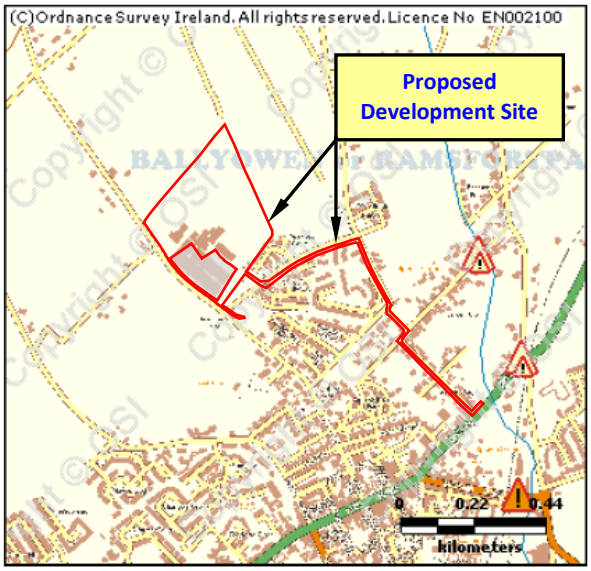
This Flood Report summarises all flood events within 2.5 kilometres of the map centre.

The map centre is in:

County: Wexford

NGR: T 152 602

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 1:18,274

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. Thier purpose and scope is explained in the Glossary.

3 Results

Figure 5 – OPW Flood Maps

Figure 5 above indicates instances of recurring or historical flooding in the vicinity of the proposed development site. These flooding occurrences refer to a flooding event that occurred in the Gorey area in November 2005. A summary of the areas reported to have flooded are included in *Appendix B.* These occurrences do not appear to have resulted in any flooding within the boundary of the proposed development site.

4.4 Ordnance Survey Historic Mapping

Available historic mapping for the area was consulted, as this can provide evidence of historical flooding incidences or occurrences. The maps that were consulted were the historical 6-inch maps (pre-1900), and the historic 25-inch map series.

Figures 6 and *Figure 7* below show the historic mapping for the area of the proposed development site.

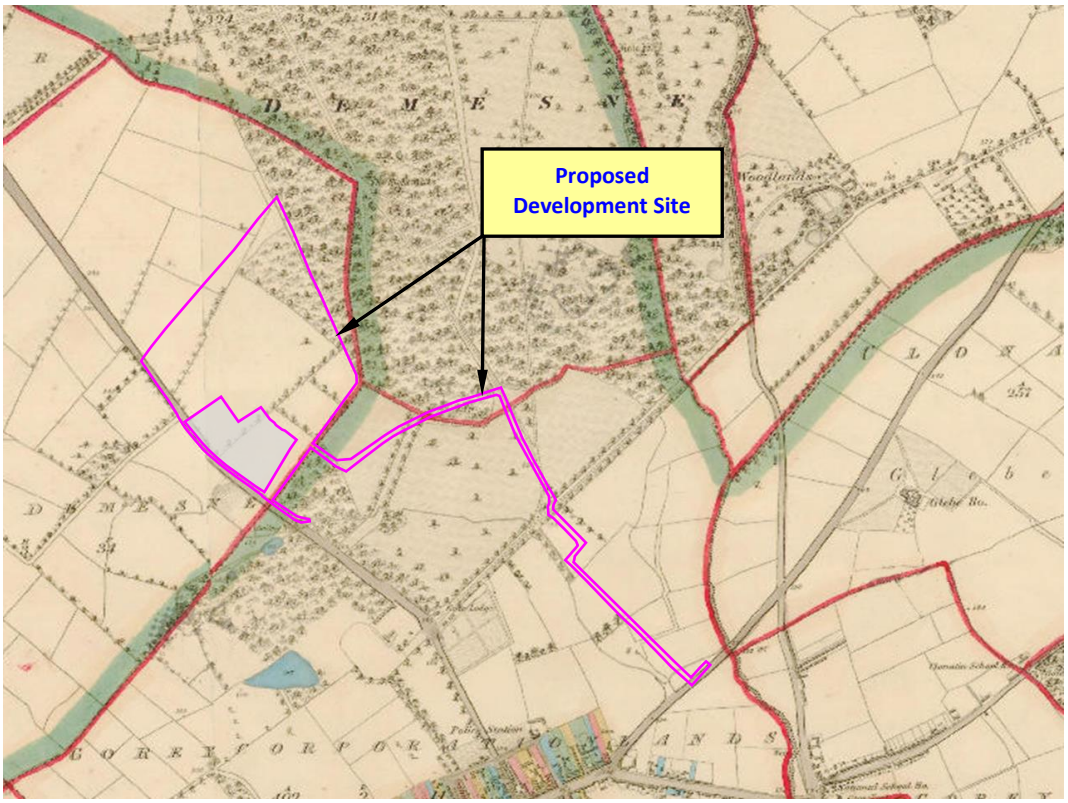


Figure 6 – Historic 6-Inch Mapping

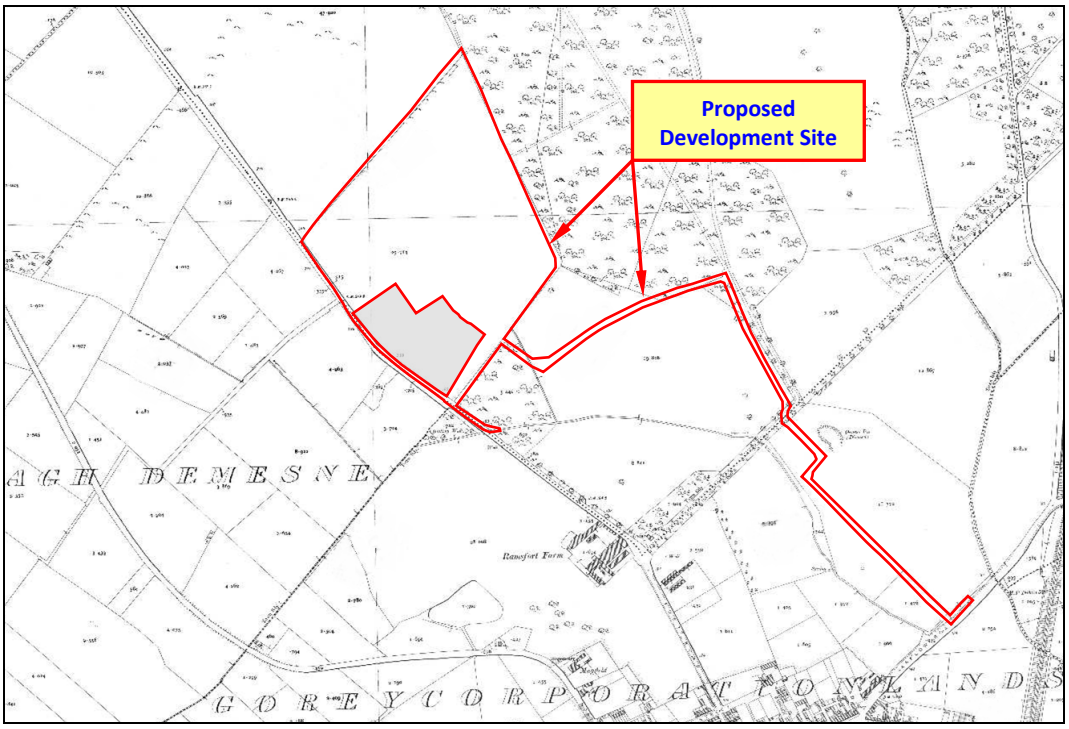


Figure 7 – Historic 25-Inch Mapping

The historic 6 inch and 25 inch mapping does not indicate any historical or anecdotal instances of flooding within or adjacent to the boundary of the proposed development site.

4.5 Geological Survey of Ireland Mapping

The alluvial deposit maps of the Geological Survey of Ireland (GSI) were consulted to assess the extent of any alluvial deposits in the vicinity of the proposed development site. Alluvial deposits can be an indicator of areas that have been subject to flooding in the recent geological past.

Figure 8 below illustrates the sub-soils mapping for the general area of the site.

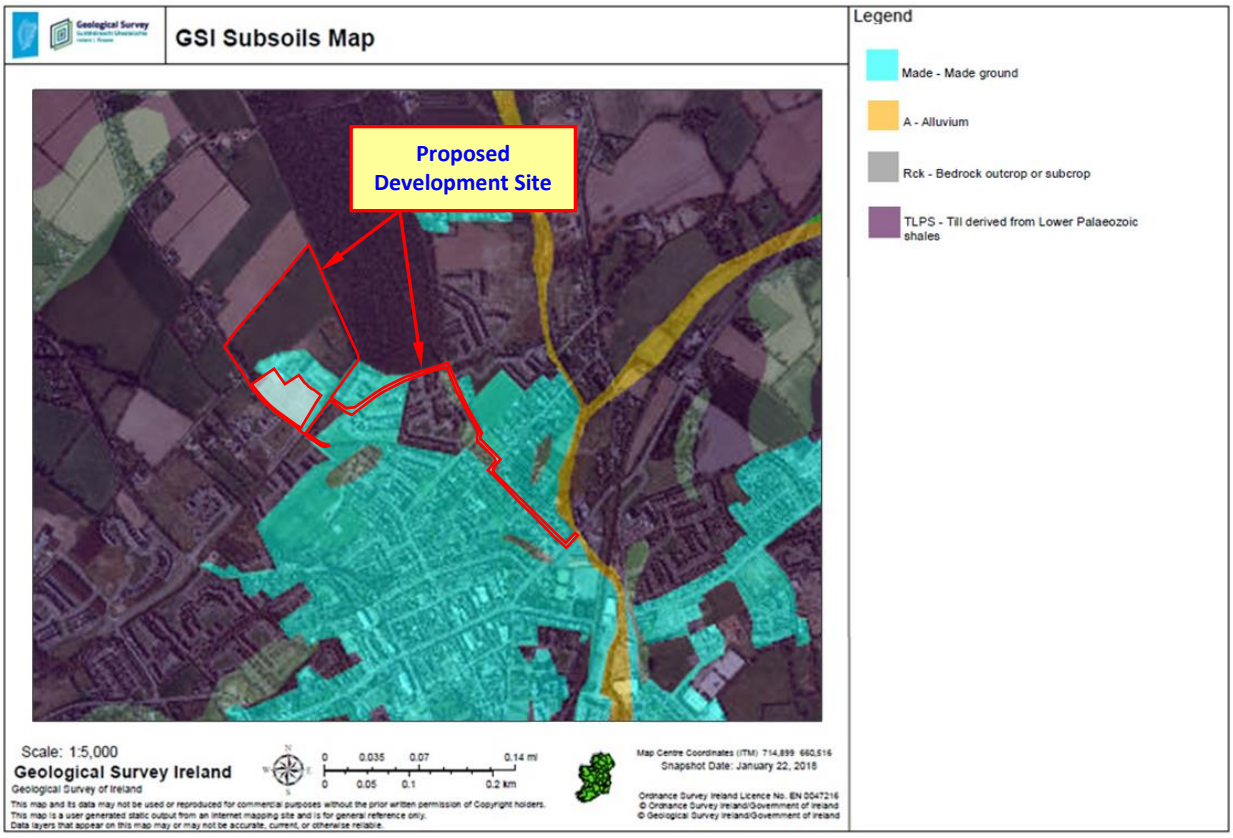


Figure 8 – GSI Subsoil Mapping

Figure 8 above indicates that the proposed development site is largely underlain by Till derived from Lower Palaeozoic shales, made-ground and rock. There is a small area of alluvium deposits at the end of the route of the proposed foul sewer. This area of alluvium deposits could be indicative of the areas that have flooded in the recent geological past, however it is considered to be negligible in the context of the proposed foul sewer.

4.6 South Eastern CFRAM Study

The South Eastern Region Catchment Flood Risk & Management Study (CFRAMS) has been undertaken by the OPW and the Final version of the flood maps were issued in July 2016. Flood risk extent and depth maps for further assessment areas within the general area of the proposed development site have also been produced. OPW CFRAMS predictive flood map number *O11GOR_EXFCD_F0_05* illustrates predictive extreme fluvial flood extent zones associated with the Ballyowen Stream in the vicinity of the proposed development site.

Figure 9 below (extracted from CFRAMS flood maps *O11GOR_EXFCD_F0_05*), illustrates the predicted extreme 10% AEP (1 in 10 year), 1% AEP (1 in 100 year) or 0.1% AEP (1 in 1000 year) flood extents in the vicinity of the proposed development site.

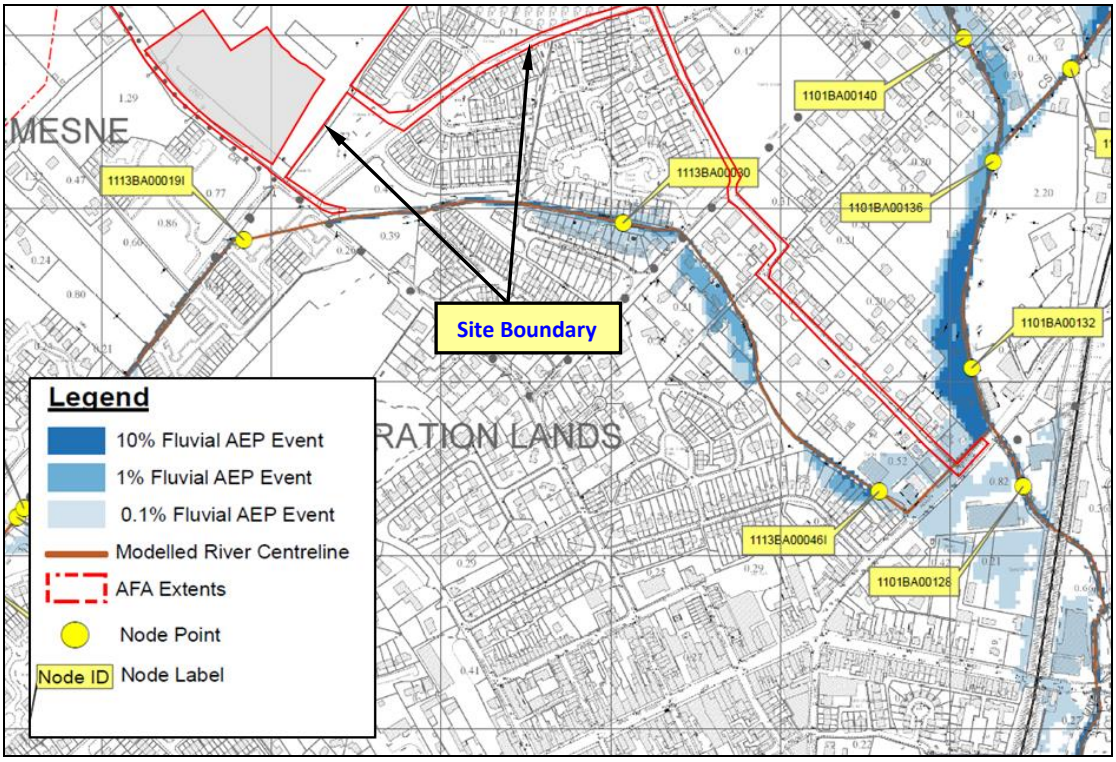


Figure 9 – CFRAMS Fluvial Flood Maps

This above map also indicates the predicted water levels for 10% AEP, 1% AEP and 0.1% AEP fluvial flood events at various node points along the Ballyowen Stream. Details of the predicted fluvial flood levels and flows rates for these node points in the vicinity of the site are listed in Table 2 below, which have been extracted from CFRAMS flood map reference *O11GOR_EXFCD_F0_05*.

Node Label	Water Level (OD) 10% AEP	Flow (m³/s) 10% AEP	Water Level (OD) 1% AEP	Flow (m³/s) 1% AEP	Water Level (OD) 0.1% AEP	Flow (m³/s) 0.1% AEP
1113BA00019I	50.95	N/A	51.40	N/A	51.93	N/A
1113BA00030	44.27	N/A	44.80	N/A	44.89	N/A
1113BA00046I	38.62	1.92	38.93	4.22	39.04	6.03

Table 2 –CFRAMS Fluvial Map - Predicted Flood Levels

4.7 Irish Water Drainage Records

Drainage records for the area were obtained from Irish Water, an extract from which is illustrated in *Figure 10* and *Figure 11* below.

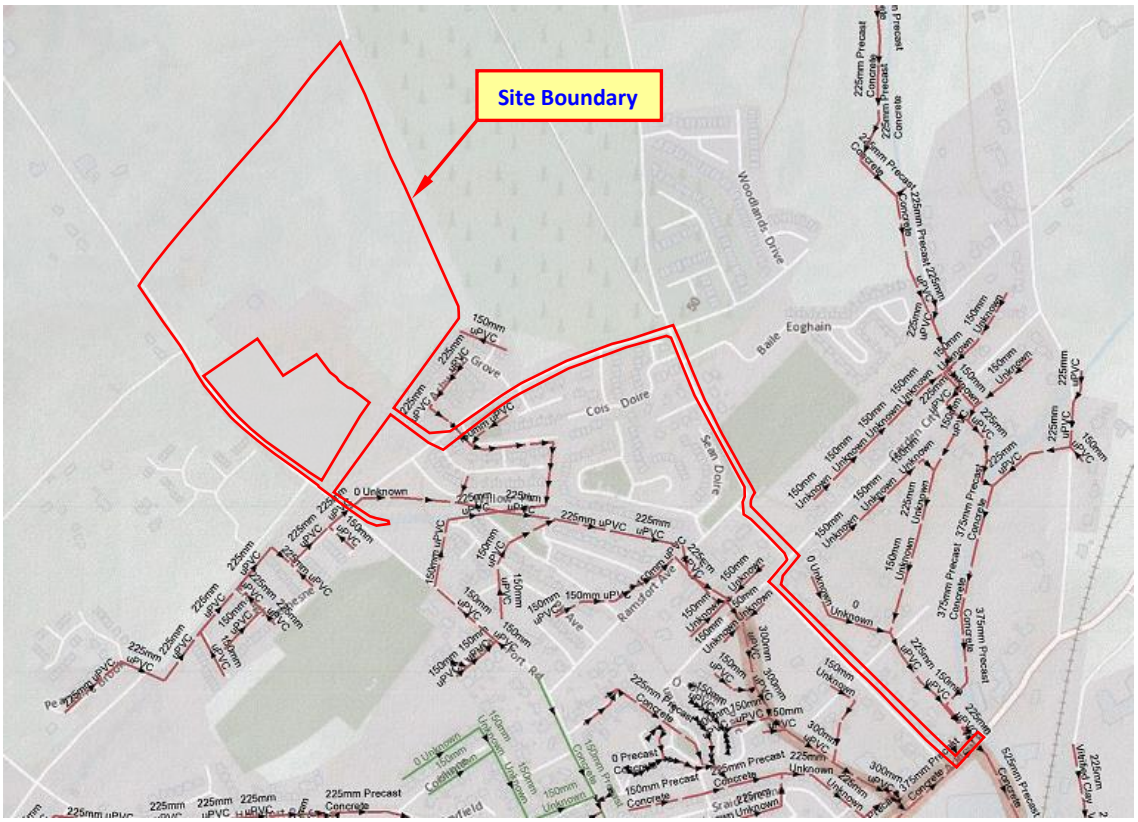


Figure 10 – Foul & Stormwater Drainage

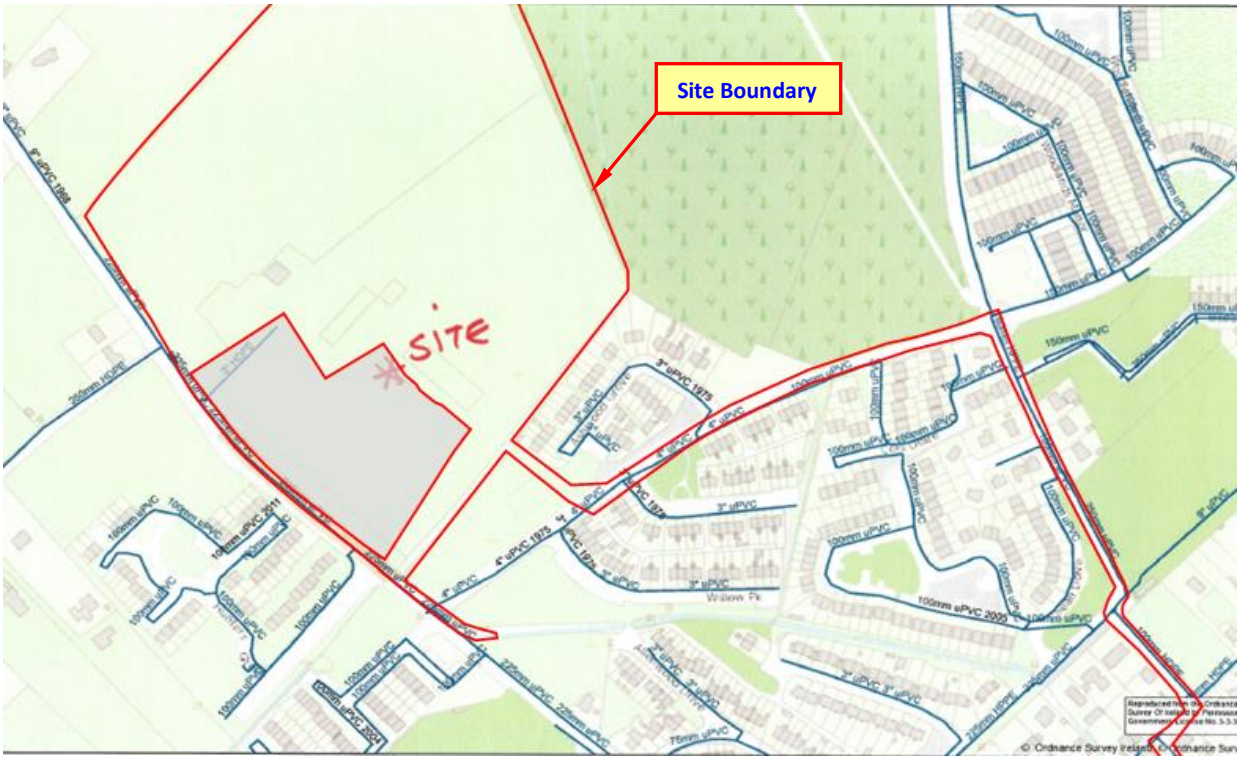


Figure 11 – Water Mains

Figure 10 and *Figure 11* above indicate that there are existing water mains located adjacent to the western boundary of the main development area. There are also foul and water mains along the proposed route of the storm and foul pipes.

5 Scoping Assessment

The purpose of the scoping stage is to identify possible flood risks and to implement the necessary level of detail and assessment to assess these possible risks, and to ensure these can be adequately addressed in the flood risk assessment. The scoping exercise should also identify that sufficient quantitative information is already available to complete a flood risk assessment appropriate to the scale and nature of the development proposed.

The above screening assessment indicates that the main development area where the proposed dwelling units are located is not susceptible to a direct flood risk from potential fluvial, pluvial or groundwater sources. In particular, the current flood extent maps for the area produced as part of the South Eastern CFRAM study are based on the results of detailed hydraulic modelling undertaken along the Ballyowen Stream, and therefore provide a reasonably accurate delineation of flood zones and prediction of flood depths in the general vicinity of the proposed development site. In addition, any potential flood waters from a potential surcharging of the urban drainage network or water main infrastructure in the vicinity of this area of the site would flow away from the site in a southerly direction within the public roads. Overall, the flood risk to this area of the proposed development site is considered to be **LOW**.

The proposed foul pipes located outside the main development area and outside the applicants lands may be susceptible to fluvial flooding from the Ballyowen Stream. The potential flood risk from existing urban drainage or water main infrastructure does not pose a significant risk to the proposed foul pipe.

In consideration of the information collated as part of the screening exercise, and the availability of other information and data specific to the area of the proposed development site, it is considered that sufficient quantitative information to complete an appropriate flood risk assessment for the area of the proposed foul pipework outside the main area of the proposed development site can be derived from the information collated as part of the screening exercise alone. These risks are assessed in the subsequent 'Assessing Flood Risk' section of this study report.

6 Assessing Flood Risk

6.1 Fluvial Flood Risk to the Proposed Foul Drainage Pipe

The South Eastern CFRAMS flood extent map indicates that a small portion of the route of the proposed foul pipe is potentially susceptible to fluvial flood inundation from the Ballyowen Stream in one location as shown in *Figure 12* below.

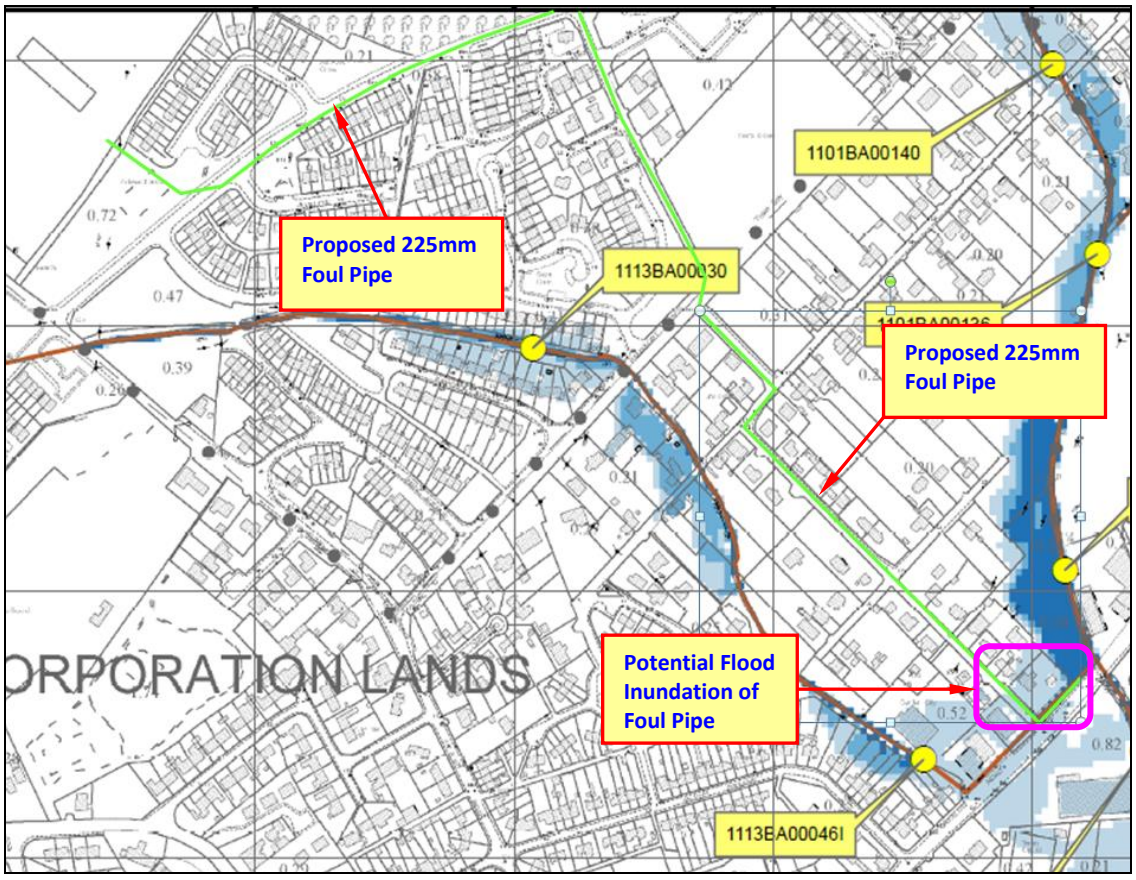


Figure 12 – Proposed Foul Pipe within Fluvial Flood Extents

In order to prevent fluvial flood waters from the Ballyowen Stream from flowing into the proposed 225mm foul pipe in the location shown in *Figure 12* above it is recommended that the manholes in these locations are constructed with sealed flood proof covers.

There are no proposed local connections to this foul pipe within these locations and therefore there is no residual flood risk posed to people or property beyond that of the existing scenario (no foul pipe constructed in these locations).

6.2 Hydrological Impact of the Proposed Development

There is potential for surface water runoff generated within the main area of the proposed development site to result in an adverse impact to the existing hydrological regime of the area. Surface water runoff generated within the main development area of the site shall be attenuated to Greenfield Runoff rates to protect the hydrological regime of the area including the Ballyowen Stream.

The surface water management plan proposed incorporates Sustainable Urban Drainage System (SuDS) proposals to limit the surface water discharge from the main area of development in accordance with the GDSDS. The proposed stormwater drainage within the site shall be divided into two catchments with separate attenuation systems proposed in each area. These attenuation systems have been designed for no flooding up to the 1 in 100 year rainfall event including 10% climate change. The discharge from each of these attenuation systems shall be limited to Greenfield Runoff rates using a flow control device such as a 'Hydrobrake'.

The proposed surface water management system shall not result in any displacement of flood waters and is completely separate from the existing drainage infrastructure in the area.

As such there will be no increase in runoff from the site beyond the 'greenfield' runoff rate and therefore the development as proposed will not pose an increased flood risk to the area.

A section of the proposed route of the foul pipe shall be constructed within an area of potential fluvial flood risk. The proposed foul pipe will not result in any loss in flood plain storage as a result of its construction. There will be no local connections to the foul pipe downstream of the main development site area and therefore there is no flood risk posed to any existing or future residents as a result of connection to the foul pipe.

7 Discussion

The analysis undertaken as part of this Site Specific Flood Risk Assessment (SSFRA) has identified a drainage channel located within the eastern boundary of the site. This channel conveys surface water runoff from surrounding lands. Although this drainage channel does not present a direct fluvial flood risk to the proposed development site, it is proposed to modify this drainage channel in order to accommodate the development as proposed, whilst also maintaining the functionality of the drainage channel to convey surface water runoff from surrounding lands. Details of the proposed drainage works are shown on *Drawing Number IE1544-002-E, Appendix A.*

A hydrological analysis has been undertaken to estimate predicted 1 in 100 year (1% AEP) and 1 in 1000 year (0.1% AEP) flood volumes in the drainage channel within the boundary of the proposed development site.

7.1 Drainage Channel Catchment Area

As illustrated in *Figure 13* below, the delineated catchment area for the drainage channel to a point downstream of the proposed development site is estimated as 0.656km^2.

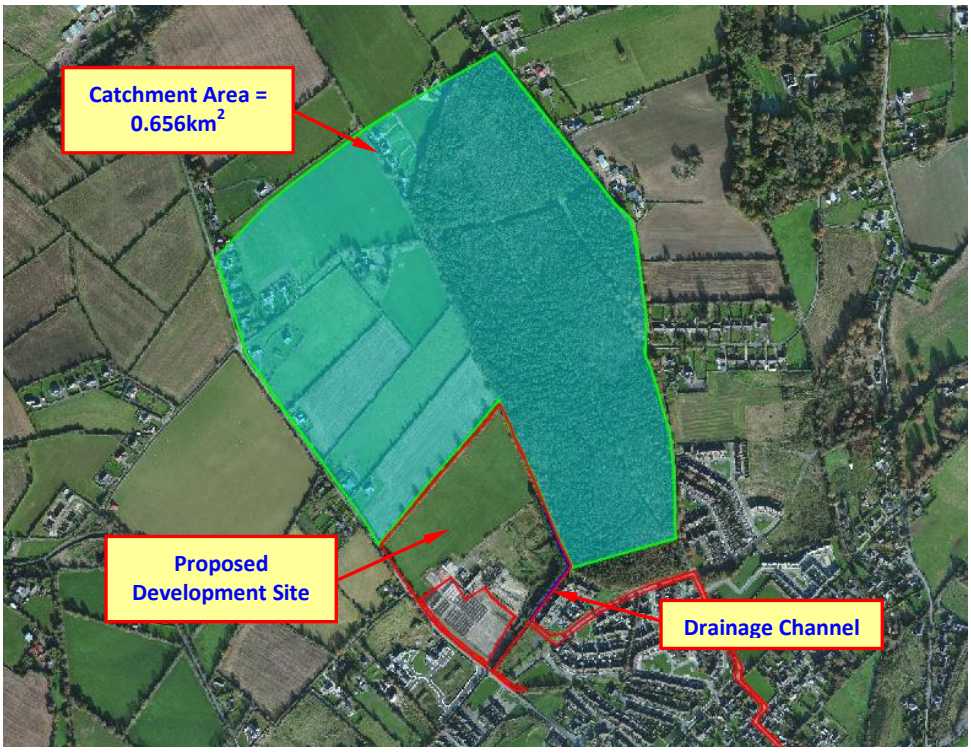


Figure 13 – Catchment Area

7.2 Peak Flow Estimation –Mean Annual Flood Method for Small Catchments

Given the small size of the catchment area of the drainage channel, the FSU portal software is not considered appropriate to estimate the median or mean flood volume. The mean annual flood , Q_{BAR} *(m^3/s)*, is therefore estimated by utilising any of the two multiple parameter regression equations detailed in the Flood Studies Report (FSR) and Flood Studies Supplementary Reports (FSSR) and the Institute of Hydrology Report (IH) No. 124 'Flood Estimation for Small Catchments' regression equation. These equations are listed below:-

Qbar Rural = 0.00066 x Area$^{0.92}$ x SAAR$^{1.22}$ x SOIL$^{2.0}$ *EQN 1.5 (FSSR)*

Qbar Rural = 0.0288 x Area$^{0.90}$ x RSMD$^{1.23}$ x SOIL$^{1.77}$ x STMFRQ$^{0.23}$ *EQN 1.6 (FSR)*

Qbar Rural = 0.00108 x Area$^{0.89}$ x SAAR$^{1.17}$ x SOIL$^{2.17}$ *EQN 7.1 (IH124)*

where,

AREA = the topographic catchment area

Area = 0.656 Km^2

SAAR = Standard Annual Average Rainfall

SAAR = 951.1 mm (*from Met Éireann data)*

STMFRQ = the stream frequency of the catchment, which is equal to the number of channel junctions within the catchment divided by the catchment area. STMFRQ = (J/ A) = 1/0.656.

STMFRQ = 1.524

RSMD = the 5 year, 1 day rainfall excess (mm) for the catchment and is estimated using the following equation or can be directly derived from Figure 14 below:

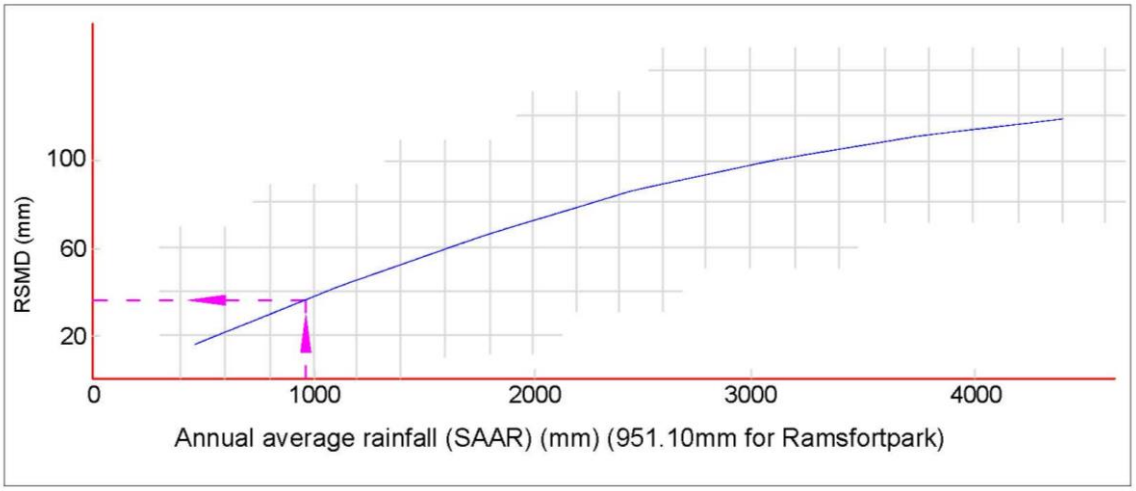


Figure 14 – Plot of 5 year, 1 day rainfall excess, RSMD, against mean annual rainfall, SAAR

RSMD = 36.48, *for SAAR value of 951.10mm taken from Met Éireann data*

SOIL = A number depending on the soil type and relating to the winter rain acceptance potential of the soils in the catchment. Values for SOIL are obtained from *Figure 15* & *Figure 16* below, which are replicated from map I. 4.18 (I) in the FSR.

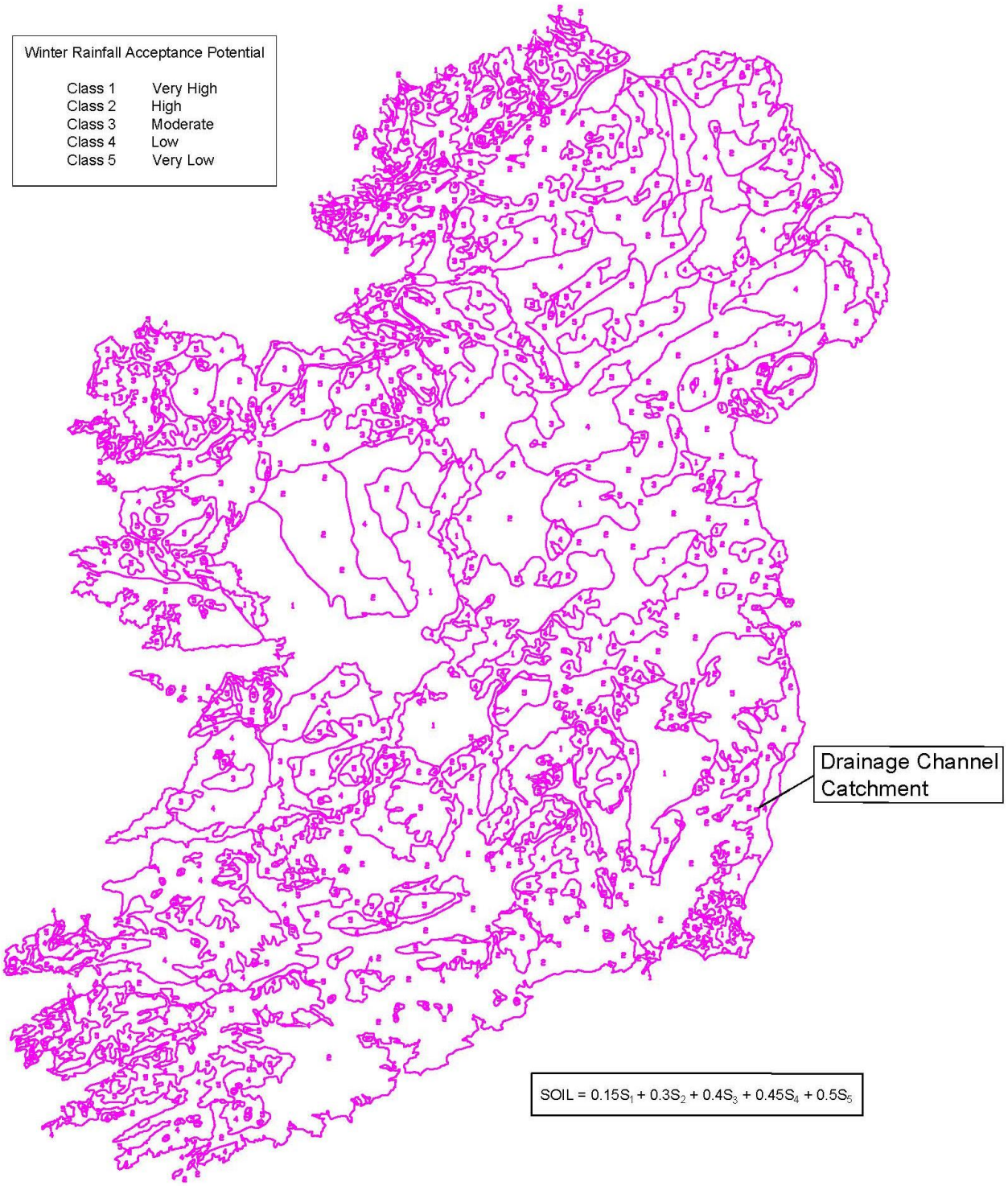


Figure 15 - Winter Rainfall Acceptance Potential

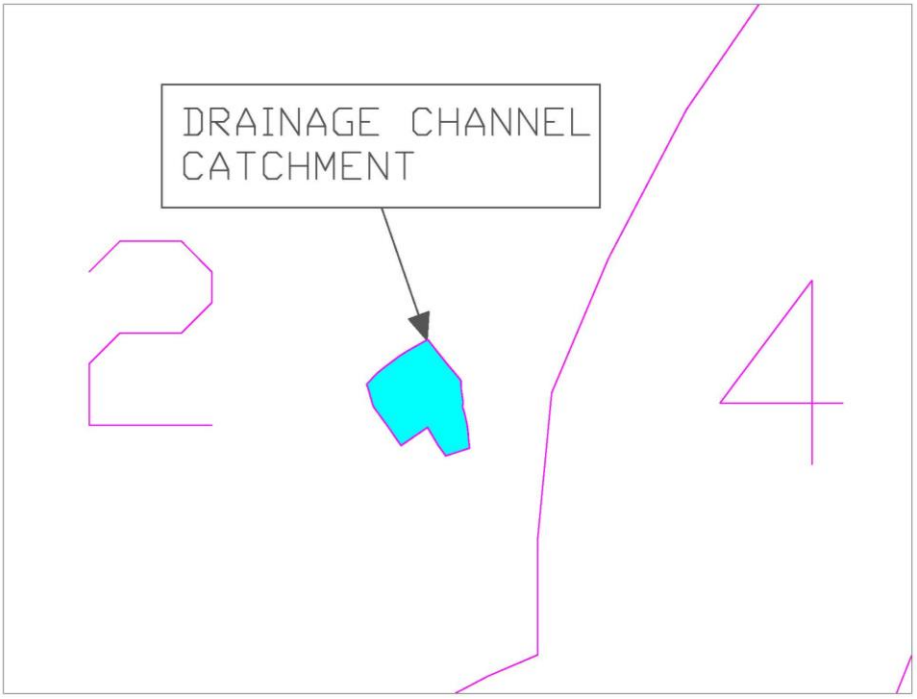


Figure 16 - Winter Rainfall Acceptance Potential

From *Figure 15* & *Figure 16* above (not to scale) the drainage channel catchment area comprises of 100% SOIL Type 2.

Therefore:

SOIL = 0.15(S1) + 0.3(S2) + 0.40(S3) + 0.45(S4) + 0.5(S5)

SOIL = 0.15(0) + 0.3(1) + 0.40(0) + 0.45(0) + 0.5(0)

SOIL = 0.3

Therefore:

Qbar Rural = 0.00066 x Area$^{0.92}$ x SAAR$^{1.22}$ x SOIL$^{2.0}$ *EQN 1.5(FSSR)*

$\Rightarrow$ 0.00066 x 0.656$^{0.92}$ x 951.10$^{1.22}$ x 0.3$^{2.0}$

$\Rightarrow$ ***Q_{BAR} = <u>0.173 m^3/s</u>***

Qbar Rural = 0.0288 x Area$^{0.90}$ x RSMD$^{1.23}$ x SOIL$^{1.77}$ x STMFRQ$^{0.23}$ *EQN 1.6 (FSR)*

$\Rightarrow$ 0.0288 x 0.656$^{0.90}$ x36.48$^{1.23}$ x 0.3$^{1.77}$ x 1.524$^{0.23}$

$\Rightarrow$ ***Q_{BAR} = 0.215 m^3/s***

Qbar Rural = 0.00108 x Area$^{0.89}$ x SAAR$^{1.17}$ x SOIL$^{2.17}$ *EQN 7.1 (IH124)*

$\Rightarrow$ 0.00108 x 0.656$^{0.89}$ x 951.10$^{1.17}$ x 0.3$^{2.17}$

$\Rightarrow$ ***Q_{BAR} = 0.166 m^3/s***

For the purposes of this Site Specific Flood Risk Assessment, the more conservative Q_{BAR} estimate of ***0.215 m^3/s*** is utilised. The FSR equation has a standard factorial error of 1.53, therefore the design ***Q_{BAR} Rural*** estimate = 0.215 m^3/s x 1.53 = ***0.328 m^3/s.***

7.3 Estimated Flows for Different Return Periods

The return period flows 'Q_T' are estimated using the index flood method and multiplying the annual maximum flow by the appropriate growth factor 'X_T' using the FSR (1975) national growth curve for Ireland, as illustrated in *Figure 17* below: -

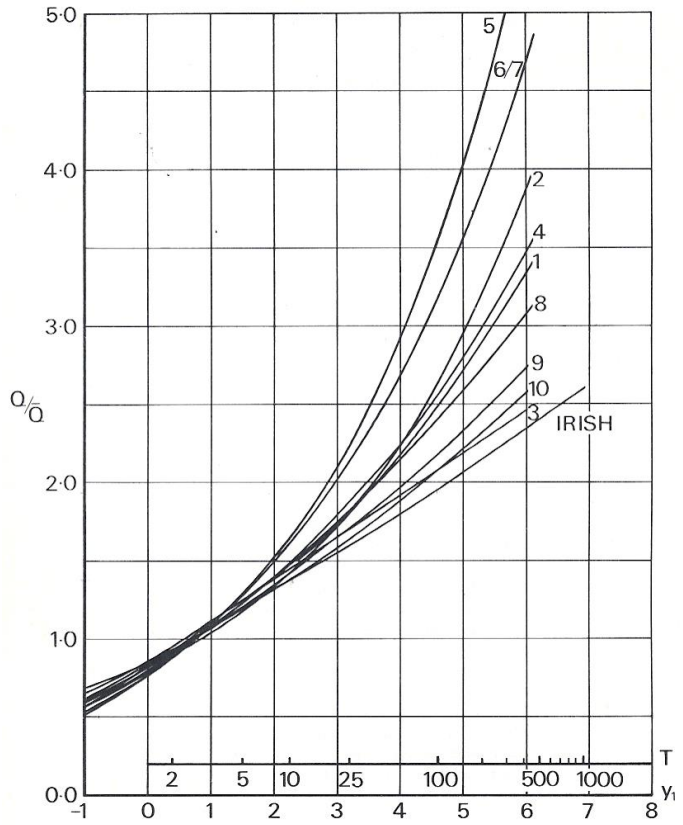


Figure 17 – Regional Growth Factors

For flood return periods 2, 5, 10, 20, 50, 100 and 1000 years the growth factors determined from *Figure 15* are listed in *Table 3* below: -

Flood Return Period (Yrs)	2	5	10	20	50	100	1000*
Growth Curve Factor (Q_T/Q_{BAR})	0.95	1.20	1.37	1.54	1.77	1.96	2.59

Table 3 - Growth Factors Applied to Irish Catchments for Q_{BAR} Discharge Prediction

Table 4 below shows the estimated peak flood flow in the channel at the point of interest for different return periods: -

Flood Return Period (Yrs)	2	5	10	20	50	100	1000*
Estimated Peak Flow (m^3/s)	0.313	0.395	0.451	0.507	0.582	0.645	0.852

Table 4 – Estimated Peak Flows in the Drainage Channel for Different Return Periods

The estimated 100-year (1% AEP) and 1000-year (0.1% AEP) flood flows for the drainage channel along the reach under consideration is therefore:-

Q_{100} = 0.645 m^3/s

Q_{1000} = 0.852 m^3/s

*(*Note – The Q_{100} value is a design flow. The Q_{1000} value is estimated and is presented only to assess the 1000 year Average Recurrence Interval (ARI) in the context of the 'Planning System and Flood Risk Management Guidelines')*

7.4 Climate Change

It is generally acknowledged that future climate change will cumulate in decreases in summer precipitation amounts and increases in winter precipitation amounts. The levels or percentages of increase or decrease are still subjective and dependant on future studies and analysis.

The suggested increases in winter rainfall depth will inevitably result in higher catchment run-off and therefore greater flood peaks. It is therefore prudent to include a climate change factor in any estimation of flood peak volumes. Standard current practice suggests that a 20% increase in estimated flood peaks should be applied for flood estimation studies to account for the potential impacts of climate change.

Therefore, the estimated 100-year (1% AEP) and 1000-year flood peak flows derived in the above section are increased to reflect the climate change factor: -

$\Rightarrow$ ***Q_{100+CC} = 0.645 x1.20 = <u>0.774 m³/s</u>***

$\Rightarrow$ ***$Q_{1000+CC}$ = 0.852 x1.20 = <u>1.022 m³/s</u>***

7.5 Proposed Drainage Channel Design

As illustrated on *Drawing Number IE1544-002-E, Appendix A*, it is proposed to modify the existing drainage channel within the application lands located along the eastern boundary of the site in order to accommodate the development as proposed, whilst also maintaining the functionality of the drainage channel to convey surface water runoff from surrounding lands.

It is proposed to construct a 525mm diameter perforated pipe within the channel surrounded by Type B filter drain material within the existing drainage channel. This pipe has adequate hydraulic capacity to convey the 1 in 100 year (1% AEP) + Climate Change flood volume of 0.774m^3/s. Refer to *Appendix C* for pipe capacity calculations.

The existing drainage channel above the 525mm diameter pipe shall be re-profiled and vegetated in order to form a swale type channel to capture any surface water runoff from the forest area to the east. as illustrated on *Drawing Number IE1544-002-E, Appendix A.* Potential surface water runoff volume in excess the 1 in 100 year flow rate of 0.744 m^3/s and up to the 1 in 1000 year flow rate of 1.022 m^3/s shall be conveyed within the profiled swale channel.

8 Proposed Development in the Context of the Guidelines

In the context of the *'Planning System and Flood Risk Management Guidelines, DOEHLG, 2009'* three flood zones are designated in consideration of flood risk to a particular development site.

Flood Zone 'A' – where the probability of flooding from rivers and watercourses is the highest (greater than 1% or 1 in 100 year for river and watercourse flooding and 0.5% or 1 on 200 for coastal or tidal flooding).

Flood Zone 'B' – where the probability of flooding from rivers and watercourses is moderate (between 0.1% or 1 in 1000 year for river and watercourse flooding and 0.5% or 1 on 200 for coastal or tidal flooding).

Flood Zone 'C' – where the probability of flooding from rivers and watercourses is low or negligible (less than 0.1% of 1 in 1000 year for both river and watercourse and coastal flooding). *Flood Zone 'C'* covers all areas that are not in *Zones 'A'* or '*B*'.

The *'Planning System and Flood Risk Management Guidelines'* list the planning implications for each flood zone, as summarised below:-

Zone A – High Probability of Flooding. Most types of development would not be considered in this zone. Development in this zone should be only be considered in exceptional circumstances, such as in city and town centres, or in the case of essential infrastructure that cannot be located elsewhere, and where the *'Planning System and Flood Risk Management Guidelines'* justification test has been applied. Only water-compatible development, such as docks and marinas, dockside activities that require a waterside location, amenity open space and outdoor sports and reaction would be considered appropriate in this zone.

Zone B – Moderate Probability of Flooding. Highly vulnerable development such as hospitals, residential care homes, Garda, fire and ambulance stations, dwelling houses, strategic transport and essential utilities infrastructure would generally be considered inappropriate in this zone, unless the requirements of the justification test can be met. Less vulnerable development such as retail, commercial and industrial uses and recreational facilities might be considered appropriate in this zone. In general however, less vulnerable development should only be considered in this zone if adequate lands or sites are not available in *Zone 'C'* and subject to a flood risk assessment to the appropriate level of detail to demonstrate that flood risk to the development can be adequately managed and that development in this zone will not adversely affect adjacent lands and properties.

Zone C – Low to Negligible Probability of Flooding. Development in this zone is appropriate from a flood risk perspective. Developments in this zone are generally not considered at risk of fluvial flooding and would not adversely affect adjacent lands and properties from a flood risk perspective.

In the context of the *'Planning System and Flood Risk Management Guidelines, DOEHLG, 2009'* this Site Specific Flood Risk Assessment has determined the main development site area where the dwelling units are proposed falls within Flood Zone 'C'. In accordance with the *'Planning System & Flood Risk Management Guidelines, DOEGLG, 2009'* development proposals for this area of the site are therefore not subject to the requirements of the Justification Test.

The proposed foul water pipe located outside the ownership of the applicant falls within Flood Zone 'A' and Flood Zone 'B' in two locations. In accordance with the *'Planning System & Flood Risk Management Guidelines, DOEGLG, 2009'* development proposals for this area of the site may be to the requirements of the Justification Test.

9 Justification Test for Development Management

In the context of the '*Planning System and Flood Risk Management Guidelines, DOEHLG, 2009*' and in consideration of the scenario that the proposed development site is undefended, this Site Specific Flood Risk Assessment has determined that proposed foul pipe located outside the applicant's lands falls within Flood Zone 'A' and Flood Zone 'B'. The main development area where the dwelling units are proposed is located within Flood Zone 'C'.

Table 3.1 of the guidelines lists the vulnerability class of various types of development. The proposed foul pipe is therefore classified as Highly Vulnerable development.

Table 3.2 of the guidelines (*duplicated below*) provides a matrix of different vulnerability classes of development in relation to Flood Zones A, B and C, and lists if development is appropriate in each Zone and where the Justification Test should be applied.

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

Table 3.2: Matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test.

With reference to the table above, the proposed foul pipe is 'Less Vulnerable Development' and the foul pipe falls within a delineated Flood Zone 'A' and Flood Zone 'B' in one location, therefore development proposals for the site are subject to the Justification Test.

Where 'Less vulnerable development' is proposed within a delineated Flood Zone 'A', the planning authority must be satisfied that the development satisfies the criteria of the Justification Test as described in Box 5.1 of the guidelines (*duplicated below*):-

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

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

1. The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative development plan, which has been adopted or varied taking account of these Guidelines.

2. The proposal has been subject to an appropriate flood risk assessment that demonstrates:

   (i) The development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk;

   (ii) The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible;

   (iii) The development proposed includes measures to ensure that residual risks to the area and/or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures and provisions for emergency services access; and

   (iv) The development proposed addresses the above in a manner that is compatible with the achievement of wider planning objectives in relation to development of good urban design and vibrant and active streetscapes.

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

Note: See section 5.27 in relation to major development on zoned lands where sequential approach has not been applied in the operative development plan.

Refer to section 5.28 in relation to minor and infill developments.

Each of the criteria listed in Box 5.1 above are considered as follows:-

1. *The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative development plan, which has been adopted or varied taking account of these guidelines.*

   Answer – The lands are zoned for residential development and the foul pipe will facilitate the sustainable development of this area of Gorey. The proposed development will result in the introduction of a residential accommodation land use to the subject site which will provide much needed housing for the growing population of the immediate area. The development will deliver upon the LAP objectives and zoning for the subject lands. The LAP has also undergone a Strategic Environmental Assessment, and a Flood Risk Assessment.

2. *The proposal has been subject to an appropriate flood risk assessment that demonstrates:*

   (i) The development proposed will not increase flood risk elsewhere and, if practical will reduce overall flood risk;

   Answer – The proposed foul pipe will not result in any loss in flood plain storage as a result of its construction. There will be no local connections to the foul pipe downstream of the main development site area and therefore there is no flood risk posed to any existing or future residents as a result of connection to the foul pipe.

   (ii) The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible;

   Answer – It is proposed to seal the foul manholes that are located within the flood risk area. This will ensure that the foul waters are not susceptible to inundation from fluvial flooding and therefore ensure there is no spillage from the proposed foul water network due to fluvial flood waters entering the piped system.

   (iii) The development proposed includes measures to ensure that residual risks to the area and/or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding or any future flood risk management measures and provisions for emergency services access;

   Answer – There are no residual risks posed as a result of the construction of the foul pipe within Flood Zone A and Flood Zone B.

(iv) *The development proposed addresses the above in a manner that is also compatible with the achievement of wider planning objectives in relation to development of good urban design and vibrant and active streetscapes;*

Answer - The proposed housing development on the subject site which is zoned for residential development and in close proximity to the town centre. The subject lands occupy a key location within Gorey as the site is situated on an under-utilised site on the edge of the town centre which partially exists on brownfield land, making it ideally placed for appropriate redevelopment. The layout is highly accessible for future occupants with a permeable layout both internally and externally as new linkages are provided. The layout is considered to be legible, with a clear distinction in design, character and treatment between distributor, local and shared surface streets.

The proposed development forms a significant part of the Creagh Key Development Site identified in the Gorey Town & Environs Local Area Plan 2017-2023. As such, it is seen as reflecting the natural evolution of the neighbourhood from low density outer suburban residential to a more structured and sustainable urban edge. The development of the Community & Education zoned lands will also give the opportunity to enhance the amenities of the area and surrounding developments, thus contributing to their collective viability as a neighbourhood in its own right.

10 Summary Conclusions

In consideration of the findings of this site specific flood risk assessment and analysis the following conclusions are made in respect of the proposed development site:-

- *A Site Specific Flood Risk (SSFRA) assessment, appropriate to the type and scale of development proposed, and in accordance with 'The Planning System and Flood Risk Management Guidelines – DoEHLG-2009' has been undertaken.*
- *The proposed site has been screened and scoped for flood risk in accordance with the above guidelines.*
- *The main area of the site where the residential development is proposed is not at risk of fluvial, pluvial or groundwater flooding.*
- *The proposed foul pipe route located outside the main development area and outside the applicants lands may be susceptible to fluvial flooding from the Ballyowen Stream in one location.*
- *It is proposed to modify the existing drainage channel adjacent to the eastern and southern boundaries of the site in order to accommodate the development as proposed, whilst also maintaining the functionality of the drainage channel to convey surface water runoff from surrounding lands.*
- *A hydrological analysis has been undertaken to estimate predicted 1 in 100 year (1% AEP) and 1 in 1000 year (0.1% AEP) flood volumes in the drainage channel within the boundary of the proposed development site.*
- *It is proposed to construct a 525mm diameter perforated pipe within the channel surrounded by Type B filter drain material within the existing drainage channel, which has adequate hydraulic capacity to convey the 1 in 100 year (1% AEP) + Climate Change flood volume of 0.774m3/s.*
- *The existing drainage channel above the 525mm diameter pipe shall be re-profiled and vegetated in order to form a swale type channel along the eastern boundary to capture any surface water runoff from the forest area to the east. Potential surface water runoff volume in excess the 1 in 100 year flow rate of 0.744 m^3/s and up to the 1 in 1000 year flow rate of 1.022 m3/s shall be conveyed within the profiled swale channel.*
- *In the context of the 'Planning System and Flood Risk Management Guidelines, DOEHLG, 2009' this Site Specific Flood Risk Assessment has determined the main development site area where the dwelling units are proposed falls within Flood Zone 'C'. In accordance with the 'Planning System & Flood Risk Management Guidelines, DOEGLG, 2009' development proposals for this area of the site are therefore not subject to the requirements of the Justification Test.*

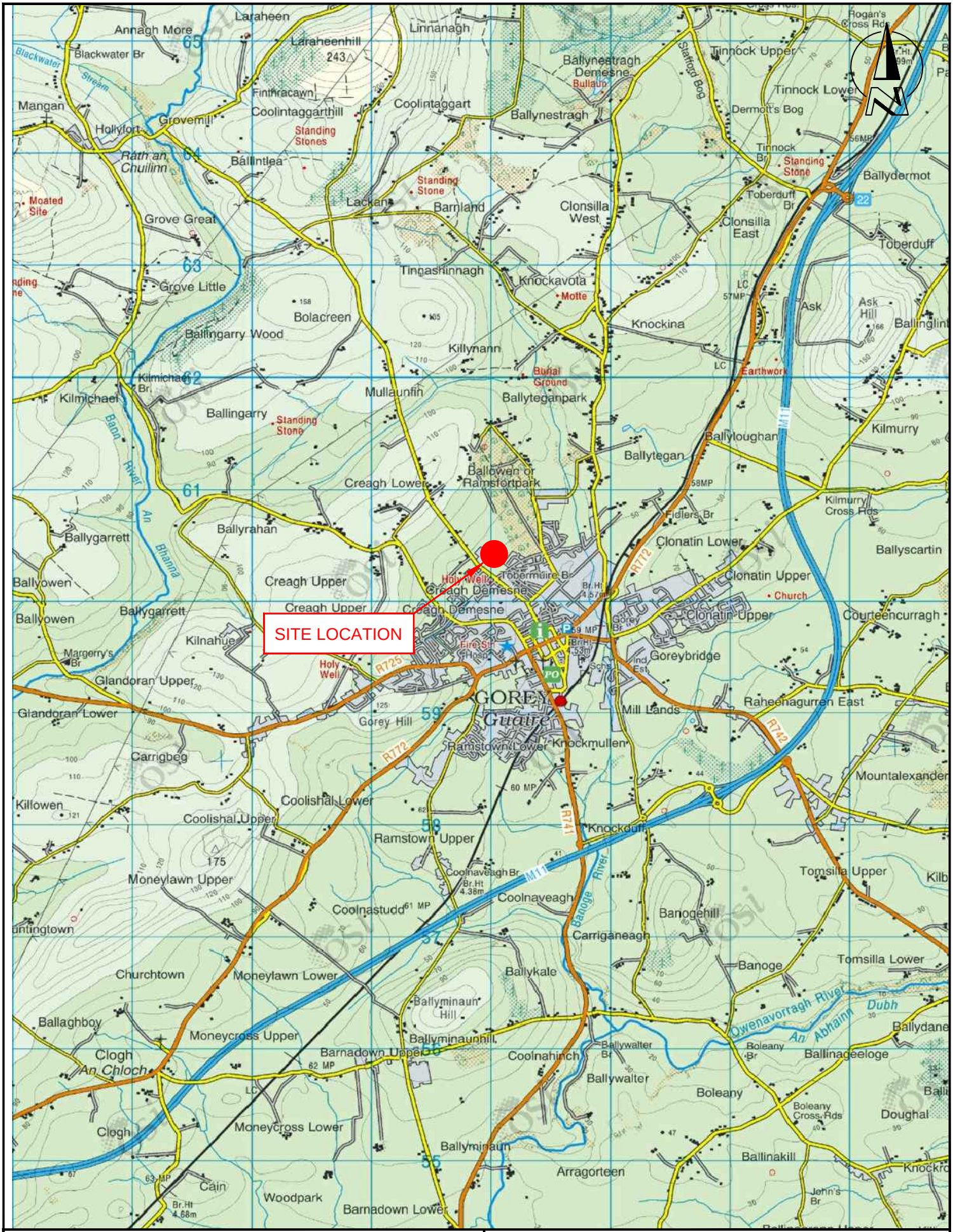
- *The proposed foul water pipe located outside the ownership of the applicant falls within Flood Zone 'A' and Flood Zone 'B' in one location. In accordance with the 'Planning System & Flood Risk Management Guidelines, DOEGLG, 2009' development proposals for this area of the site may be to the requirements of the Justification Test.*
- *It is proposed to construct the proposed foul manholes with sealed flood proof covers within the two flood risk areas. This will ensure that the foul waters are not susceptible to inundation from fluvial flooding and therefore ensure there is no spillage from the proposed foul water network due to fluvial flood waters entering the piped system.*
- *The proposed development is considered to comply with the requirements of the Justification Test for development management.*
- *Overall, the flood risk to the proposed development site is LOW. In consideration of this analysis, development of the site is not expected to result in an adverse impact to the hydrological regime of the area or to increase flood risk elsewhere and is therefore considered to be appropriate from a flood risk perspective.*

IE CONSULTING
WATER-ENVIRONMENTAL-CIVIL

APPENDIX A

Drawing Number IE1544-001-B

Drawing Number IE1544-002-E



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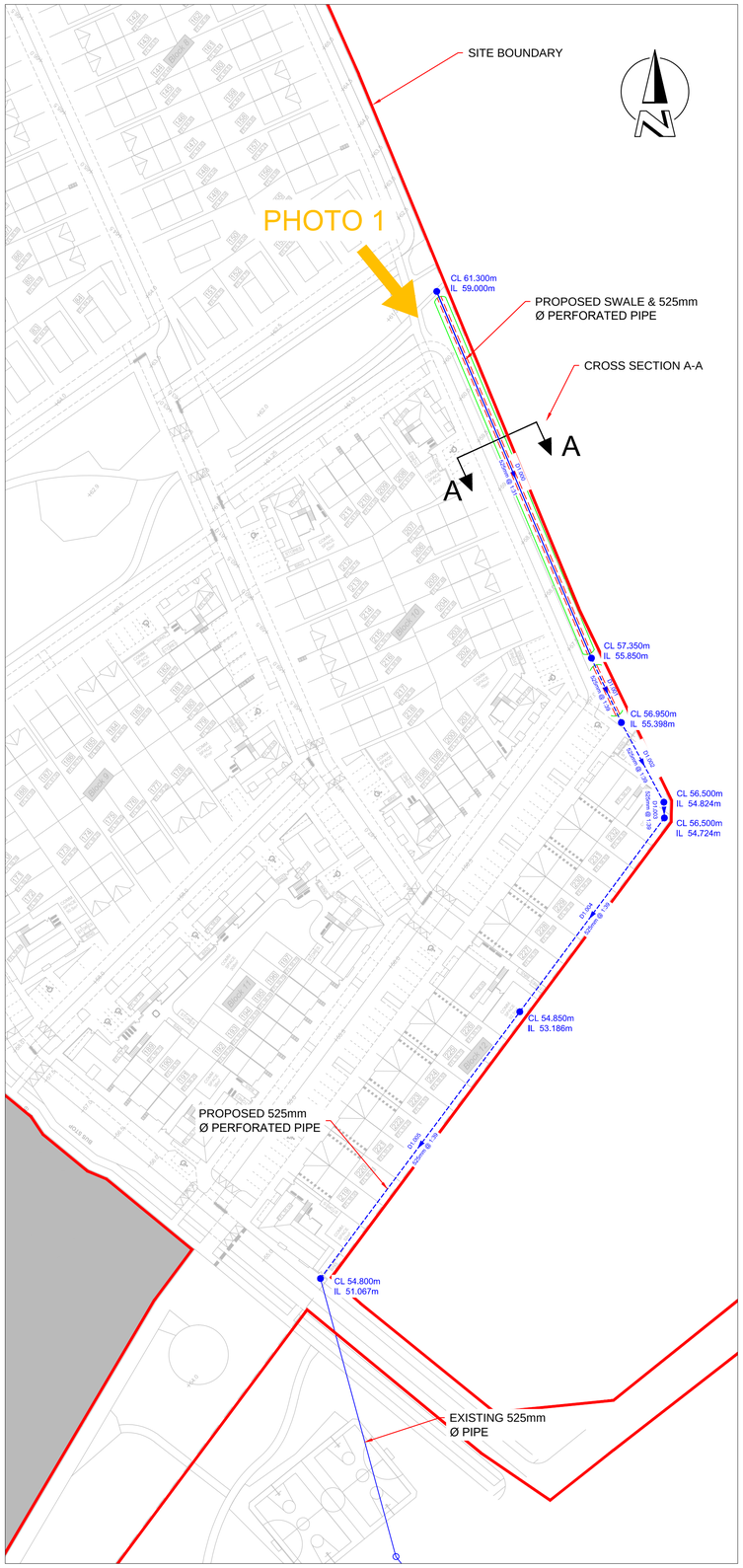
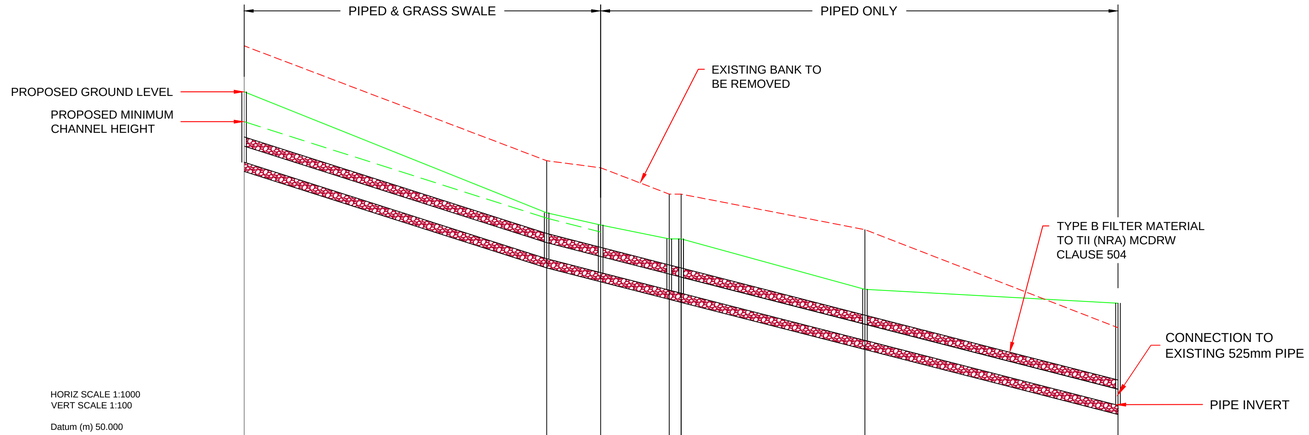
WATER-ENVIRONMENTAL-CIVIL

Project Title:	FLOOD RISK ASSESSMENT
Project Address:	CREAGH DEMENSE, GOREY, CO WEXFORD
Client:	AMIL PROPERTIES LTD.
Drg. Title:	SITE LOCATION MAP

Dwg.Scale:	Date:	Dwg.No:	Job No:	Revision:	Dwg.By:
1:50,000	16-08-18	IE1544-001	IE1544	B	JMCG



LAYOUT PLAN
SCALE 1:750

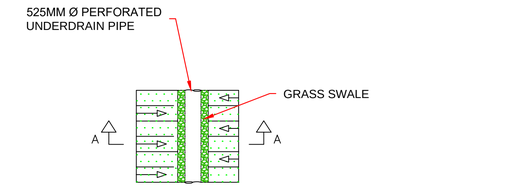


HORIZ SCALE 1:1000
VERT SCALE 1:100

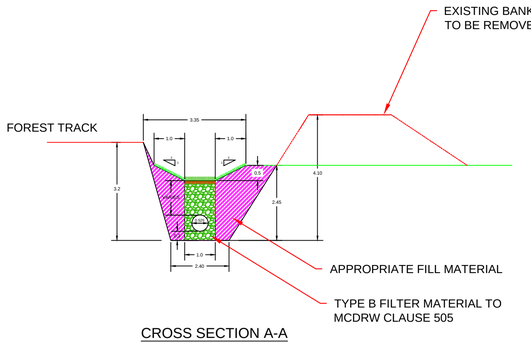
Datum (m) 50.000

PN	D1.000		D1.001	D1.002		D1.004		D1.005	
Dia (mm)	525		525	525		525		525	
Slope (1:X)	31		39	39		39.0		39.0	
EXISTING GROUND LEVEL (m)	62.800		59.050	58.820	57.710	57.710		54.850	54.400
PROPOSED GROUND LEVEL (m)	61.300		57.350	56.950	56.500	56.500		54.850	54.800
PROPOSED PIPE INVERT LEVEL (m)	59.000		55.850	55.398	54.824	54.724		53.186	51.067
Length (m)	98.756		17.625	22.398		60.000		82.621	
Pipe Material & Type	Perforated Polypropylene								

LONG SECTION
VERT SCALE 1:100
HORIZ SCALE 1:1000



PLAN VIEW
SCALE 1:100



CROSS SECTION A-A
SCALE 1:100

PHOTO 1 - EXISTING DRAINAGE CHANNEL

LEGEND

rev.	date	amendment	drn	ckd
E	19.12.18	PLANNING	JMC	PMS

PROPOSED DEVELOPMENT AT
CREAGH DEMENSE, GOREY,
CO. WEXFORD

PROPOSED DRAINAGE CHANNEL

PLAN & SECTION DETAILS

IE CONSULTING
WATER-ENVIRONMENTAL-CIVIL

INNOVATION CENTRE
GREEN ROAD
CARLOW

TELEPHONE: 059 91 33084
FAX: 059 91 40499
EMAIL: info@iece.ie

file location:	N:\IE1544\DRAWINGS	scale:	AS SHOWN A1
drawing status:	PLANNING	datum:	MALIN
		drawn:	JMC
drawing no.	rev	checked:	NOM
IE1544-002	E	approved:	PMS
		date:	19.12.2018

APPENDIX B

OPW FLOODING REPORT

GOREY AREA : FLOOD HISTORY

LOCATION	TOWNLAND	RD NO.	STATUS.	COMMENTS.
GLANBIA			N 11	REMEDIAL WORK CARRIED OUT IN CONJUNCTION WITH GLANBIA 4-8 years ago – (SOLVED)
ARKLOW ROAD BRIDGE			N11	NEW pipe system put in place DRAIN ALONG BY RAILWAY CLEANED + DEEPENED. (NB) COULD RETURN if DRAINGE THROUGH ALDI SITE INTER-FERES WITH.
AHARE BRIDGE			Co. Rd.	ON GOING DURING HEAVY RAIN
GARDEN CITY			Co. Rd	NEW BRIDGE INSTALLED (SOLVED)
CLONOUGH BRIDGE			Co. Rd.	BRIDGE COLLAPSED DURING HURRICANE CHARLIE NEW BRIDGE CONSTRUCTED
CASTLE TOWN BR.			Co. Rd	BRIDGE COLLAPSED DURING HURRICANE CHARLIE NEW BRIDGE CONSTRUCTED.
LR. ESMONDE ST.			REGIONAL RD.	MAJOR FLOODING DURING HURRICAN CHARLIE - WALL COLLAPSED. RIVER HAS SINCE BEEN DIVERTED & SCHOOL BUILT + COMMERCIAL DEVELOPMENT IN AREA.
RIVER CHAPEL			REGIONAL + Co.	FLOODING CAUSED BY BRIANOGUE RIVER DURING HEAVY RAIN. FLOOD BARRIERS (DOOR) SUPPLIED TO LOW LYING HOUSES.
CARRIGANEAGH			REGIONAL	FLOODING ALONG BY CARRIGANEAGH ROCK during HEAVY RAIN. ROAD RAISED ½ METRE. (SOLVED)
COOLOOK BRIDGE			Co. Rd.	PERIODIC FLOODING AT COOLOOK – MAYBE 6-7 years SINCE LAST OCCASION.

APPENDIX C

DRAINAGE PIPE CAPACITY CALCULATIONS

Existing Network Details 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
D1.000	98.756	3.150	31.4	0.000	10.00	0.0	0.600	o	525	Pipe/Conduit
D1.001	17.625	0.452	39.0	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit
D1.002	22.398	0.574	39.0	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit
D1.003	3.884	0.100	38.8	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit
D1.004	60.000	1.538	39.0	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit
D1.005	82.621	2.119	39.0	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit
D1.006	71.490	2.217	32.2	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit
D1.007	94.677	2.212	42.8	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit

Network Results Table

PN	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Vel (m/s)	Cap (l/s)
D1.000	59.000	0.000	0.0	4.01	868.2
D1.001	55.850	0.000	0.0	3.59	778.2
D1.002	55.398	0.000	0.0	3.59	778.0
D1.003	54.824	0.000	0.0	3.60	779.7
D1.004	54.724	0.000	0.0	3.59	778.2
D1.005	53.186	0.000	0.0	3.60	778.3
D1.006	51.067	0.000	0.0	3.95	856.1
D1.007	48.850	0.000	0.0	3.43	742.7