Site Specific Flood Risk Assessment

Haggardstown, Blackrock, Co. Louth

May 2025

IE CONSULTING
WATER-ENVIRONMENTAL-CIVIL

Site Specific Flood Risk Assessment

Client: Marina Quarter Ltd

Location: Haggardstown, Blackrock, Co. Louth

Date: 16th May 2025

Document Control

PROJECT NUMBER: IE3047		DOCUMENT REF: IE3047_Report_6382			
6.0	ISSSUE-04	NOM	MOF	PMS	27-05-2025
5.0	ISSSUE-03	NOM	MOF	PMS	16-05-2025
4.0	ISSSUE-02	NOM	MOF	PMS	30-04-2025
3.0	ISSSUE-01	NOM	MOF	PMS	10-02-2025
2.0	DRAFT-02	NOM	MOF	PMS	14-01-2025
1.0	DRAFT-01	NOM	MOF	PMS	12-12-2024
Revision	Purpose Description	Originated	Checked	Reviewed	Date

CARLOW OFFICE: INNOVATION CENTRE, GREEN ROAD, CARLOW, R93 W248
Tel: 059 91 33084 Email: info@iece.ie Web: www.iece.ie

NEWRY OFFICE: 7 LINENHALL, WIN BUSINESS PARK, NEWRY, BT35 6PH
Tel: 048 302 57974 Email: info@iece.ie Web: www.iece.ie

Contents

1.	**Introduction**	**1**
2.	**Proposed Site Description**	**2**
2.1.	General	2
2.2.	Existing Topography Levels at Site	3
2.3.	Local Hydrology, Landuse & Existing Drainage	3
3.	**Flood Risk Identification**	**4**
3.1.	Possible Flooding Mechanisms	4
3.2.	Screening Assessment	5
3.2.1.	OPW/EPA/Local Authority Hydrometric Data	5
3.2.2.	OPW PFRA Indicative Flood Mapping	5
3.2.3.	OPW Flood Info Website	6
3.2.4.	Ordnance Survey Historic Mapping	8
3.2.5.	Geological Survey of Ireland Mapping	9
3.2.6.	North Western Neagh Bann CFRAM Study	10
3.2.7.	Irish Coastal Wave and Water Level Modelling Study (ICWWS) 2018 – Phase 1	12
3.2.8.	National Coastal Flood Hazard Mapping (NCFHM) 2021	13
3.2.9.	Louth County Development Plan 2021-2027	15
3.2.10.	Dundalk Local Area Plan 2025-2031	16
3.3.	Summary	17
4.	**Initial Flood Risk Assessment**	**18**
5.	**Detailed Flood Risk Assessment**	**19**
5.1.	Assessment of Tidal Flood Risk	19
5.1.1.	Tidal Cycle Profiles	19
5.1.2.	2D Tidal Model Build	20
5.1.3.	Modelling Results for Present Day Scenario	23
5.1.4.	Modelling Results for MRFS	25
5.2.	Assessment of Secondary Flood Risk – Pluvial Overland Flow	26
5.2.1.	Overland Flow Paths	26
5.2.2.	Rainfall Data	27
5.2.3.	2D Pluvial Model Build	28
5.2.4.	Critical Duration Analysis	32
5.2.5.	Modelling Results for Present Day Scenario	33
5.2.6.	Modelling Results for MRFS	34
6.	**Development in the Context of the Guidelines**	**36**

7. Assessment of Hydrological Impact of Proposed Development 38

7.1. Tidal Flooding 38

7.1.1. Modelling Results for Present Day Scenario 39

7.1.2. Modelling Results for MRFS 40

7.2. Pluvial Flooding (Overland Flow) 41

7.2.1. Main Site Area 42

7.2.2. Proposed Entrance Road Embankment 42

8. Justification Test for Development Management 53

9. Summary Conclusions and Recommendations 59

Appendices

Appendix A. Drawings

Appendix B. Met Éireann Rainfall Data

1. Introduction

IE Consulting was requested by Donnachadh O'Brien & Associates Consulting Engineers, on behalf of Marina Quarter Ltd, to undertake a Site Specific Flood Risk Assessment (SSFRA) in support of a planning application for a development site at Haggardstown, Blackrock, Co. Louth. It is proposed to construct a Large Scale Residential Development (LRD) and all associated site works at this location.

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

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 and in compliance with the following guidance document:

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

2. Proposed Site Description

2.1. General

The proposed development site is located at Haggardstown, Blackrock, Co. Louth. The site is bounded to the north and east by existing residential properties, to the west by a golf course and to the south by agricultural lands. The total area of the proposed development site is approximately 18.54 hectares.

The location of the proposed development site is illustrated on *Figure 1* below and shown on Drawing Number *IE3047-001-A*, *Appendix A*.

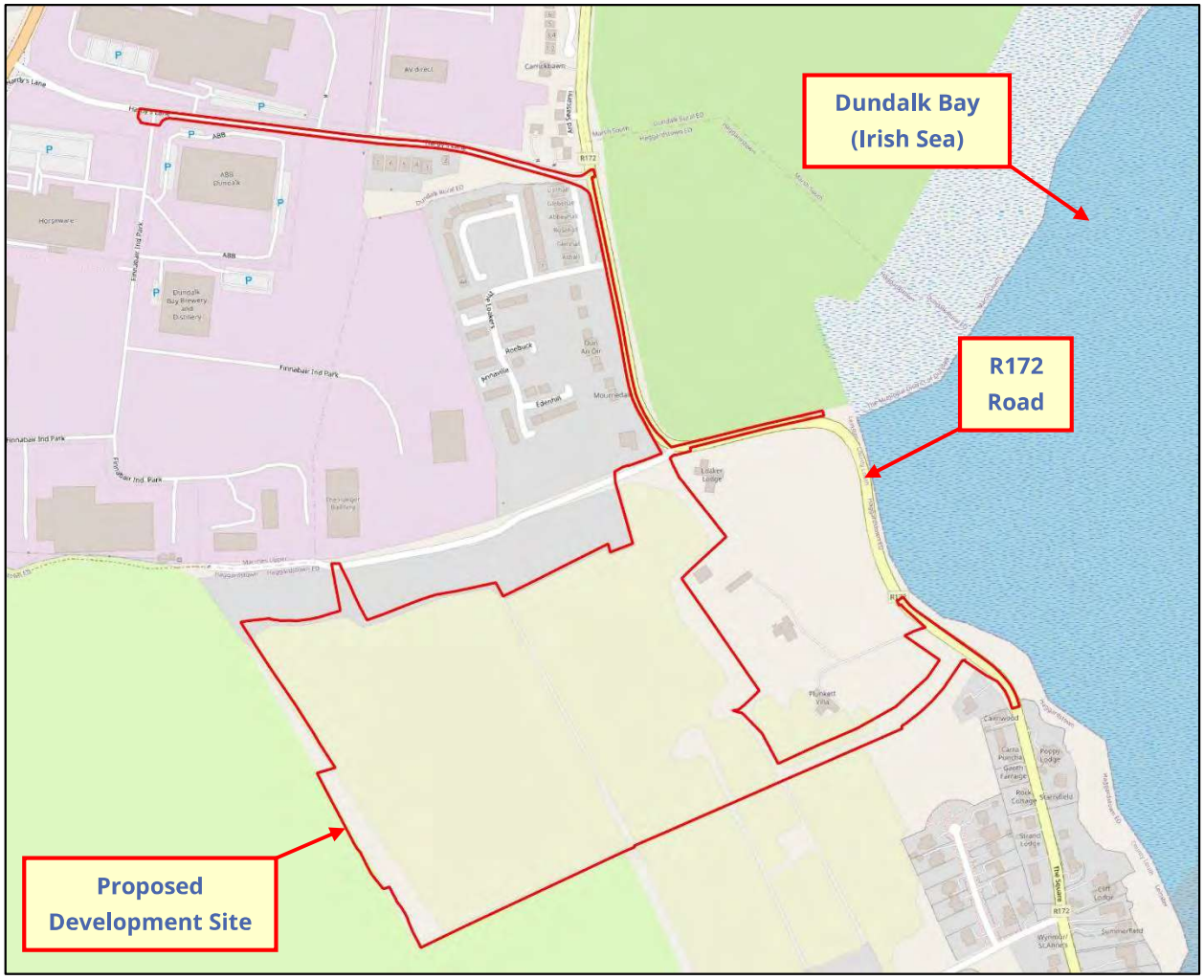


Figure 1 – Site Location

2.2. Existing Topography Levels at Site

The proposed development site slopes moderately from the south-western corner of the site to the eastern boundary of the site at an average gradient of approximately 2.9% (1 in 34).

Existing ground elevations range from approximately 23.05m OD (Malin) located in the south-western corner of the site to 3.204m OD (Malin) at the eastern entrance to the site.

2.3. Local Hydrology, Landuse & Existing Drainage

The most immediate and significant hydrological feature in the vicinity of the proposed development site is the Irish Sea (Dundalk Bay), which is located adjacent to the proposed development entrance on the eastern boundary of the site. There are also two drainage channels located beyond the eastern and northern boundaries of the site adjacent to the R172 road. The eastern drainage channel connects two wetland areas, to the point where the channel crosses under the R172 road as shown in *Figure 2* below.

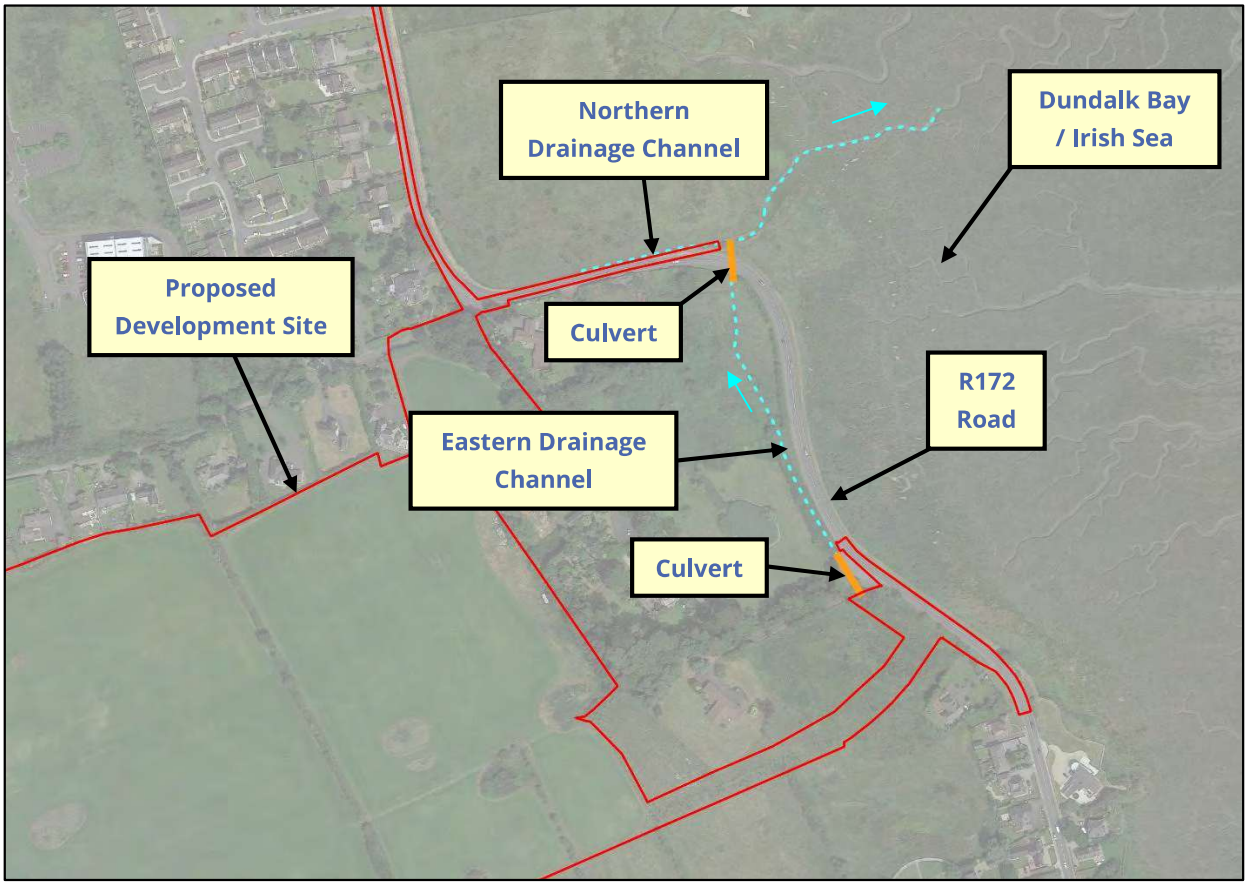


Figure 2 – Hydrological Features

3. Flood Risk Identification

The flood risk assessment for the proposed development site is undertaken in three principal stages, these being 'Stage 1 – Flood Risk Identification', 'Stage 2 – Initial Flood Risk Assessment' and 'Stage 3 – Detailed Flood Risk Assessment'.

3.1. Possible Flooding Mechanisms

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

Source/Pathway	Significant?	Comment/Reason
Tidal/Coastal	Yes	The site is located in a tidal area.
Fluvial	Possible	There are drainage channels located in the eastern and northern area of the site.
Pluvial (urban drainage)	No	There is no significant or major urban drainage or water supply infrastructure located at or in the immediate vicinity of the site.
Pluvial (overland flow)	Possible	There are elevated lands within the western area of the site.
Blockage	Possible	There are culverts located on the drainage channels in the vicinity of the site.
Groundwater	No	There are no significant springs or groundwater discharges mapped or recorded in the immediate vicinity of the site.

Table 1: Flooding Mechanisms

The primary potential flood risk to the proposed development site can be attributed to an extreme tidal flood event in the vicinity of the site and/or potential pluvial flooding from overland flow of surface waters from elevated lands within and potentially beyond the western boundary of the site.

In accordance with 'The Planning System and Flood Risk Management – Guidelines for Planning Authorities - DOEHLG 2009' the potential flood risk to the proposed development site is analysed in the subsequent 'Screening Assessment' and 'Initial Flood Risk Identification" section of this study report.

3.2. 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 'Stage 2 – Initial Flood Risk Assessment' or if no potential flood risk is identified from the screening stage then the overall flood risk assessment can end at 'Stage 1'.

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

3.2.1. OPW/EPA/Local Authority Hydrometric Data

Existing sources of OPW, EPA and local authority hydrometric data were investigated. This assessment has determined that there are no hydrometric gauging stations located in the vicinity of the proposed development site.

3.2.2. OPW PFRA Indicative Flood Mapping

Preliminary Flood Risk Assessment (PFRA) Mapping for Ireland was produced by the OPW in 2011. OPW PFRA flood map number 2019/MAP/252/A illustrates indicative flood zones within this area of County Louth. *Figure 3* below illustrates an extract from the above indicative flood map in the vicinity of the proposed development site.

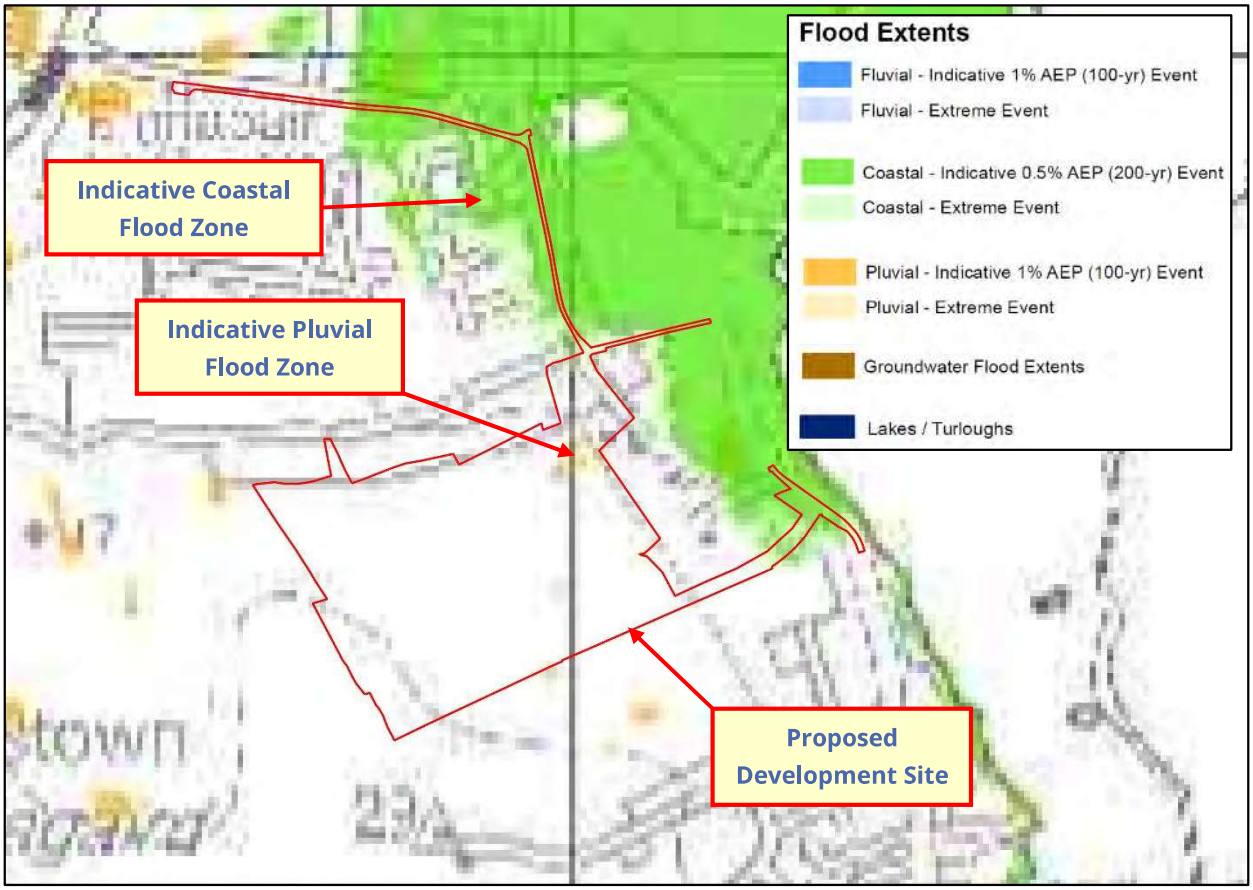


Figure 3 - OPW PFRA Mapping

Figure 3 above shows coastal flooding mapped in the eastern area of the site. There are no mapped indicative fluvial or groundwater flood zones within the boundary of the proposed development site.

It should also be noted that the indicated 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.

3.2.3. OPW Flood Info Website

The OPW Flood Info website (www.floodinfo.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 4* below illustrates mapping from the OPW Flood Info website in the vicinity of the site, which identifies recurring flood events recorded in the vicinity of the proposed development site.

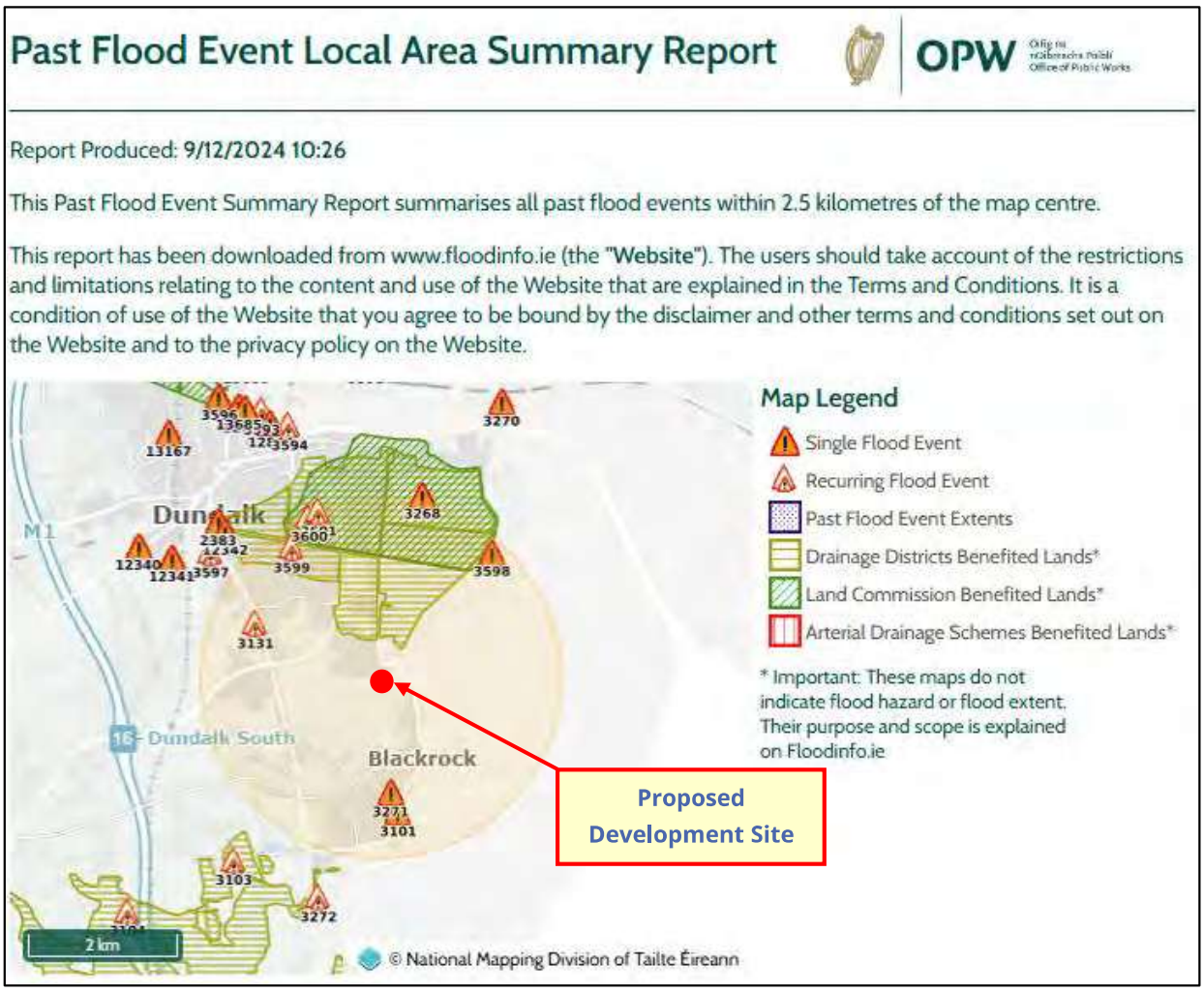


Figure 4 - OPW Past Flood Events

There are single flood events and recurring flooding recorded within 2.5km of the site as shown in *Figure 4* above. These are summarised below:

- **Flood ID 3101** refers to flooding in the Rock Court housing estate area following heavy rainfall in March 2001. A letter from local residents suggests this is due to an undersized culvert under Southend Road.

  There is also a report from Louth County Council, dated 22nd February 2002, of damage to a sea wall/defence along Main Street, Blackrock due to "unprecedented high tides and easterly gales".

- **Flood IDs 3271, 3598, 3599 & 3600** include meeting minutes from October 2005, which refer to Blackrock Promenade as being an area prone to flooding. The report states that "high tide in February 2002 severely flooded this area. Houses along Main St. were damaged. Also badly

effected Village Green/new Golf Links Road and Wallis Road/Rock Road junction. Floods impact approx. 1 in 5 years.

- **Flood ID 3131** includes a letter from An Garda Siochana to Dundalk Urban District Council, dated October 1997, regarding flooding on Mullaharlin Road (Marshes Upper). This stated that the flooding exposed motorists and pedestrians to considerable danger.

The above reports do not specifically identify the area of the proposed development site as having been subjected to a flood event or recurring flooding.

There are areas designated as 'Drainage District Benefiting Lands' located 300m north of the site boundary. 'Benefiting Lands' are defined as 'land that was drained as part of the Drainage District' and does not necessarily indicate areas of existing flood risk. Local authorities are charged with responsibility to maintain Drainage Districts.

3.2.4. 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. *Figure 5* and *Figure 6* below show the historic mapping for the area of the proposed development site.

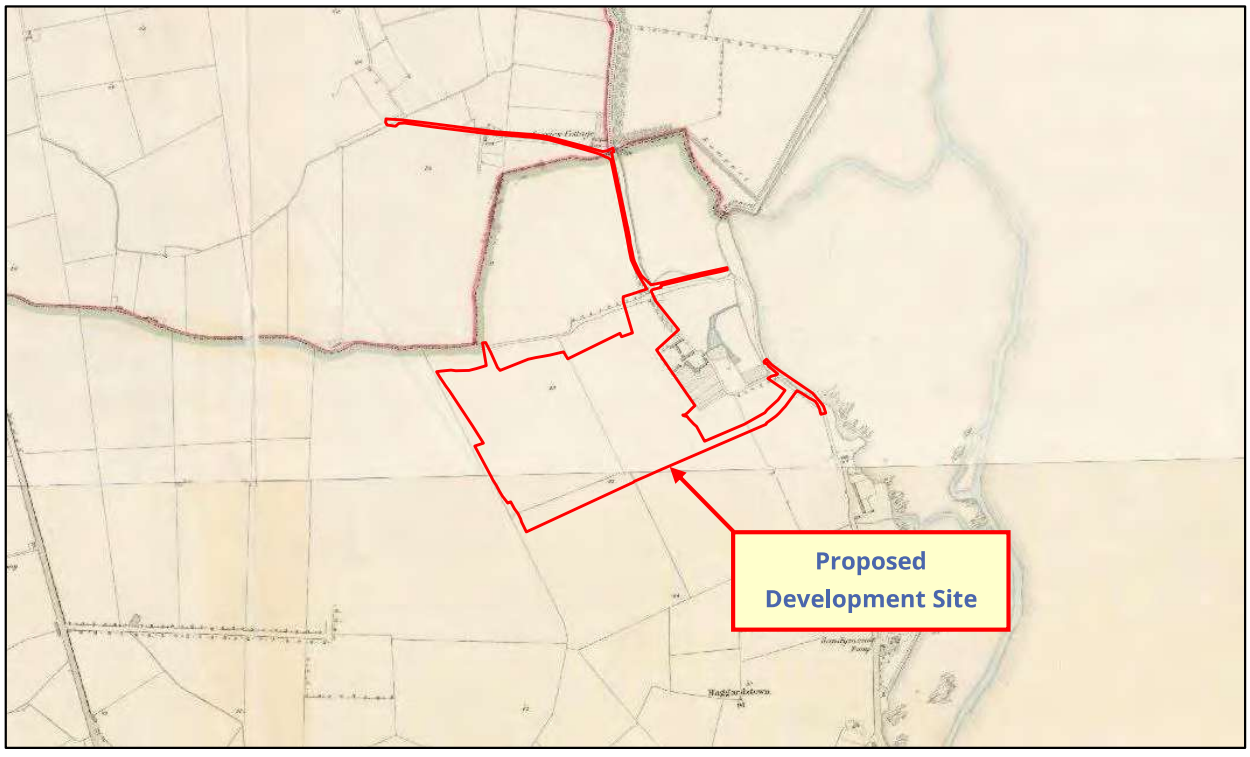


Figure 5 - Historic 6 Inch Mapping

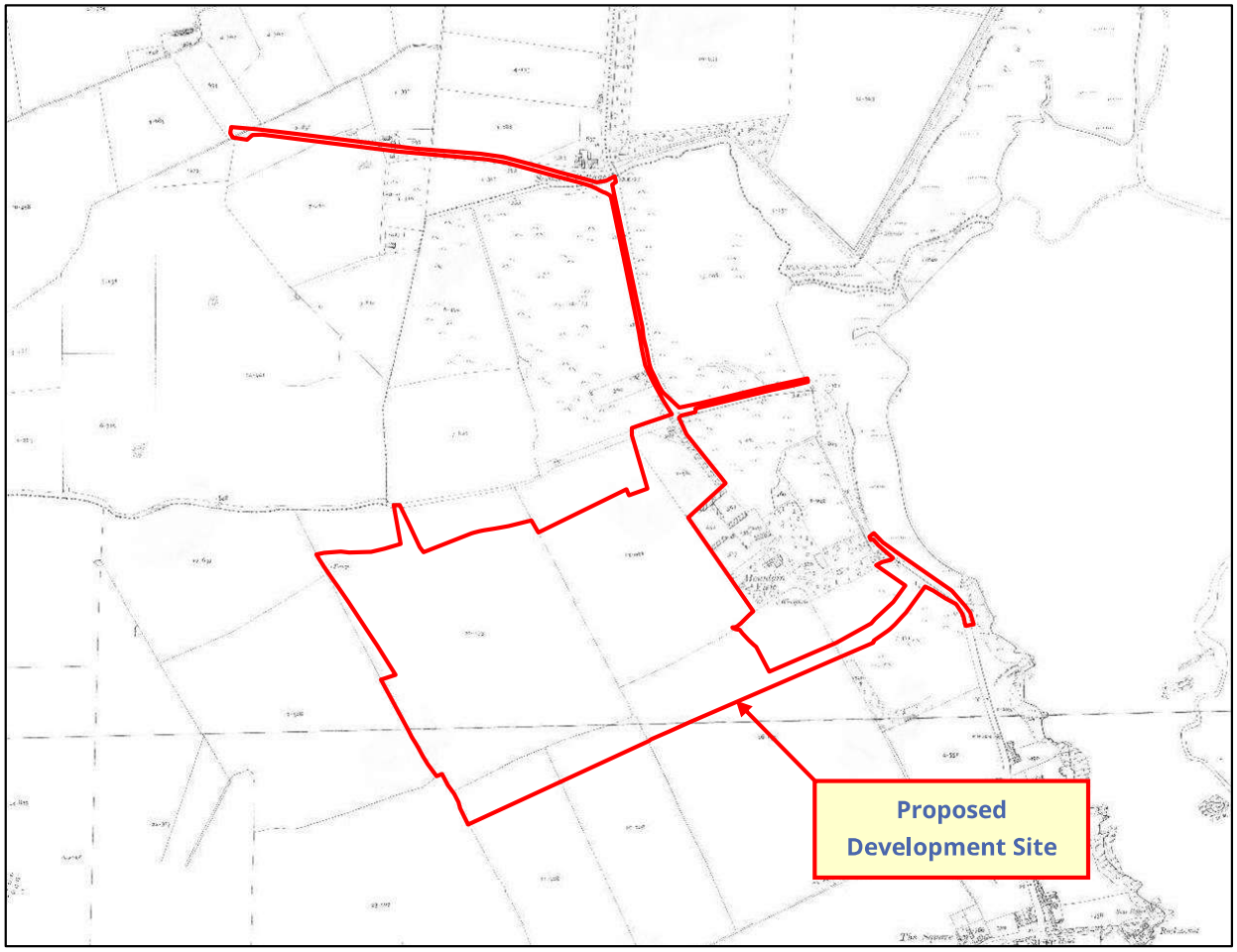


Figure 6 - Historic 25 Inch Mapping

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.

3.2.5. 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 7* below illustrates the sub-soils mapping for the general area of the site. This indicates that the proposed development site is underlain by Sandstone & Shale Till, Sandstone & Shale Till With Matrix Of Irish Sea Basin Origin, Marine Sand and Gravels and Made Ground. There are no Alluvium deposits mapped within the boundary of the site.

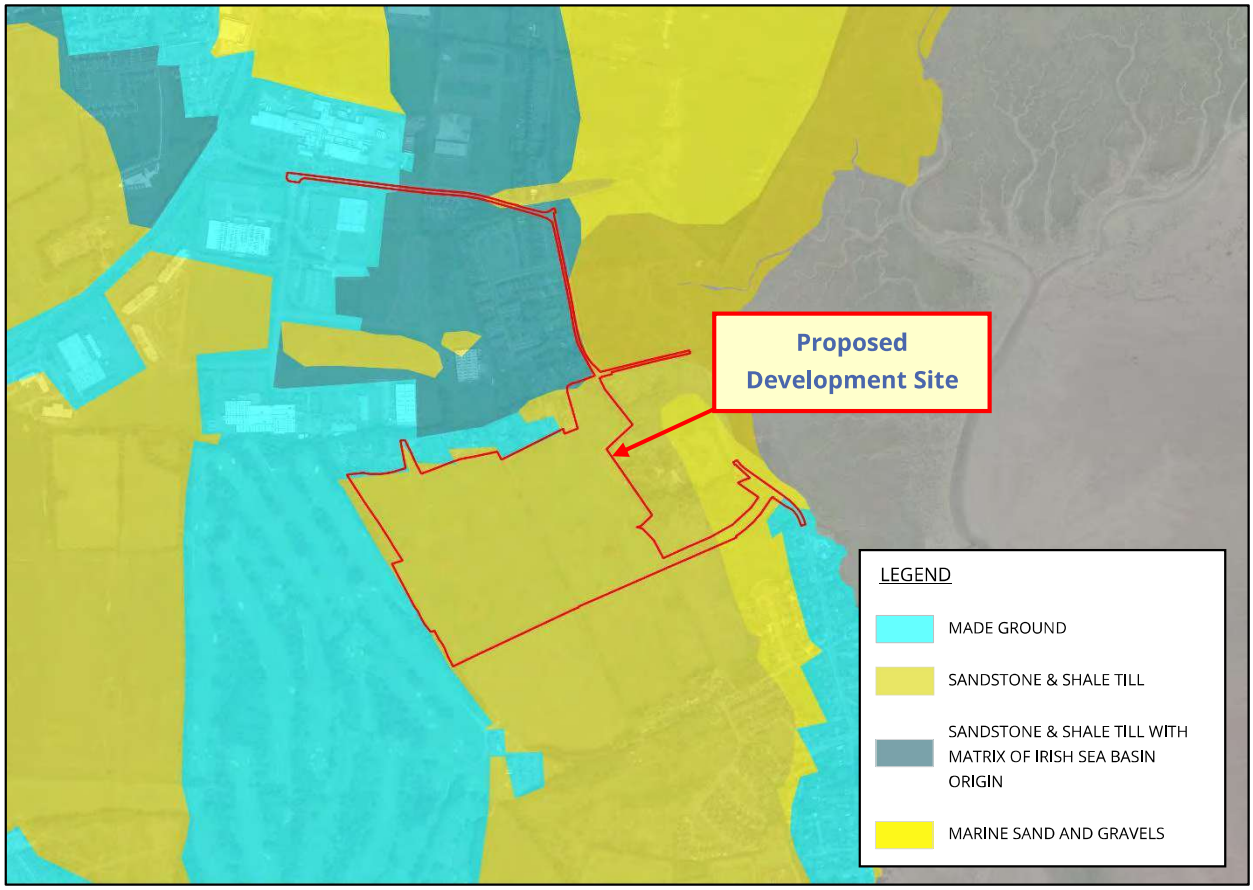


Figure 7 - GSI Subsoil Mapping

3.2.6. North Western Neagh Bann CFRAM Study

The North Western Neagh Bann Catchment Flood Risk & Management Study (CFRAMS) has been undertaken by the OPW and the final version of the flood maps were issued in August 2016. Fluvial and tidal flood risk extent and depth maps for further assessment areas within Blackrock have been produced. OPW CFRAMS predictive flood map numbers *N06BRK_EXFCD_F0_02* and *N06DDK_EXCCD_F0_21* illustrate predictive extreme fluvial and tidal flood extent zones in the vicinity of the proposed development site.

Figure 8 below (extracted from CFRAMS flood map *N06BRK_EXFCD_F0_02*), illustrates the predictive extreme 10% AEP (1 in 10 year), 1% AEP (1 in 100 year) and 0.1% AEP (1 in 1000 year) fluvial flood extents in the vicinity of the proposed development site.

Figure 9 below (extracted from CFRAMS flood map *N06DDK_EXCCD_F0_21*), illustrates the predictive extreme 10% AEP (1 in 10 year), 0.5% AEP (1 in 200 year) and 0.1% AEP (1 in 1000 year) tidal flood extents in the vicinity of the proposed development site.

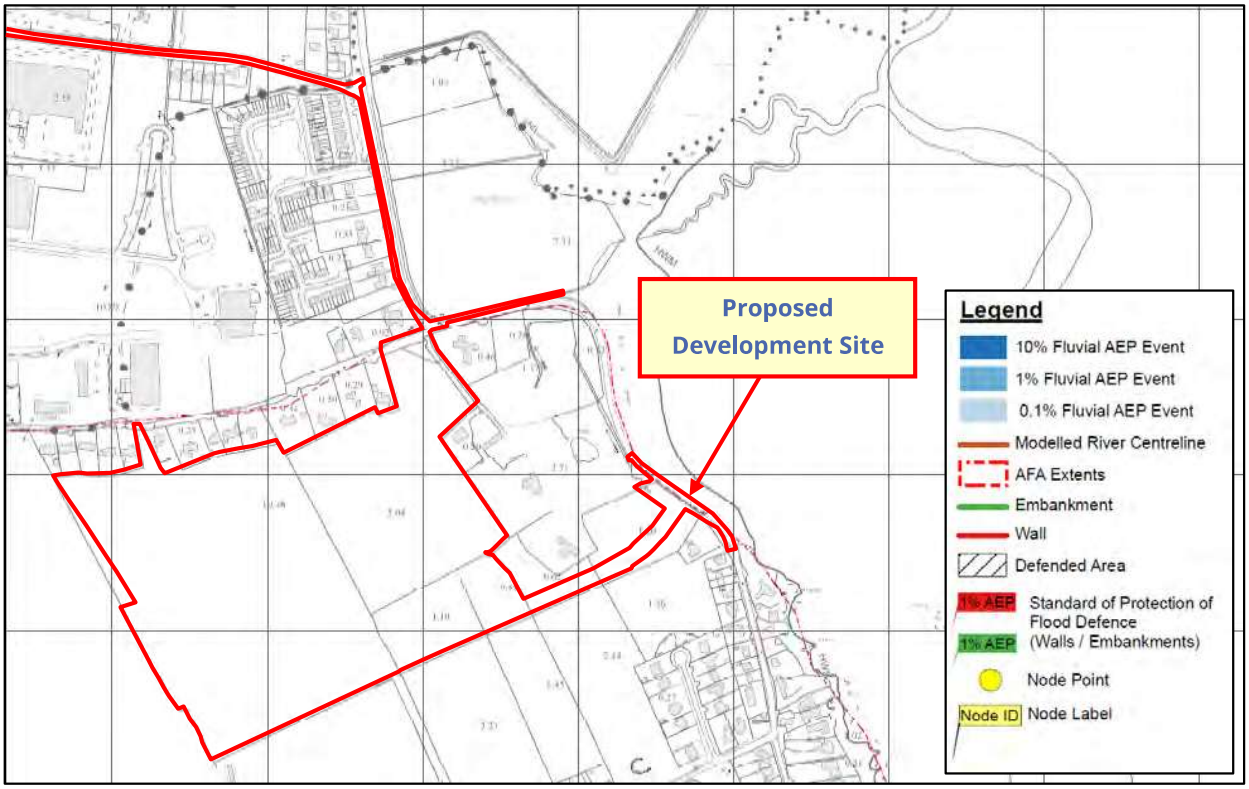


Figure 8 - CFRAMS Fluvial Flood Maps

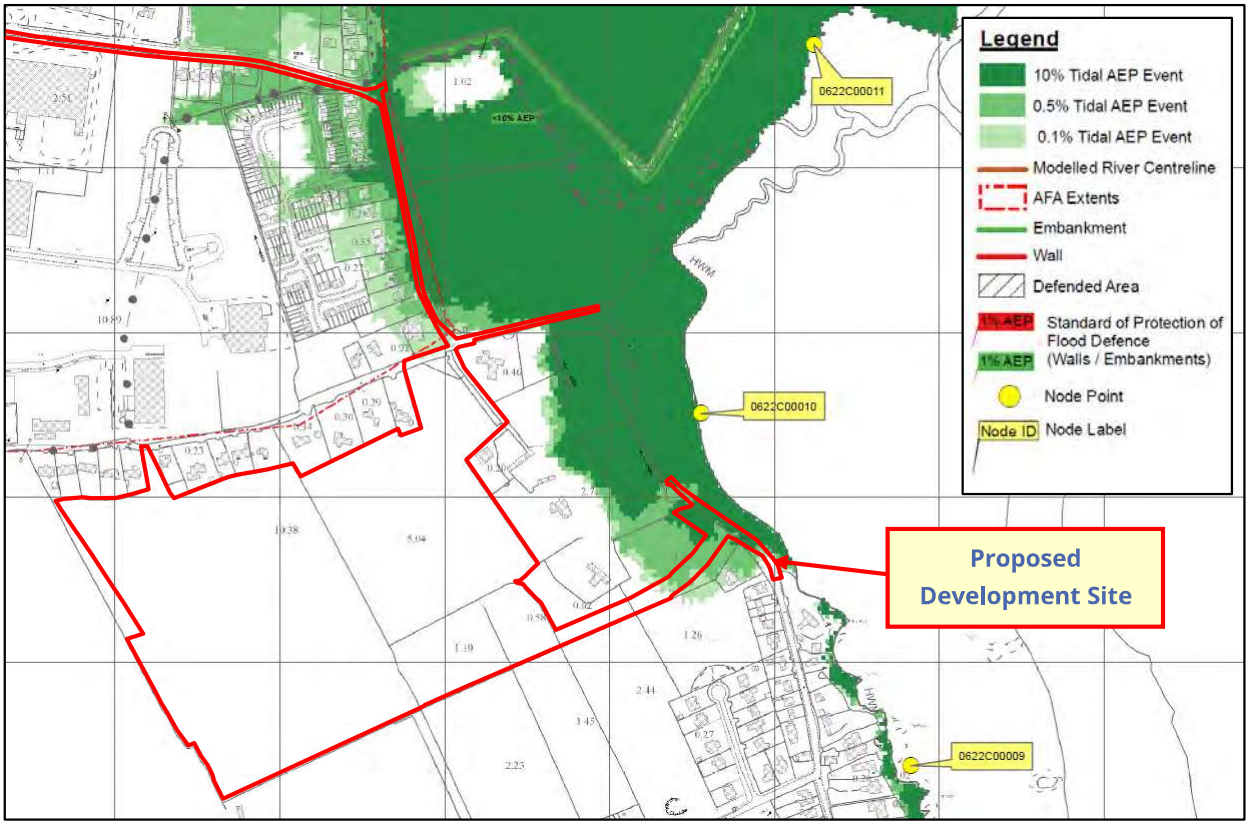


Figure 9 - CFRAMS Tidal Flood Maps

Figure 8 above indicates that the proposed development site does not fall within a predictive 1% AEP (1 in 100 year) or 0.1% AEP (1 in 1000 year) fluvial flood zone.

Figure 9 above indicates the eastern area of the site may be at risk of inundation due to an extreme 10% AEP (1 in 10 year), 0.5% AEP (1 in 200 year) and 0.1% AEP (1 in 1000 year) tidal flood event. The CFRAMS tidal flood map reference *N06DDK_EXCCD_F0_21* provides information on predictive water levels and for the 10% AEP (1 in 10 year), 0.5% AEP (1 in 200 year) and 0.1% AEP (1 in 1000 year) tidal flood events at various node points within Dundalk Bay. The closest node points to the proposed development site are referenced as node points *0622C00011*, *0622C00010* and *0622C00009* as illustrated in *Figure 9* above. Details of the predictive tidal flood levels for these CFRAMS node points are listed in *Table 2* below.

Node Label	Water Level (m OD) 10% AEP	Water Level (m OD) 0.5% AEP	Water Level (m OD) 0.1% AEP
0622C00009	3.28	3.72	3.95
0622C00010	3.28	3.72	3.94
0622C00011	3.28	3.72	3.95

Table 2: CFRAMS Predicted Tidal Flood Levels

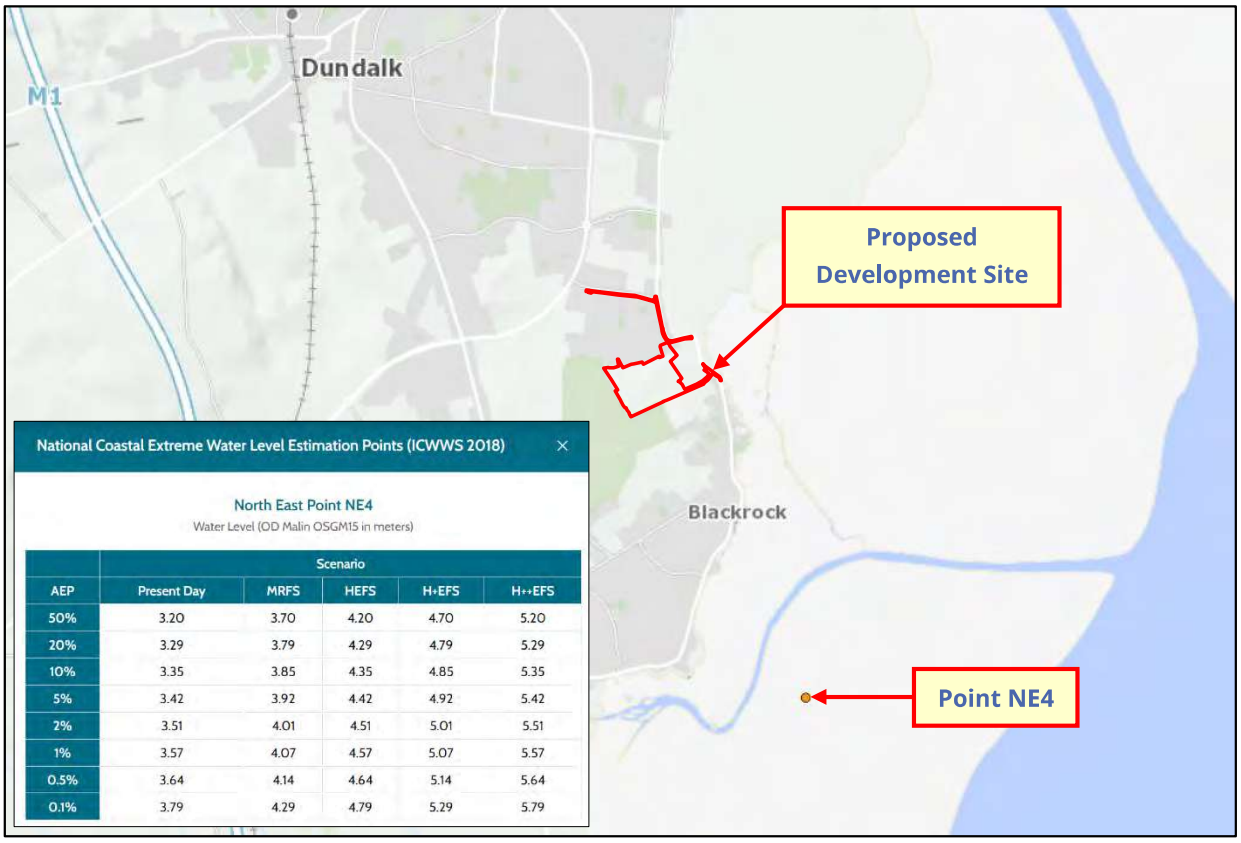
3.2.7. Irish Coastal Wave and Water Level Modelling Study (ICWWS) 2018 – Phase 1

This study was undertaken in 2018 as an update of the extreme water level estimation undertaken as an update to the Irish Coastal Protection Strategy Study (ICPSS) undertaken between 2004 and 2013. There is no updated flood extent mapping provided as part of this study, however the extreme water levels in the Dundalk Bay area are shown in *Figure 10* below.

The closest point to the site is NE4 located 2.45km to the south of the site in Dundalk Bay. The predictive 0.5% AEP (1 in 200 year) and 0.1% AEP (1 in 1000 year) tidal flood levels at point NE4 are **3.64m OD** and **3.79m OD** respectively for the present day scenario. The predictive 0.5% AEP (1 in 200 year) tidal flood level for the Mid-Range Future Scenario (MRFS) at point NE4 is **4.14m OD**.

The extreme water levels refer to total water levels, i.e. water levels that include the effects of astronomic tides and storm surge (tidal Surge) residuals. Astronomic tides are the daily change in sea levels due to the rotation of the earth and the gravitational forces of the sun and moon along with the hydrodynamic response to the bathymetry, whilst storm surge residual refers to the change in sea level caused by the effect of atmospheric pressure variations and persistently strong winds. A joint

probability analysis was therefore undertaken of astronomic tides and storm surge residuals in deriving extreme water levels for the various return period events.



	Scenario				
AEP	Present Day	MRFS	HEFS	H+EFS	H++EFS
50%	3.20	3.70	4.20	4.70	5.20
20%	3.29	3.79	4.29	4.79	5.29
10%	3.35	3.85	4.35	4.85	5.35
5%	3.42	3.92	4.42	4.92	5.42
2%	3.51	4.01	4.51	5.01	5.51
1%	3.57	4.07	4.57	5.07	5.57
0.5%	3.64	4.14	4.64	5.14	5.64
0.1%	3.79	4.29	4.79	5.29	5.79

Figure 10 – ICWWS Flood Levels

3.2.8. National Coastal Flood Hazard Mapping (NCFHM) 2021

The NCFHM mapping was produced by the OPW in 2021 utilising the estimated extreme water level outputs from Phase 1 of the Irish Coastal Wave and Water Level Modelling Study (ICWWS 2018). It includes coastal flood extent and depth maps produced for the 50% (1 in 2 year), 20% (1 in 50 year), 10% (1 in 10 year), 5% (1 in 20 year), 2% (1 in 50 year), 1% (1 in 100 year), 0.5% (1 in 200 year) and 0.1% (1 in 1000 year) Annual Exceedance Probabilities (AEPs) for the present day scenario, and for the Mid-Range Future Scenario (MRFS) and the High End Future Scenario (HEFS).

Figure 11 below illustrates the predictive extreme 0.5% AEP (1 in 200 year) and 0.1% AEP (1 in 1000 year) tidal flood extents at and in the vicinity of the proposed development site for the present day scenario.

Figure 12 below illustrates the predicted extreme 0.5% AEP (1in 200 year) and 0.1% AEP (1 in 1000 year) tidal flood extents in the vicinity of the site for the mid-range future scenario.

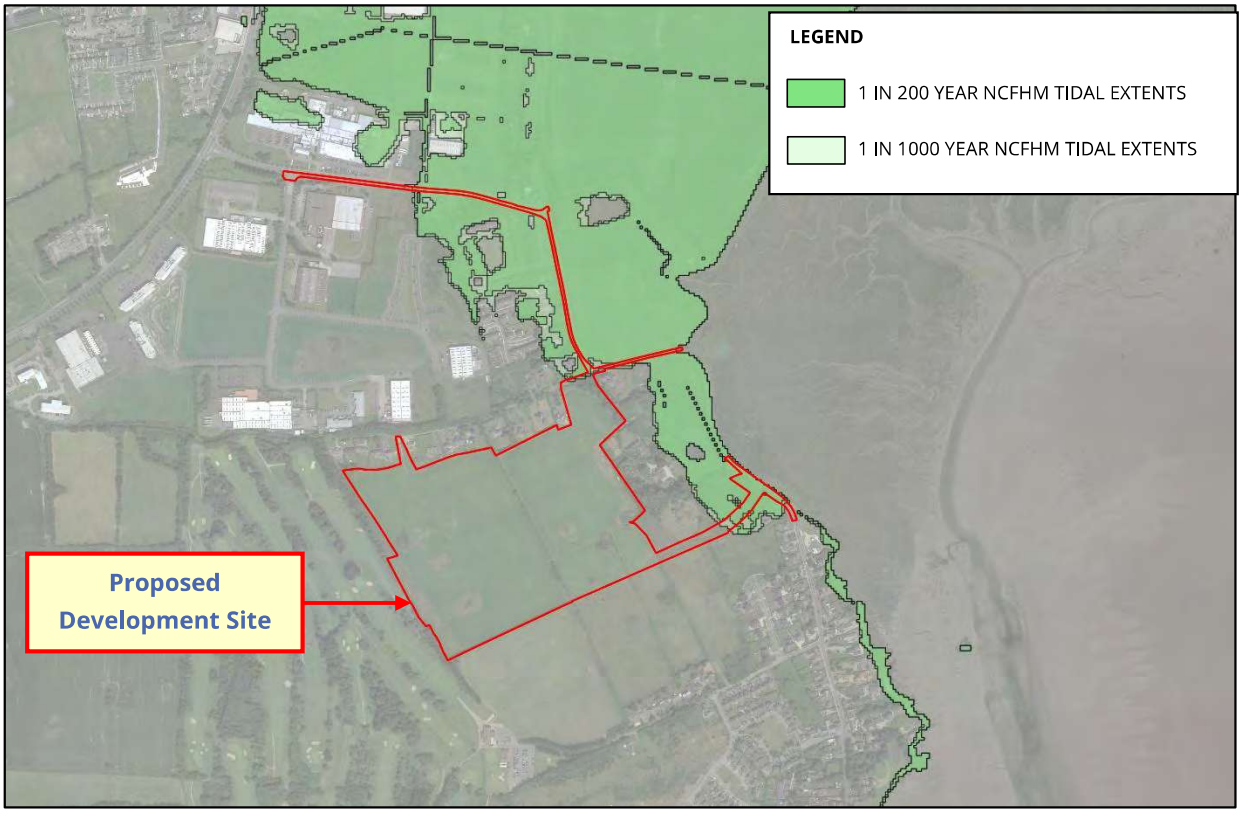


Figure 11 – NCFHM Tidal Extents Present Day Scenario

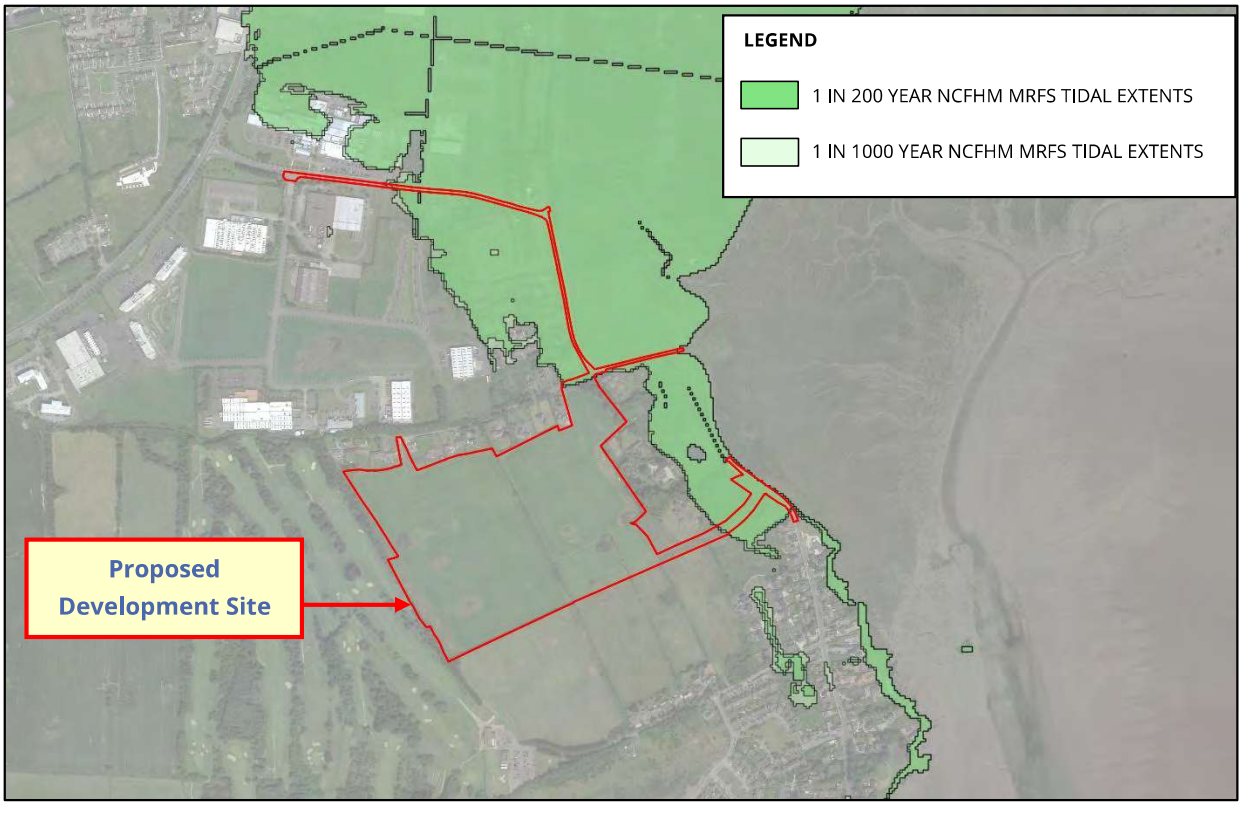


Figure 12 – NCFHM Tidal Extents MRFS

Figure 11 and *Figure 12* above indicates that the eastern area of the proposed development site falls within a 0.5% AEP and 0.1% AEP present day scenario and mid-range future climate change scenario coastal/tidal flood zone.

3.2.9. Louth County Development Plan 2021-2027

A Strategic Flood Risk Assessment (SFRA) has been produced as part of the 2021-2027 Louth Development Plan. *Figure 13* below, duplicated from the Louth SFRA, illustrates the extent of strategic fluvial and tidal flood extents in the vicinity of the proposed development site. This mapping has been developed utilising the North Western Neagh Bann CFRAMS flood extent mapping for extreme fluvial and tidal events. *Figure 13* below indicates that an area adjacent to the eastern boundary of the proposed development site falls within a Strategic Flood Zone.

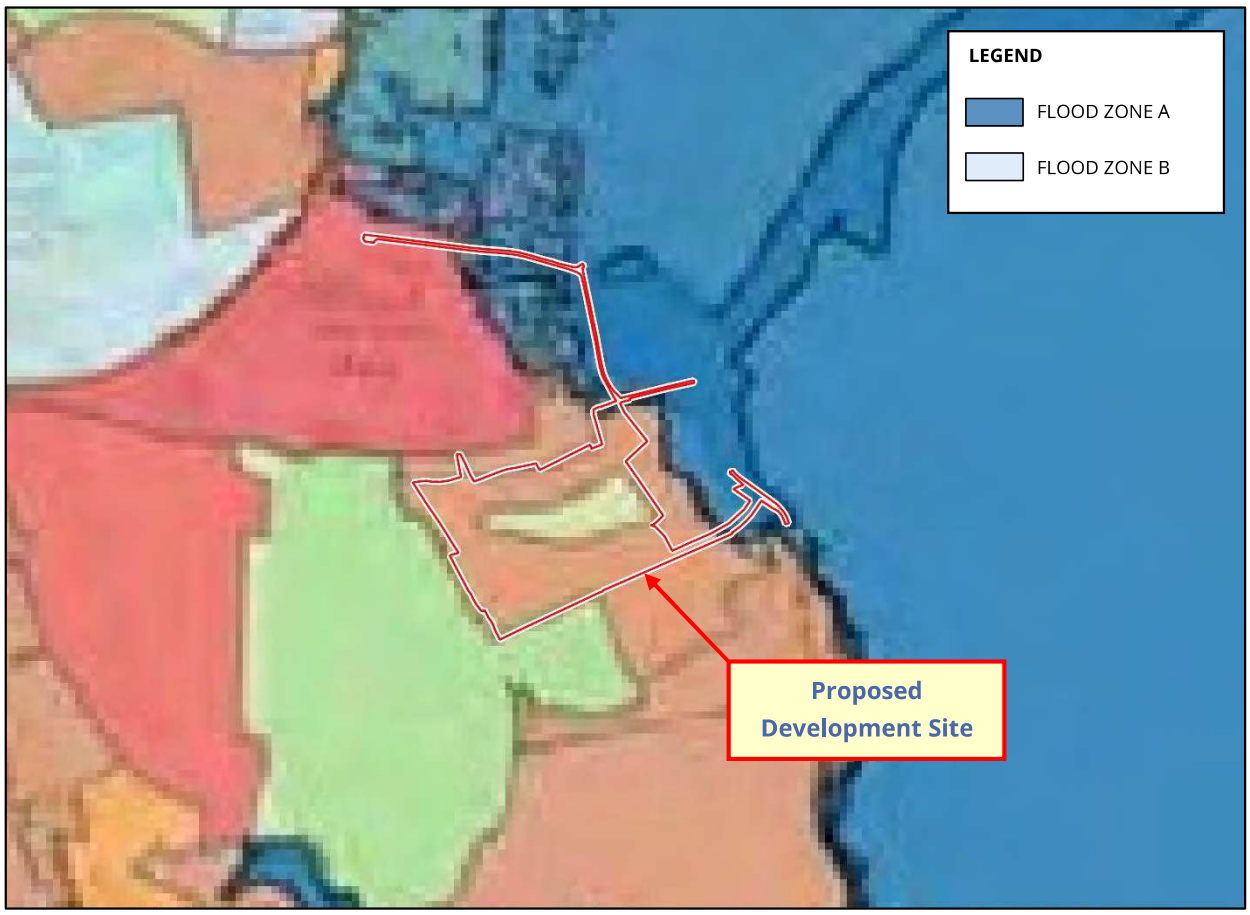


Figure 13 – Louth SFRA Flood Mapping

3.2.10. Dundalk Local Area Plan 2025-2031

A Strategic Flood Risk Assessment (SFRA) has been produced as part of the Dundalk Local Area Plan 2025-2031'. *Figure 14* below, duplicated from the Dundalk LAP zoning and flood zone mapping, illustrates the extent of strategic fluvial and tidal flood extents in the vicinity of the proposed development site. This mapping has been developed taking into account a number of information sources such as predictive and historical indicators of flood risk. These include as Recorded Flood Events from the OPW; CFRAM Study Flood Extent Mapping (2016), National Coastal Flood Hazard Mapping (NCFHM) 2021 and Emerging findings of the Dundalk Flood Relief Scheme Project, 2024.

Figure 14 below indicates that an area adjacent to the eastern boundary of the proposed development site falls within a Strategic Flood Zone A and Strategic Flood Zone B.

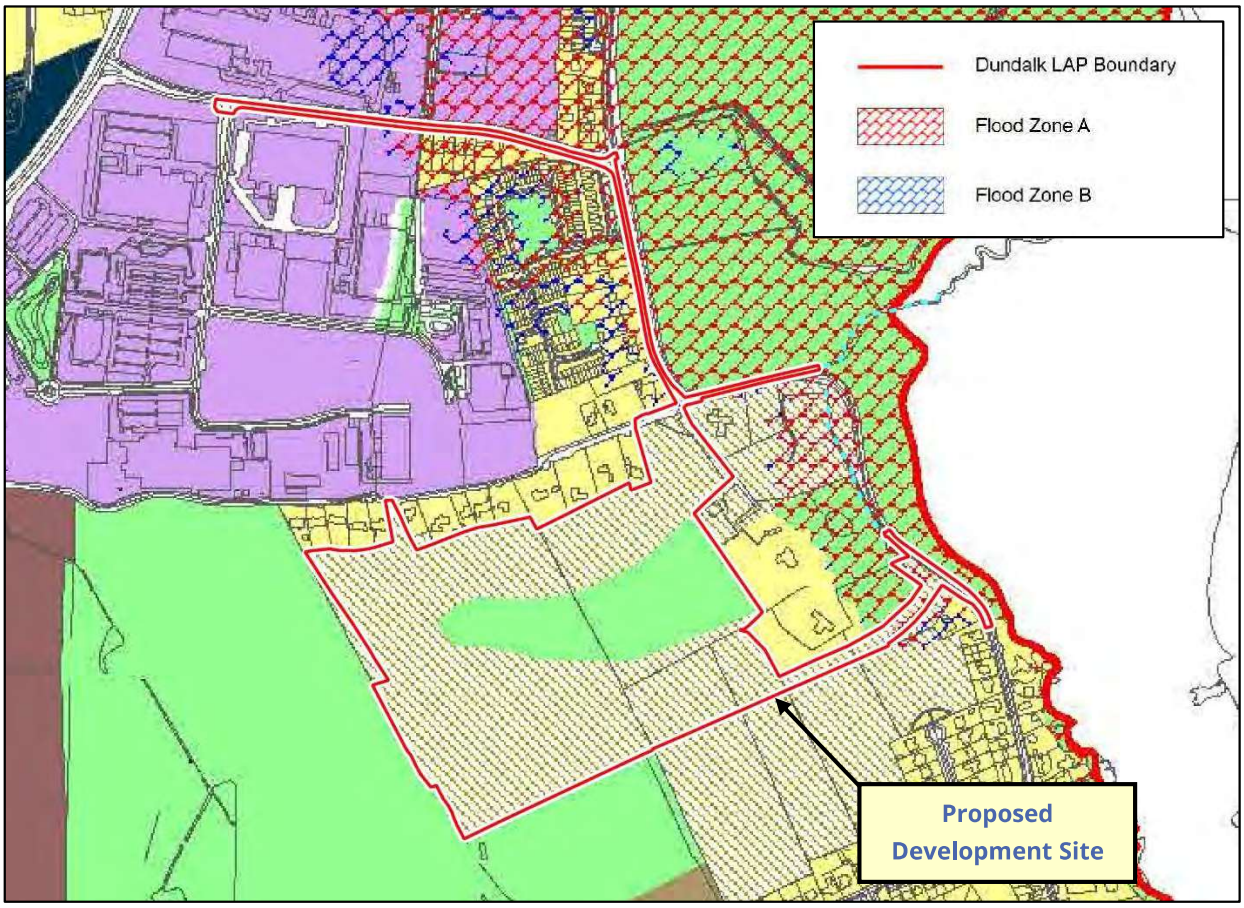


Figure 14 – Dundalk LAP SFRA Flood Mapping

3.3. Summary

The flood risk identification has been completed for the location of the proposed development site. The sources of each of the potential flood risks and potential impacts on the site are summarised below in *Table 3*.

Type	Source	Pathway	Receptor	Likelihood	Consequence	Risk
Tidal/Coastal:	Dundalk Bay	R172 Road	Proposed Access Road	Moderate	Severe	Severe
Fluvial:	Drainage Channel	Lands adjacent to R172 road	Proposed Access Road	Low	Low	Low
Pluvial (urban drainage)	Existing drainage infrastructure	Existing Roads	Proposed Access Road	Low	Low	Low
Pluvial (overland flow)	Rainfall runoff	Overland flow of runoff from west	Proposed residential development and Access Road	Moderate	Moderate	Moderate
Blockage	Existing Culverts	Lands adjacent to R172 road	Proposed Access Road	Low	Low	Low
Groundwater	Springs	Overland Flow	Proposed residential development and Access Road	Low	Low	Low

Table 3: Flood Risk Identification Summary

4. Initial Flood Risk Assessment

The purpose of the Initial Flood Risk Assessment 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. This 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 primary potential flood risk to the proposed development site can be attributed to an extreme tidal flood event in Dundalk Bay (Irish Sea). Secondary flood risk can be attributed to a pluvial event due to overland flow from the elevated lands within the western area of the site and potentially beyond the western boundary of the site. It is noted that while there is urban drainage infrastructure located in the wider area of Blackrock to the north and to the south, the proposed development site is located at a higher elevation than these urban areas and therefore any pluvial flood risk from the urban drainage is low. The site is not at risk of fluvial or groundwater flooding.

In consideration of the information collated as part of the screening exercise, and the availability of other information and data specific to the proposed development site, it is considered that sufficient quantitative information to complete an appropriate flood risk assessment cannot be derived from the information collated as part of the screening exercise alone. In this regard it is required to undertake a more detailed and robust analysis of the tidal and pluvial flooding regime at and in the vicinity of the proposed development site.

The specific flood risk to and from the proposed development site is assessed in the subsequent 'Assessing Flood Risk' stage of this study report.

5. Detailed Flood Risk Assessment

The following sections present an analysis and assessment of the pluvial flood risk due to the overland flow paths and potential tidal and pluvial flood risk to and from the proposed development site.

A precautionary approach has been applied to consider possible future changes in flood risk, including the effects of climate change and / or coastal erosion so that future occupants of the proposed development are not subject to unacceptable risks. The effect of climate change are assessed in the subsequent sections of this Detailed Flood Risk Assessment. The 2050 coastal erosion mapping produced as part of the Irish Coastal Protection Strategy Study indicates that the no further erosion is predicted at this location by 2050.

5.1. Assessment of Tidal Flood Risk

A 2D tidal model was developed using Flood Modeller Pro Version 6.2 to provide a more accurate determination of tidal flood risk to the proposed development site. Flood Modeller is capable of a wide variety of modelling applications such as simple 1D hydraulic models to dynamically linked 1D-2D model and complex surface water modelling. For this assessment the 2D Alternating Direction Implicit (ADI) solver was used. It is considered to be an accurate, robust and fast solver which is suitable for a wide variety of applications and has extensively throughout Ireland and the UK for both fluvial, pluvial and tidal flood risk assessments.

5.1.1. Tidal Cycle Profiles

Tidal profiles were developed utilising the extreme tide levels defined in the Irish Coastal Wave and Water Level Modelling Study, as detailed in *Section 3.2.7* above, and the tidal cycle developed as part of the OPW Neagh Bann CFRAM Study. These profiles include the 0.5% AEP (1 in 200 year) (0.5% AEP) and 0.1% AEP (1 in 1000 year) tidal events for the Present Day Scenario as well as the 0.5% AEP (1 in 200 year) tidal event for the Mid-Range Future Scenario (MRFS). These profiles are show in *Figure 15* below.

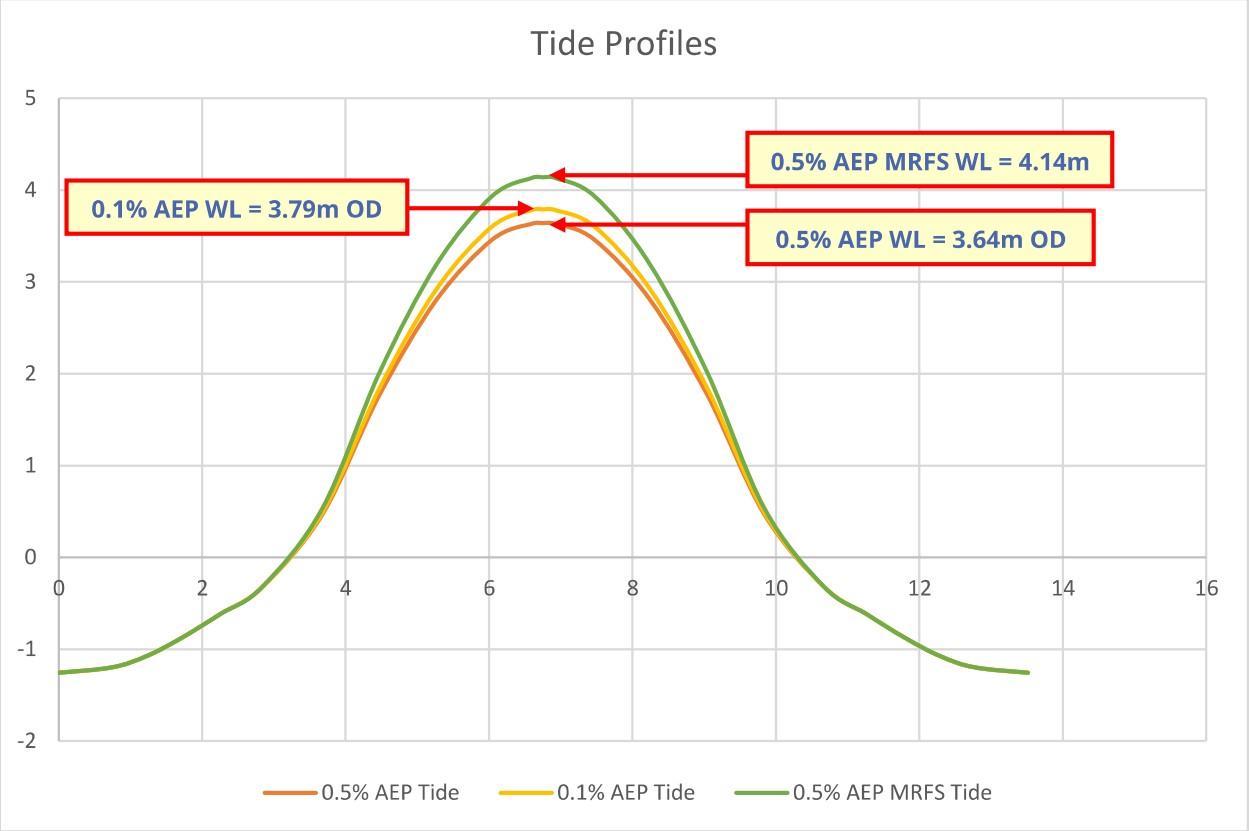


Figure 15 – Tide Cycle Profiles

5.1.2. 2D Tidal Model Build

The 2D tidal model developed utilises a detailed Digital Terrain Model (DTM) of the site area and surrounding lands and applying the tide cycle as a boundary condition. The DTM has been developed using a topographical survey of the site and OPW LiDAR data of the surrounding lands. The LiDAR has a vertical accuracy of ± 200mm. The model was developed based on a resolution cell size of 2m x 2m. The extent of the model domain is defined by an Active Area whereby a tidal boundary condition is applied, which is illustrated below in *Figure 23*.

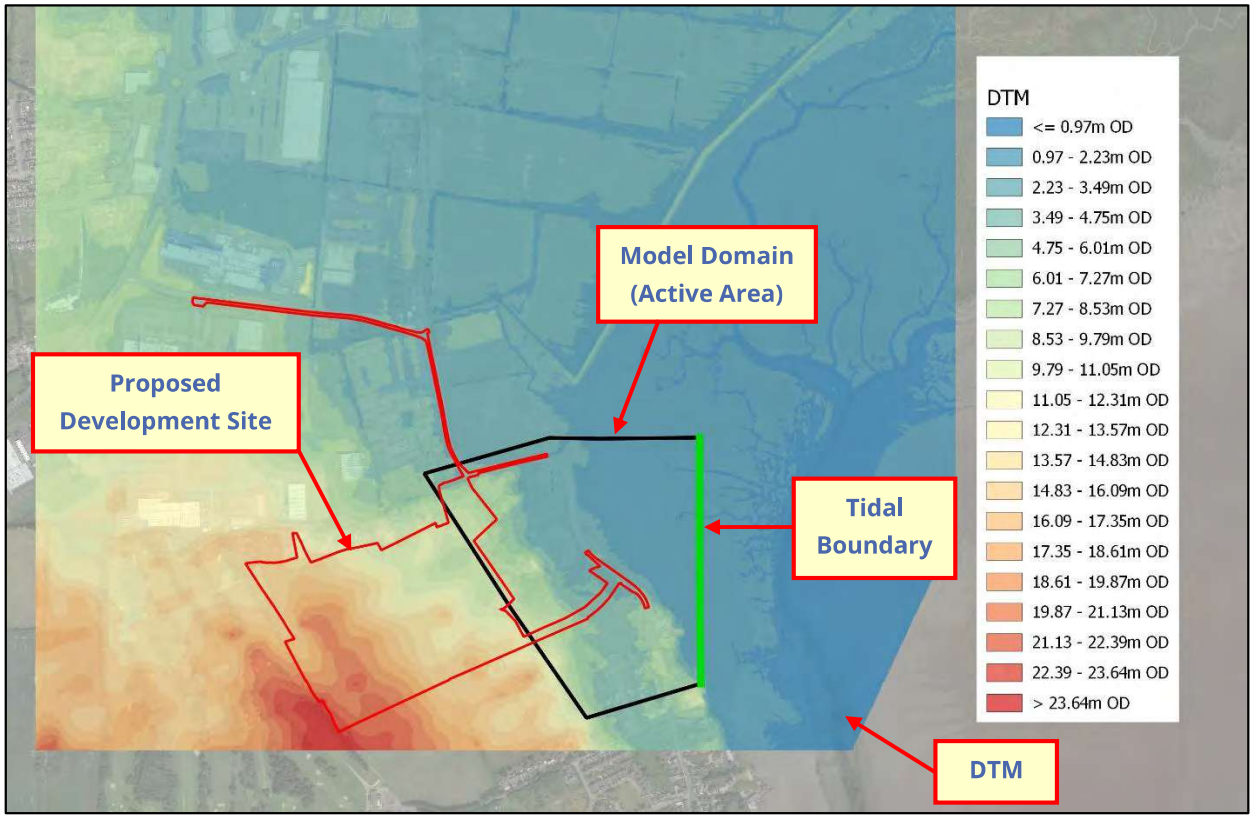


Figure 16 - 2D Tidal Model Extent

In order to account for the potential flow paths and obstructions created by roads and buildings within the model domain the 2D model includes the following features:

- Roads located where LiDAR is utilised in lieu of detailed topographical survey data being available has the topography lowered by 100mm in order to better represent the conveyance ability of roads and the impact of kerbs on flow paths.
- Buildings outlines have been increased by 300mm in order to represent their ability to block flow paths.

These features are illustrated below in *Figure 17*.

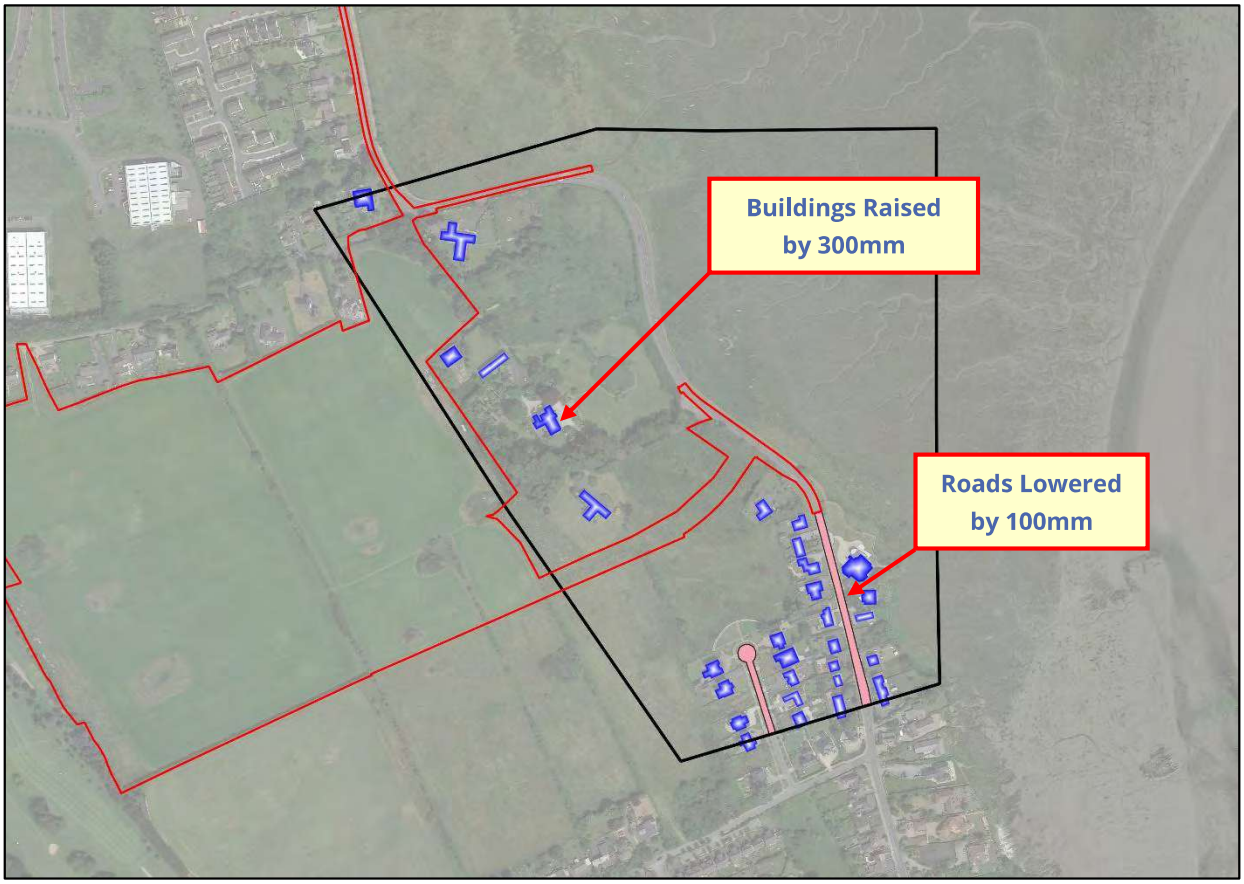


Figure 17 – Tidal Model Topographical Features

Roughness values are used to allow the model to determine the nature of the flood flows across the surface of the ground as water will flow more slowly over vegetated areas in comparison to hard-standing areas. A global roughness value of 0.045 was employed, reflecting mainly long grassland with some scattered brush and heavy weeds. Roads within the model domain were represented with a lower roughness value of 0.015, while buildings were given a roughness value of 0.3. These roughness values are illustrated below in *Figure 18*.

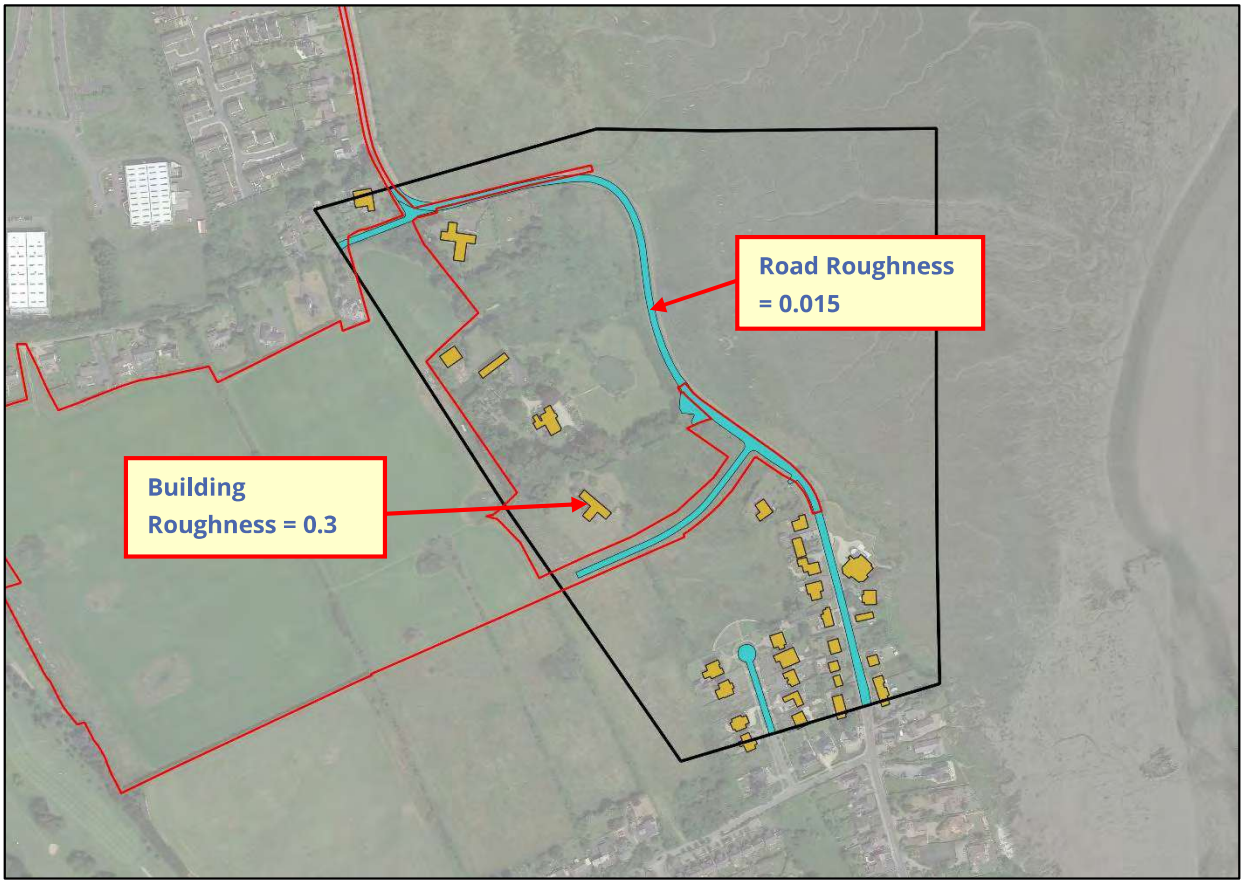


Figure 18 – Tidal Model Roughness

5.1.3. Modelling Results for Present Day Scenario

The model was run for the 0.5% AEP (1 in 200 year) and 0.1% AEP (1 in 1000 year) Present Day scenario tidal events. The model was run for 12 hours with a 2 metre grid size. As illustrated in *Figure 17* and *Figure 18* below, and on Drawing Number *IE3047-002-A, Appendix A*, the extents of the modelling results utilising the topographical survey and LiDAR data were thematically mapped in QGIS.

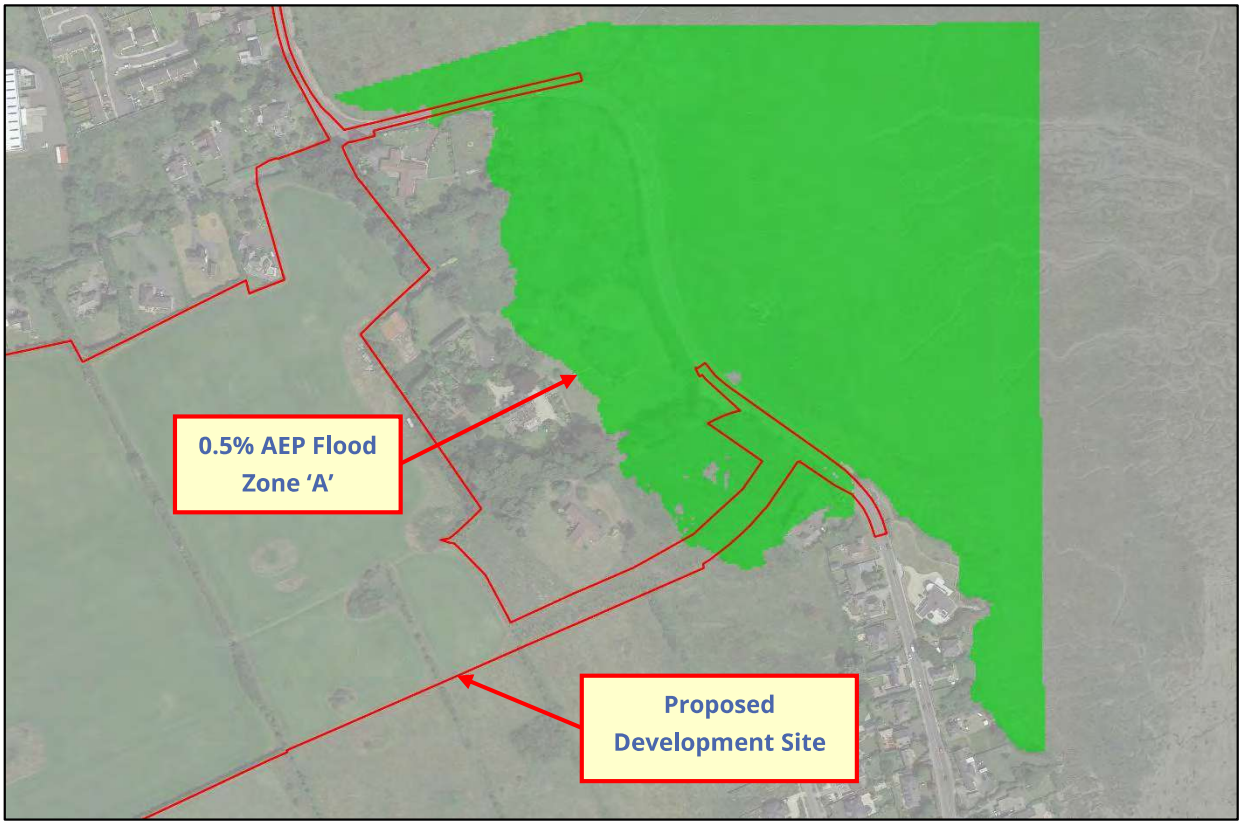


Figure 19 – Baseline Scenario 0.5% AEP Present Day Scenario Tidal Flood Extents

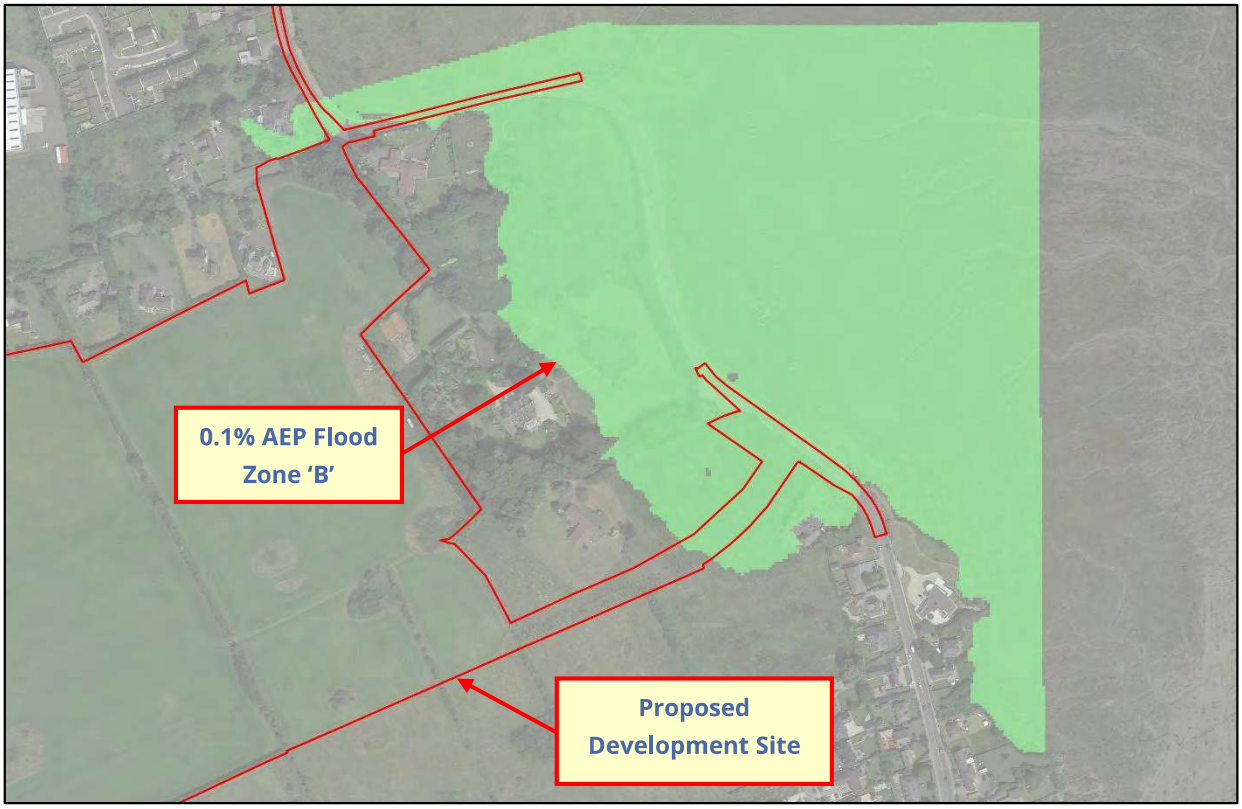


Figure 20 – Baseline Scenario 0.1% AEP Present Day Scenario Tidal Flood Extents

As illustrated above in *Figure 19* and *Figure 20*, the proposed site entrance located in the eastern area of the site falls within a predictive 0.5% AEP (1 in 200 year) Tidal Flood Zone 'A' and a 0.1% AEP (1 in 1000 year) Tidal Flood Zone 'B'. It is also noted that the extent of tidal flooding illustrated above correlates very well with the OPW National Coastal Flood Hazard Mapping for the area as illustrated in *Figure 11* above.

5.1.4. Modelling Results for MRFS

The model was also run for the 0.5% AEP (1 in 200 year) Mid-Range Future Scenario (MRFS) tidal event. The extent of the modelling results for this scenario are illustrated in *Figure 21* below and on Drawing Number *IE3047-003-A, Appendix A*.

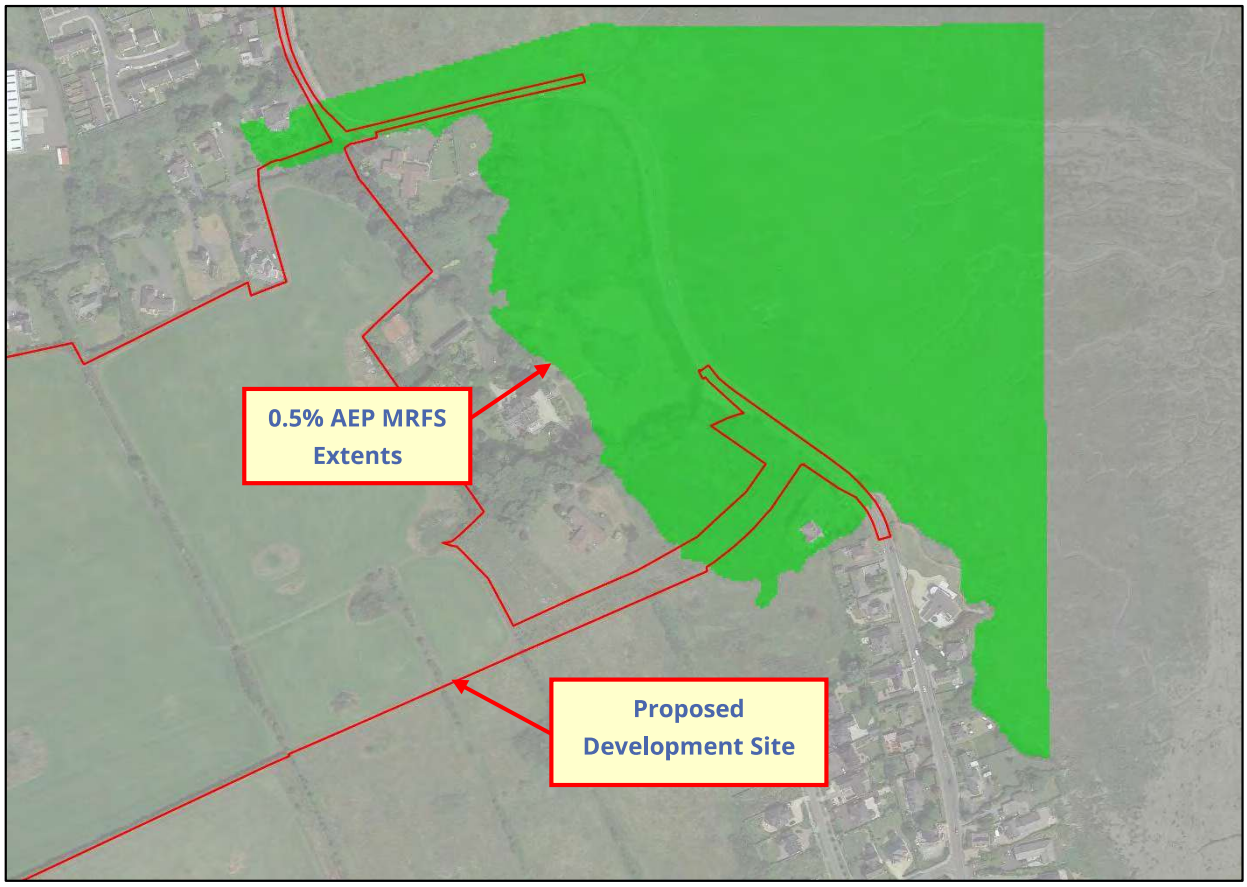


Figure 21 - Baseline Scenario 0.5% AEP MRFS Tidal Flood Extents

As illustrated in *Figure 21* above, the proposed site entrance located in the eastern area of the site falls within a predictive mid-range future climate change scenario 0.5% AEP (1 in 200 year) Tidal Flood Zone.

5.2. Assessment of Secondary Flood Risk – Pluvial Overland Flow

A 2D surface water runoff (pluvial) model was developed using Flood Modeller Pro Version 6.0 to provide a more accurate determination of pluvial flood risk to the site by assessing surface water runoff characteristics over a significant precipitation event, determine areas where surface water ponding and flooding may occur and to determine the depth and volume of any pluvial flooding within the area of the proposed development site. Flood Modeller is capable of a wide variety of modelling applications such as simple 1D hydraulic models to dynamically linked 1D-2D model and complex surface water modelling. For this assessment the 2D Alternating Direction Implicit (ADI) solver was used. It is considered to be an accurate, robust and fast solver which is suitable for a wide variety of applications and has extensively throughout Ireland and the UK for both fluvial, pluvial and tidal flood risk assessments.

An assessment of pluvial flooding has been undertaken in accordance with the methodology described in the OPW 'National Pluvial Screening Project Report' as follows.

5.2.1. Overland Flow Paths

The overland flow paths of the site and surrounding catchment have been examined using the LiDAR data and topographical survey. The majority of the surface water runoff within this area is generated within the site boundary and only a small portion of upstream catchment area outside the site boundary drains into the site. As such the lands within the site boundary do not provide a surface water discharge point for adjacent lands. The overland flow paths are illustrated in *Figure 22* below.

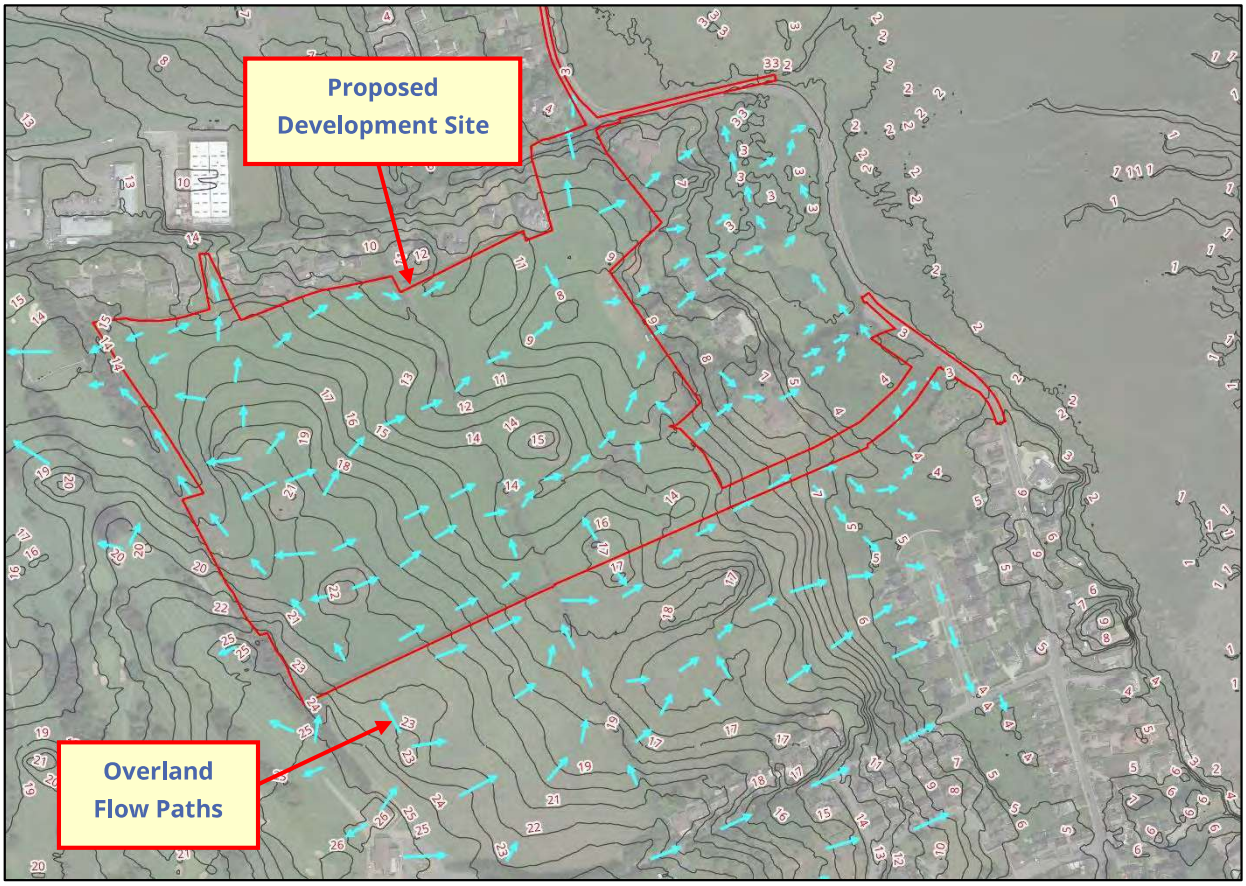


Figure 22 – Pluvial Overland Flow Paths

5.2.2. Rainfall Data

A 2D direct rainfall model was developed using Flood Modeller software, which utilises a detailed Digital Terrain Model (DTM) of the site are and surrounding lands and specific extreme rainfall data for the area obtained from Met Éireann, (refer to *Appendix B*). Depth Duration and Frequency (DDF) data was used to provide the 30 minute, 1 hour, 2 hour and 3 hour event durations for the 1% AEP (1 in 100 year) and 0.5% AEP (1 in 200 year) rainfall events. The rainfall depths derived are listed in *Table 4* below.

Return Period	0.5 hour Duration	1 hour Duration	2 hour Duration	3 hour Duration
1% AEP Rainfall Depth (mm)	23.1	28.5	35.2	39.9
0.5% AEP Rainfall Depth (mm)	26.9	33.0	40.6	45.7

Table 4: Present Day Scenario Rainfall Depths

The impact of potential future climate change on pluvial flooding has also been accounted for within in the 2D surface water model. The Mid-Range Future Scenario (MRFS) allows for an increase of 20% in rainfall depths as per OPW 'Flood Risk Management Climate Change Sectoral Adaptation Plan' (2015-2019). The increase in rainfall depths is listed in *Table 5* for the 1% AEP MRFS rainfall event.

Return Period	0.5 hour Duration	1 hour Duration	2 hour Duration	3 hour Duration
1% AEP Rainfall Depth (mm)	27.72	34.20	42.24	47.88

Table 5: MRFS Rainfall Depths

5.2.3. 2D Pluvial Model Build

The 2D surface water (pluvial) model developed utilises a detailed Digital Terrain Model (DTM) of the site area and surrounding lands and site specific extreme rainfall data. The DTM has been developed using a topographical survey of the site and OPW LiDAR data of the surrounding lands. The LiDAR has a vertical accuracy of ± 200mm. The model was developed based on a resolution cell size of 2m x 2m.

The extent of the model domain is defined by an Active Area whereby a rainfall hyetograph boundary condition is applied to this area, which is illustrated below in *Figure 23*.

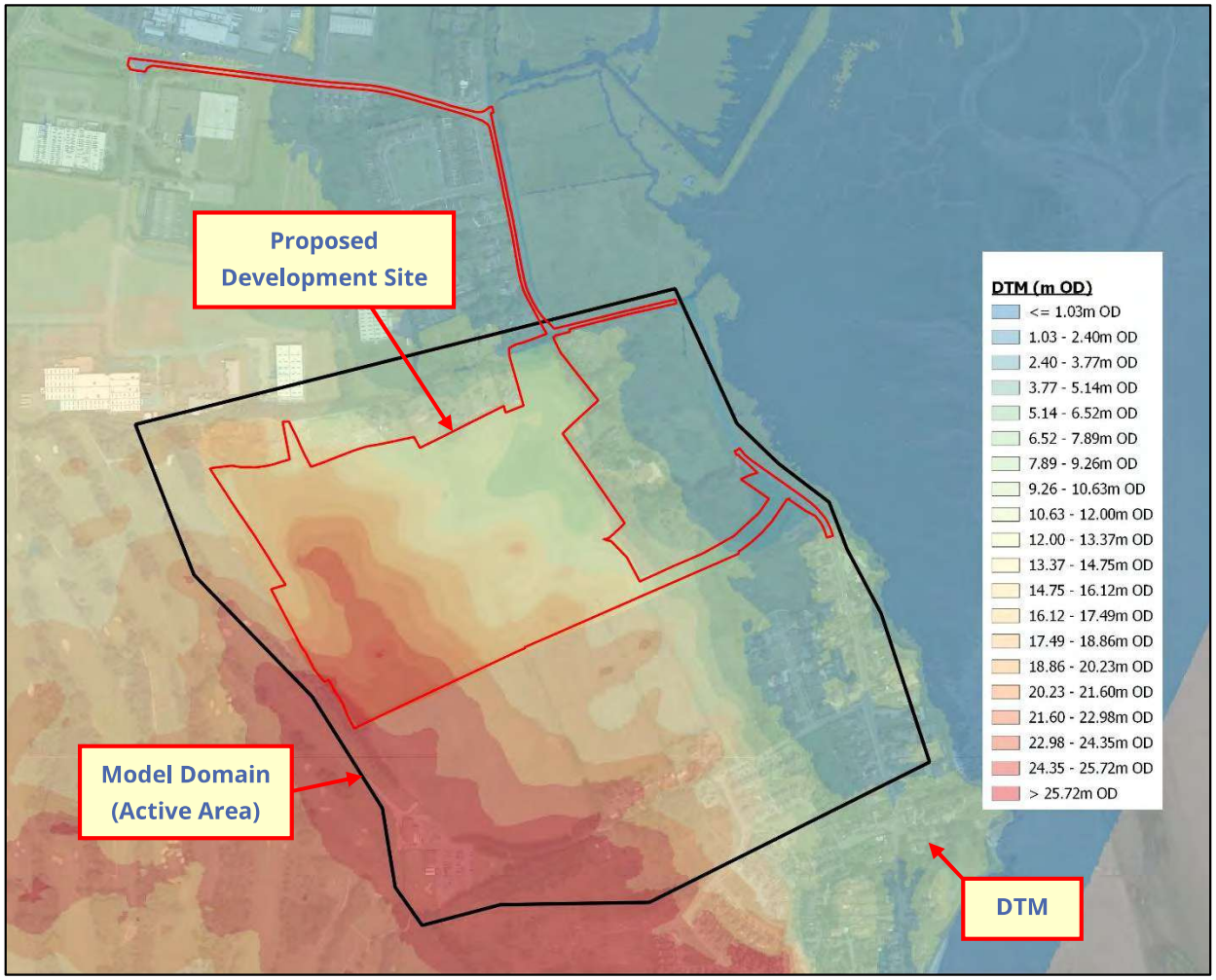


Figure 23 - 2D Surface Water Model Extent

In order to account for the potential flow paths and obstructions created by roads and buildings within the model domain the 2D model includes the following features:

- Roads located where LiDAR is utilised in lieu of detailed topographical survey data being available has the topography lowered by 100mm in order to better represent the conveyance ability of roads and the impact of kerbs on flow paths.
- Buildings outlines have been increased by 300mm in order to represent their ability to block flow paths.

These features are illustrated below in *Figure 24*.

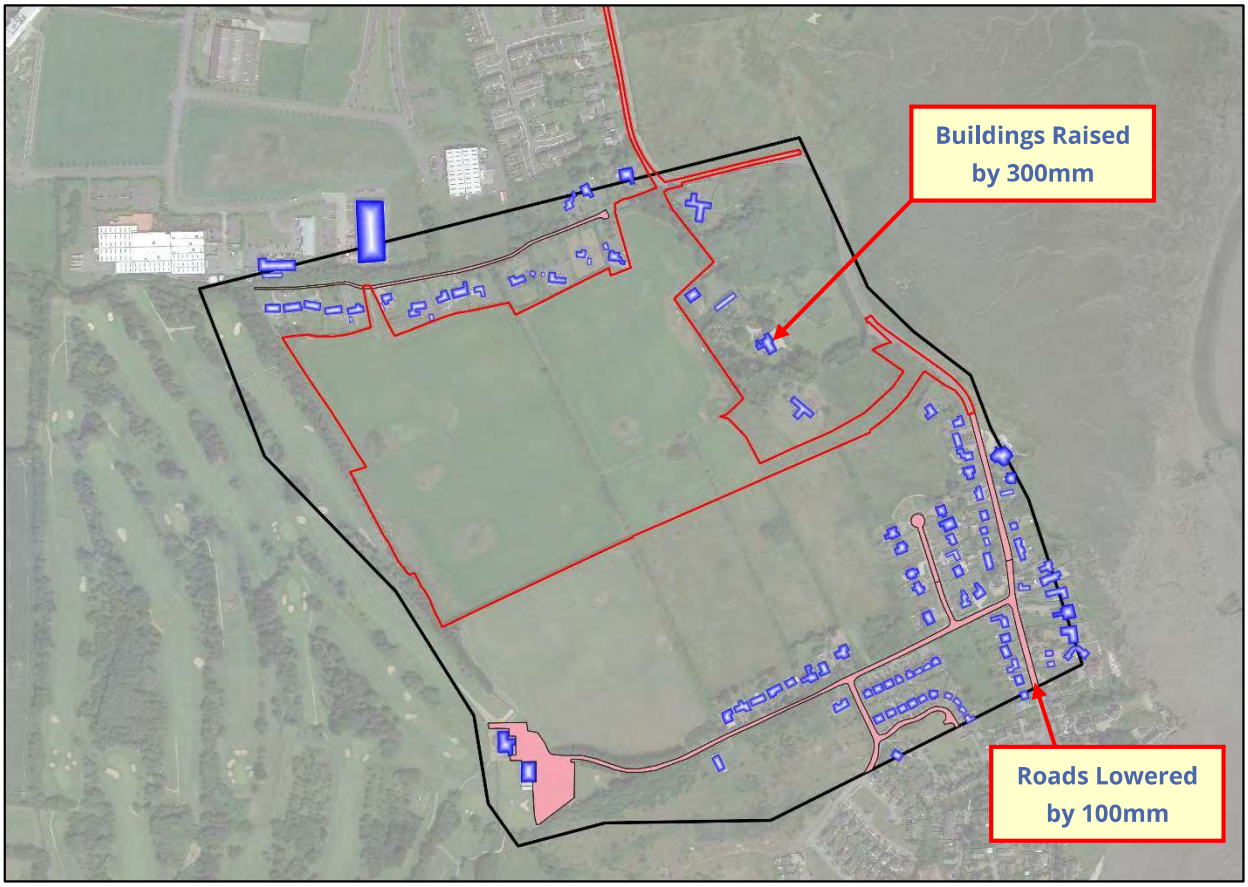


Figure 24 – Pluvial Model Topographical Features

Roughness values are used to allow the model to determine the nature of the flood flows across the surface of the ground as water will flow more slowly over vegetated areas in comparison to hard-standing areas. A global roughness value of 0.045 was employed, reflecting mainly long grassland with some scattered brush and heavy weeds. Roads within the model domain were represented with a lower roughness value of 0.015, while buildings were given a roughness value of 0.3. These roughness values are illustrated below in *Figure 25*.

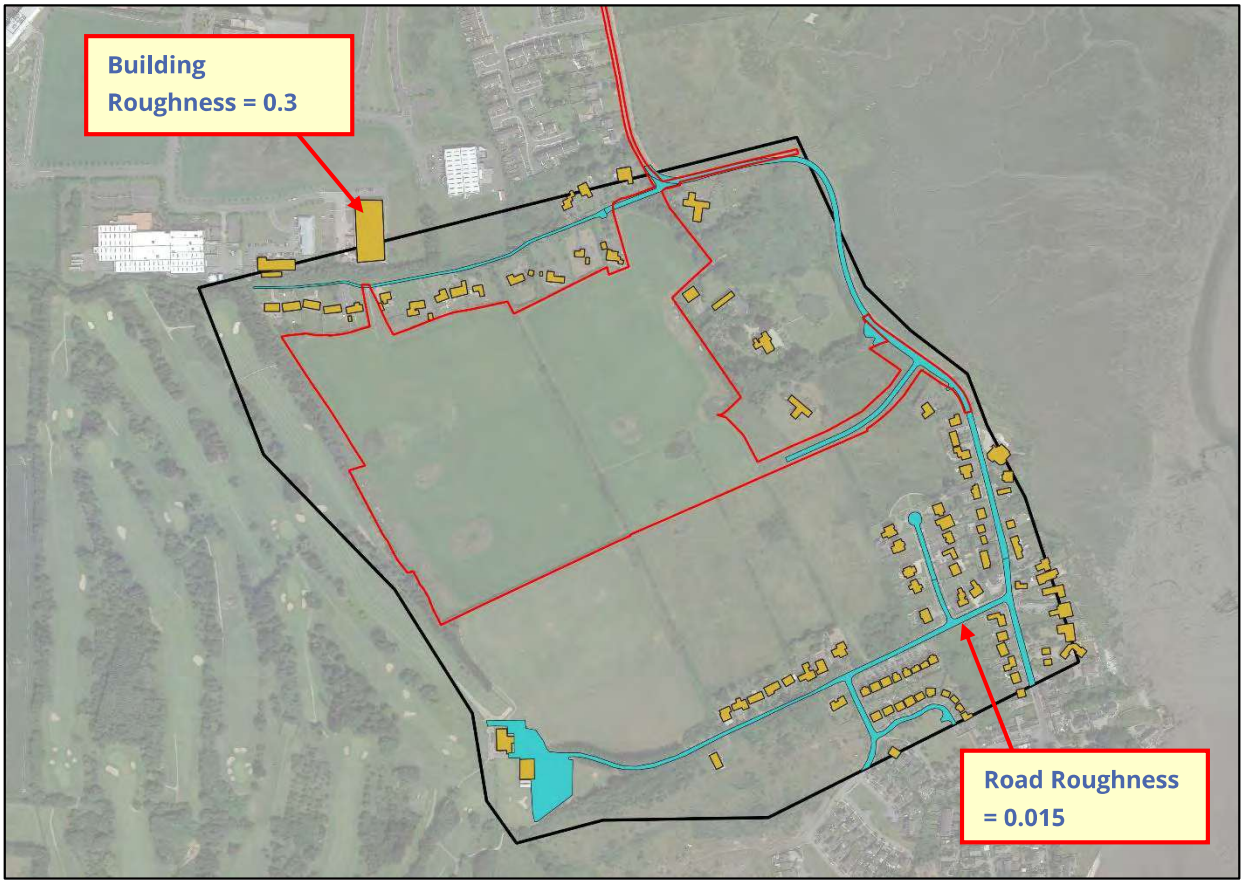


Figure 25 – Pluvial Model Roughness

In order to represent the losses due to infiltration the Green-Ampt loss model was used in the hydraulic model. The Green-Ampt method varies the infiltration rate based on the soils hydraulic conductivity, suction, porosity and initial soil content. This makes it possible to spatially vary the losses due to infiltration based on the underlying soil conditions. The Irish Soil Information System National Soils Map (SIS SOIL) created by the EPA and Teagasc was used to determine the soils within the 2D domain, which are illustrated below in *Figure 26.*

The proposed development site and the area to the south is composed of mostly of Fine Loam Drift with Limestones, which would have a moderately good drainage potential and hydraulic conductivity. Other areas in the 2D domain are underlain by developed urban areas. The potential impact of a surface water drainage system has not been included in this assessment. It is considered to be more conservative to assume there are no losses due to a drainage system and all rainfall losses are due to infiltration.

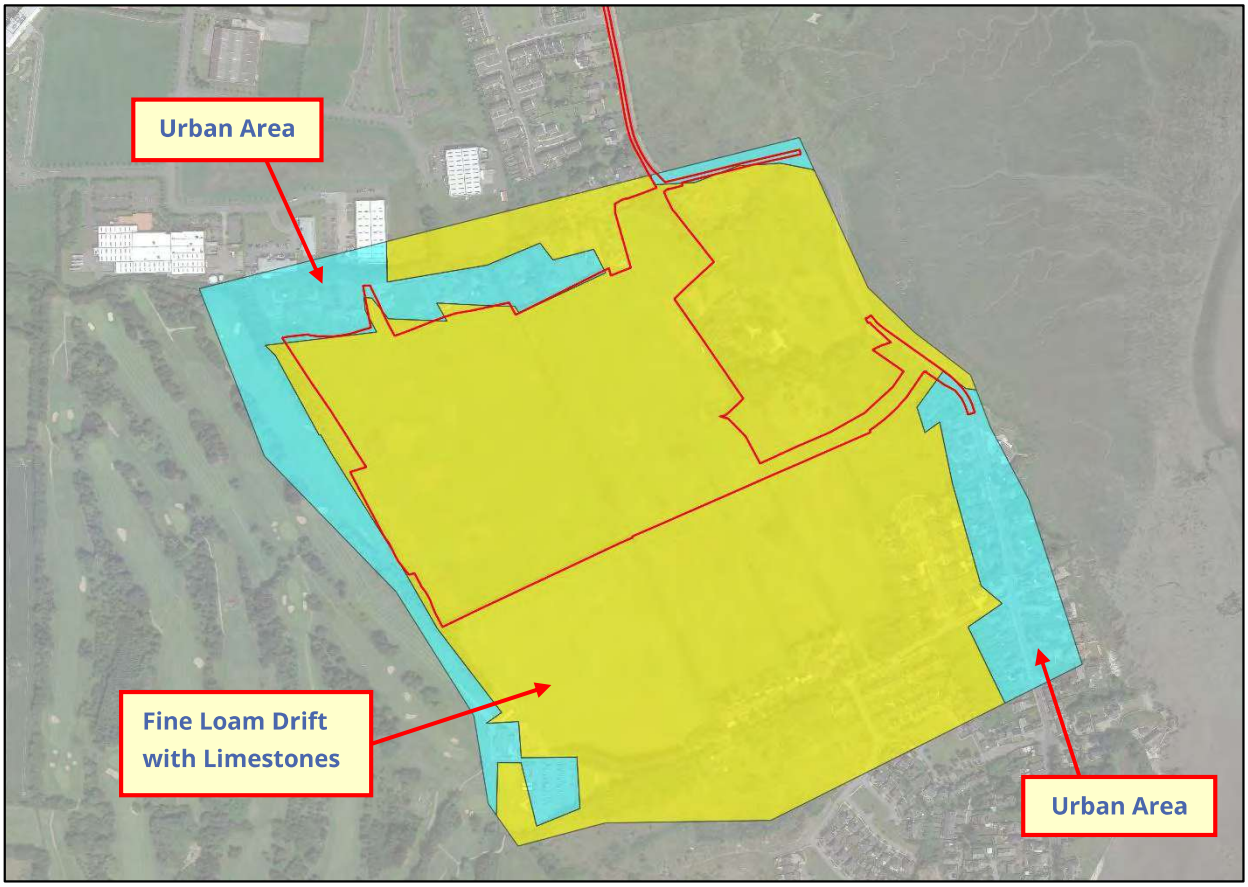


Figure 26 – Pluvial Model Soil Infiltration Classifications

5.2.4. Critical Duration Analysis

Four storm duration profiles have been generated for this study in order to determine which event creates the greatest flood extents within the proposed development site. These flood extent areas are summarised below in *Table 6.*

Rainfall Event	Max Flood Extent (m²) for Storm Duration within Proposed Development Site			
	0.5hr	1hr	2hr	3hr
1% AEP Event	**14548**	14284	12780	11684
0.5% AEP Event	**16252**	15780	14208	12836

Table 6: Critical Storm Duration Analysis

The results of the analysis show that the 0.5 hour event generates the greatest flood extent within the site during the 1% AEP (1in 100 year) and 0.5% AEP (1in 200 year) pluvial events, therefore this duration has been selected as the critical duration for the proposed development site.

5.2.5. Modelling Results for Present Day Scenario

The model was run for the 1% AEP (1 in 100 year) and 0.5% AEP (1 in 200 year) Present Day scenario events. The model was run for 2 hours with a 2 metre grid size. The extents of the surface water modelling results utilising the topographical survey data were thematically mapped in QGIS over a range of resultant surface water depths according to the following minimum and maximum depth classifications. The 1% AEP (1 in 100 year) and 0.5% AEP (1 in 200 year) Present Day scenario pluvial flood depths are illustrated in *Figure 27* and *Figure 28* below:

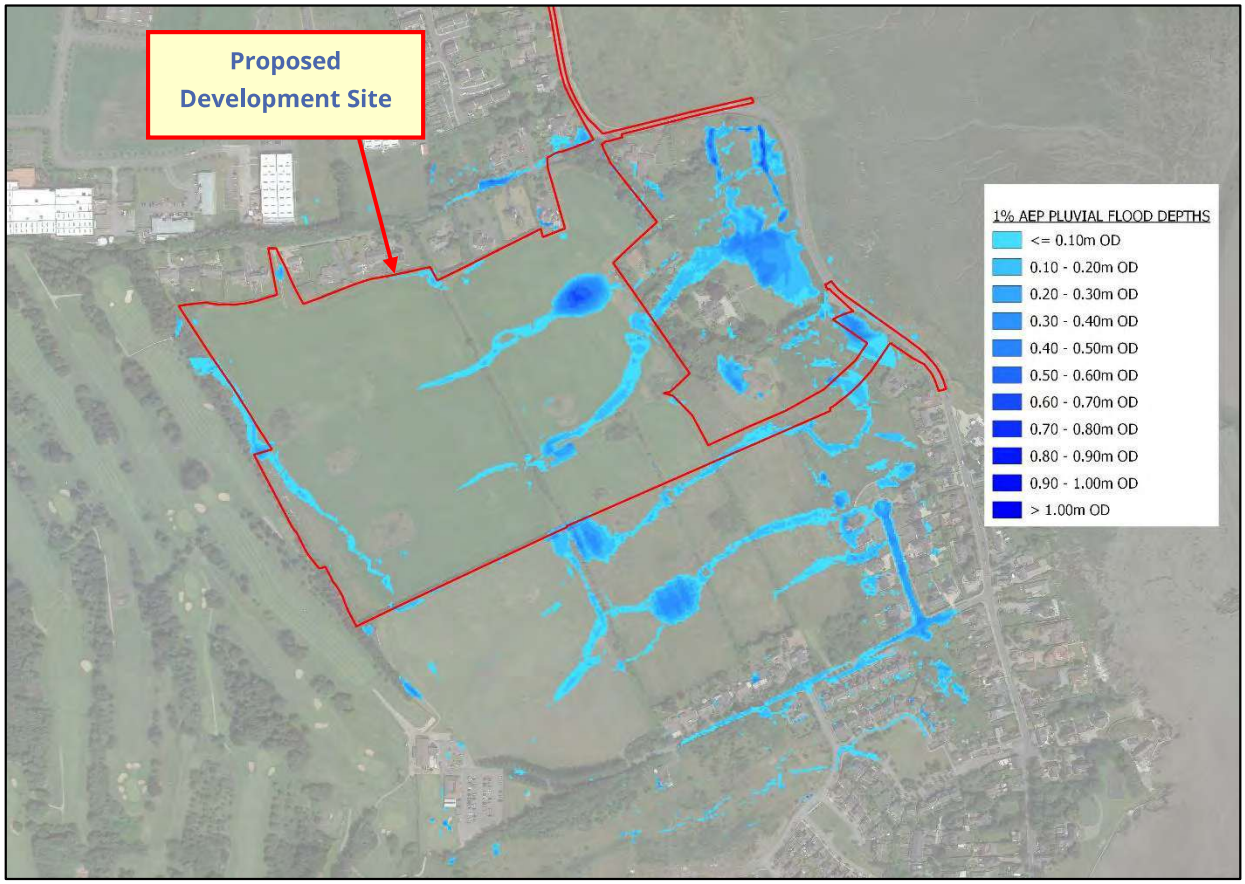


Figure 27 – 1% AEP 0.5 Hour Present Day Scenario Pluvial Flood Depths

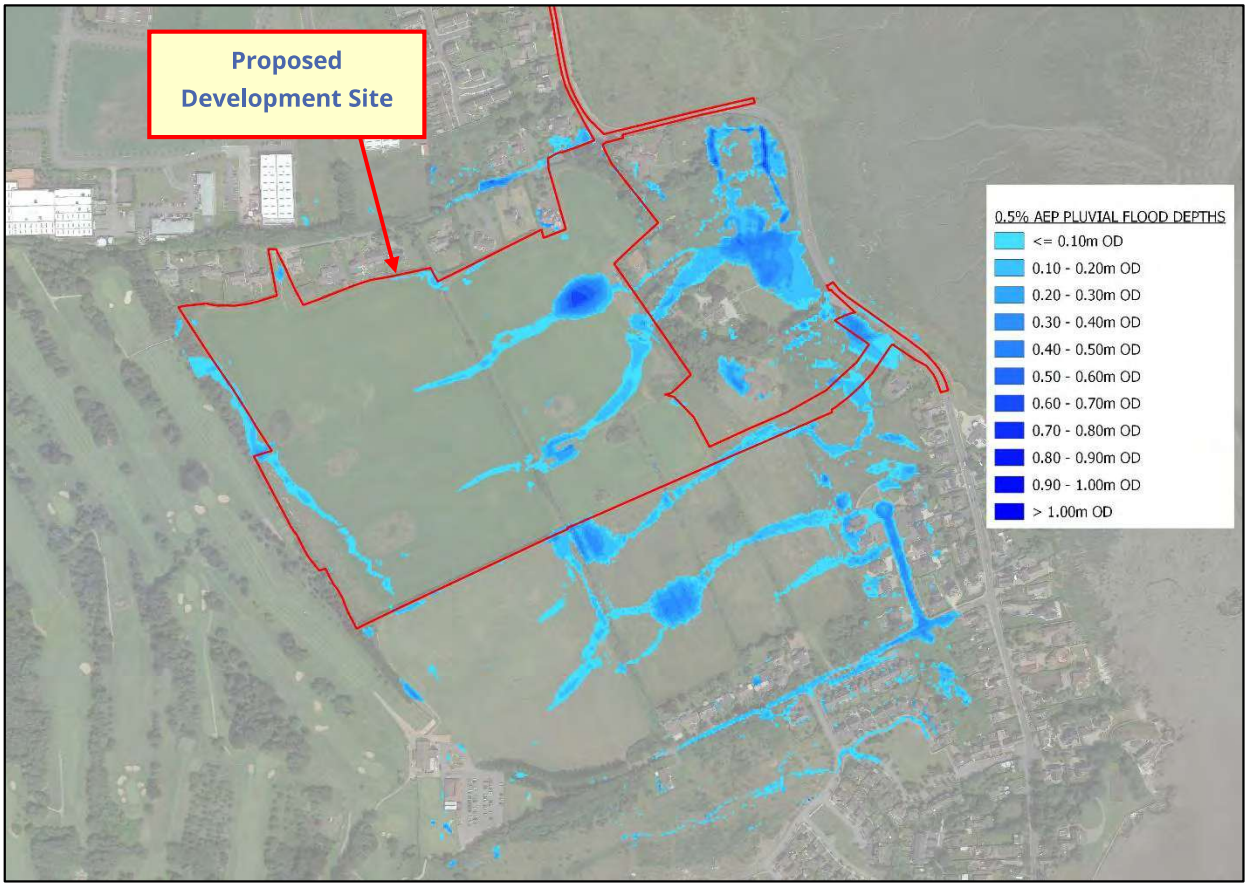


Figure 28 – 0.5% AEP 0.5 Hour Present Day Scenario Pluvial Flood Depths

As illustrated above in *Figure 27* and *Figure 28* above the flood depths within the boundary of the site range from 0 to 0.63m for the 1% AEP (1 in 100 year) Present Day scenario event and 0 to 0.656m for the 0.5% AEP (1 in 200 year) Present Day scenario event.

5.2.6. Modelling Results for MRFS

The model was run for the 1% AEP Mid-Range Future Scenario (MRFS) rainfall event. The flood depths for this scenario are illustrated in *Figure 29* and below:

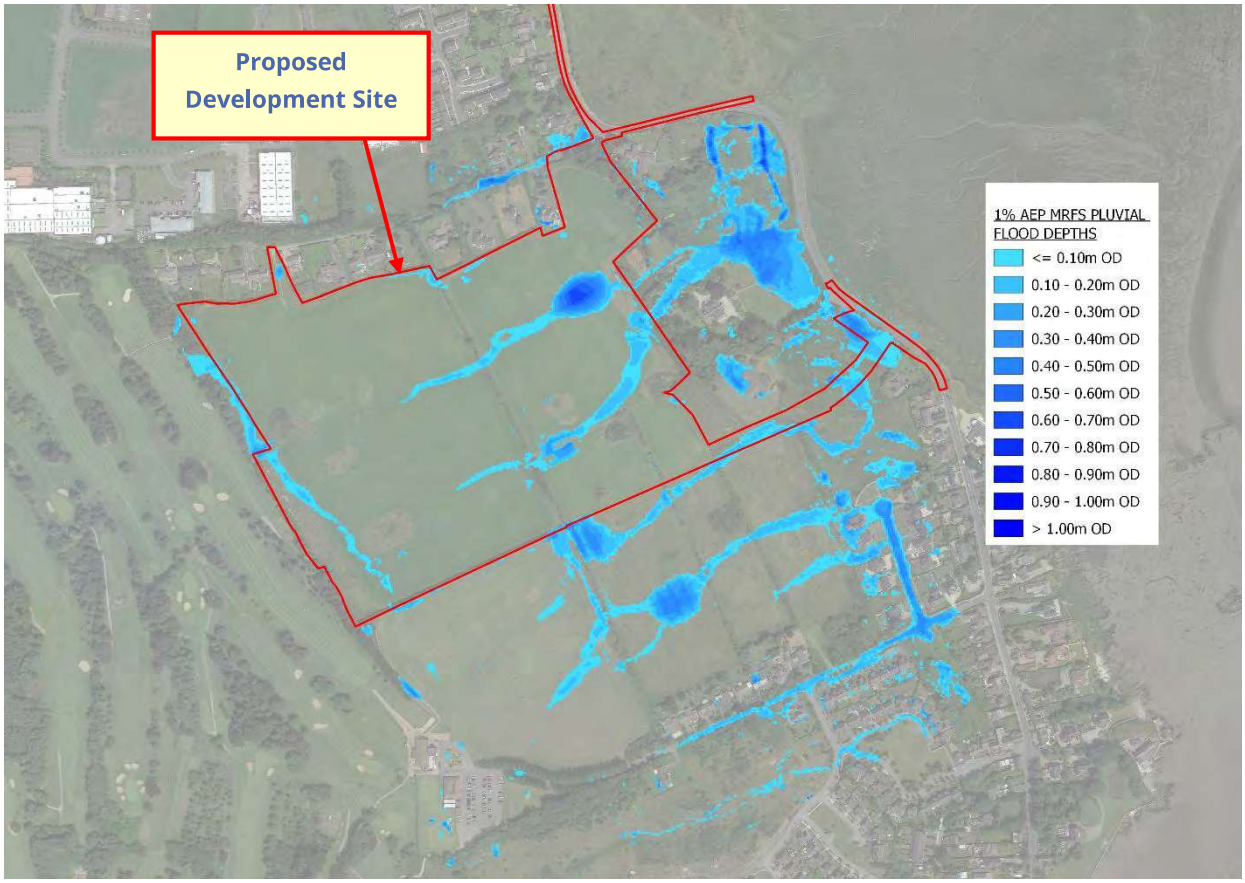


Figure 29 - 1% AEP 1 Hour MRFS Flood Depths

As illustrated in *Figure 29* and above the flood depths within the boundary of the site range from 0 to 0.661m for the 1% AEP MRFS event.

6. 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' the assessment and analysis undertaken as part of this Site Specific Flood Risk Assessment indicates that the eastern area of the site where the site entrance is proposed falls within a 0.5% AEP Tidal Flood Zone 'A' and 0.1% AEP Tidal Flood Zone 'B'. The vast majority of the proposed development site falls within Flood Zone 'C'.

In accordance with the 'Planning System & Flood Risk Management Guidelines, DOEGLG, 2009' the development as proposed may be subject to the requirements of the Justification Test.

7. Assessment of Hydrological Impact of Proposed Development

7.1. Tidal Flooding

The analysis and flood zone delineation undertaken as part of this Site Specific Flood Risk Assessment (SSFRA) indicates that the proposed site entrance road located in the eastern area of the site may be susceptible to inundation during a 1 in 200 year (0.5% AEP – Flood Zone 'A') and 1 in 1000 year (0.1% AEP – Flood Zone 'B') tidal flood event. The vast majority of the proposed development site falls within Flood Zone 'C'.

It is proposed to construct the road on an embankment to the point where it connects to and merges with the existing R172 road. It is also proposed to raise the existing R172 road at this location by up to 1.3m to ensure safe access and egress to the proposed development site during an extreme 1 in 200 year (0.5% AEP) MRFS tidal event.

The 2D tidal model was utilised to determine the potential impact of the proposed road embankment on the extent of tidal flooding in the vicinity of the site. The model was updated to include the proposed road embankment in the 2D domain as shown in *Figure 30* below.

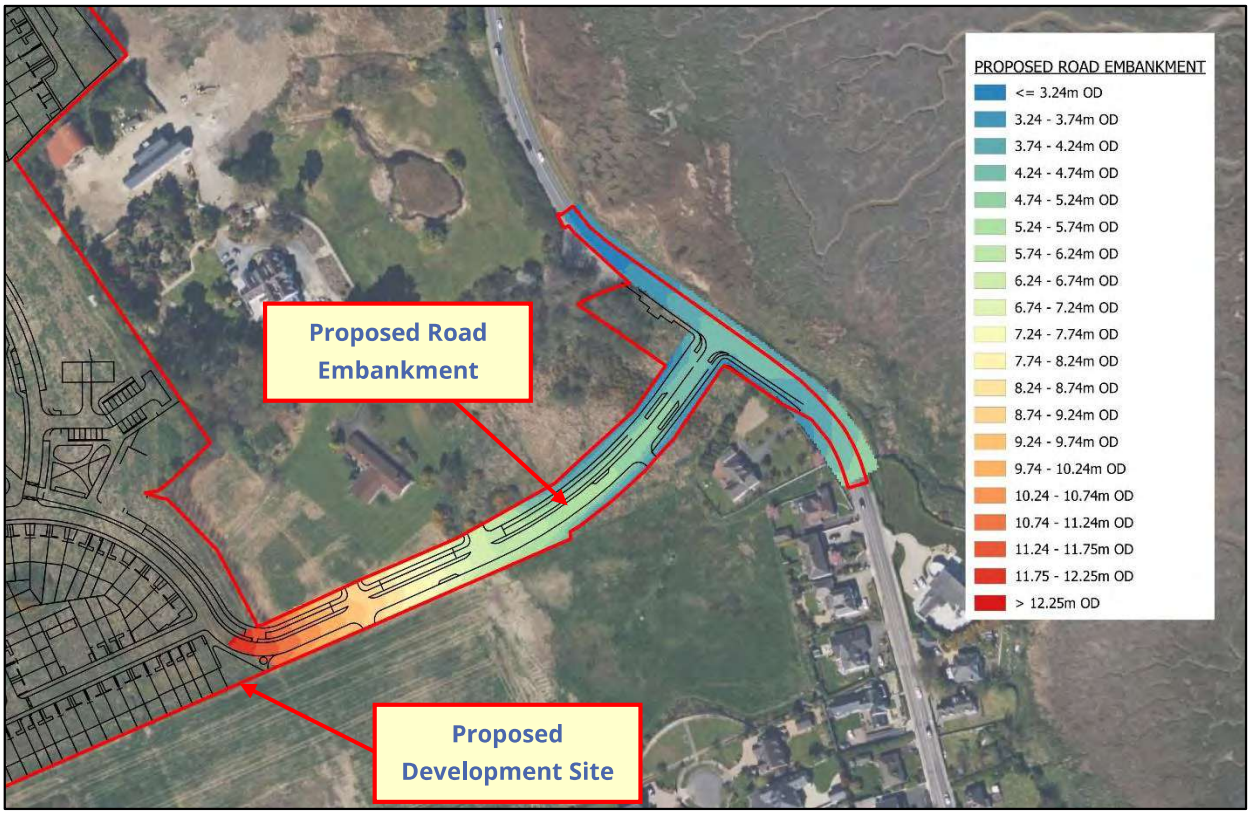


Figure 30 – Proposed Road Embankment included in 2D Domain

7.1.1. Modelling Results for Present Day Scenario

The model was run for the 0.5% AEP (1 in 200 year) and 0.1% AEP (1 in 1000 year) Present Day scenario tidal events. The flood extents in consideration of the proposed road embankment development are illustrated *Figure 31* and *Figure 32* below and also on Drawing Number *IE3047-004-A, Appendix A*.

The figures below show a comparison of the undeveloped baseline scenario tidal flood extents and the proposed road embankment development scenario tidal flood extents.

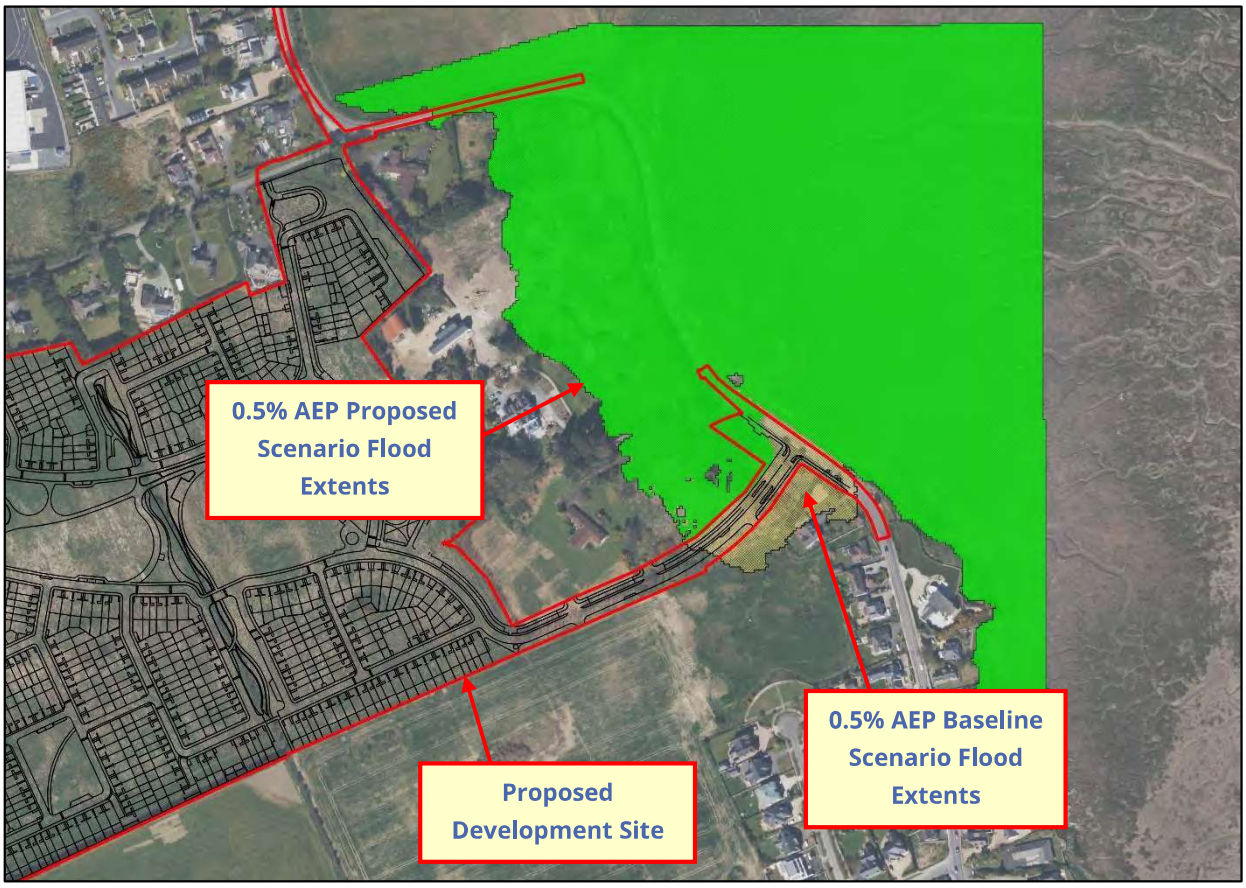


Figure 31 – Baseline v's Proposed Scenario 0.5% AEP Present Day Flood Extents

Figure 32 – Baseline v's Proposed Scenario 0.1% AEP Present Day Flood Extents

As illustrated in *Figure 30* above, there is no increase in the extent of tidal flooding as a result of the proposed road embankment for the 0.5% AEP event and the 0.1% AEP event. As illustrated in *Figure 29* and *Figure 30* above there is a reduction in the predictive tidal flood extents at the specific location shown by brown hatched area.

7.1.2. Modelling Results for MRFS

The model was also run for the 0.5% AEP MRFS tidal event. The extent of the modelling results is shown in *Figure 33* below and on Drawing Number *IE3047-005-A, Appendix A*.

The figure below shows a comparison of the undeveloped baseline scenario tidal flood extents and the proposed road embankment development scenario tidal flood extents.

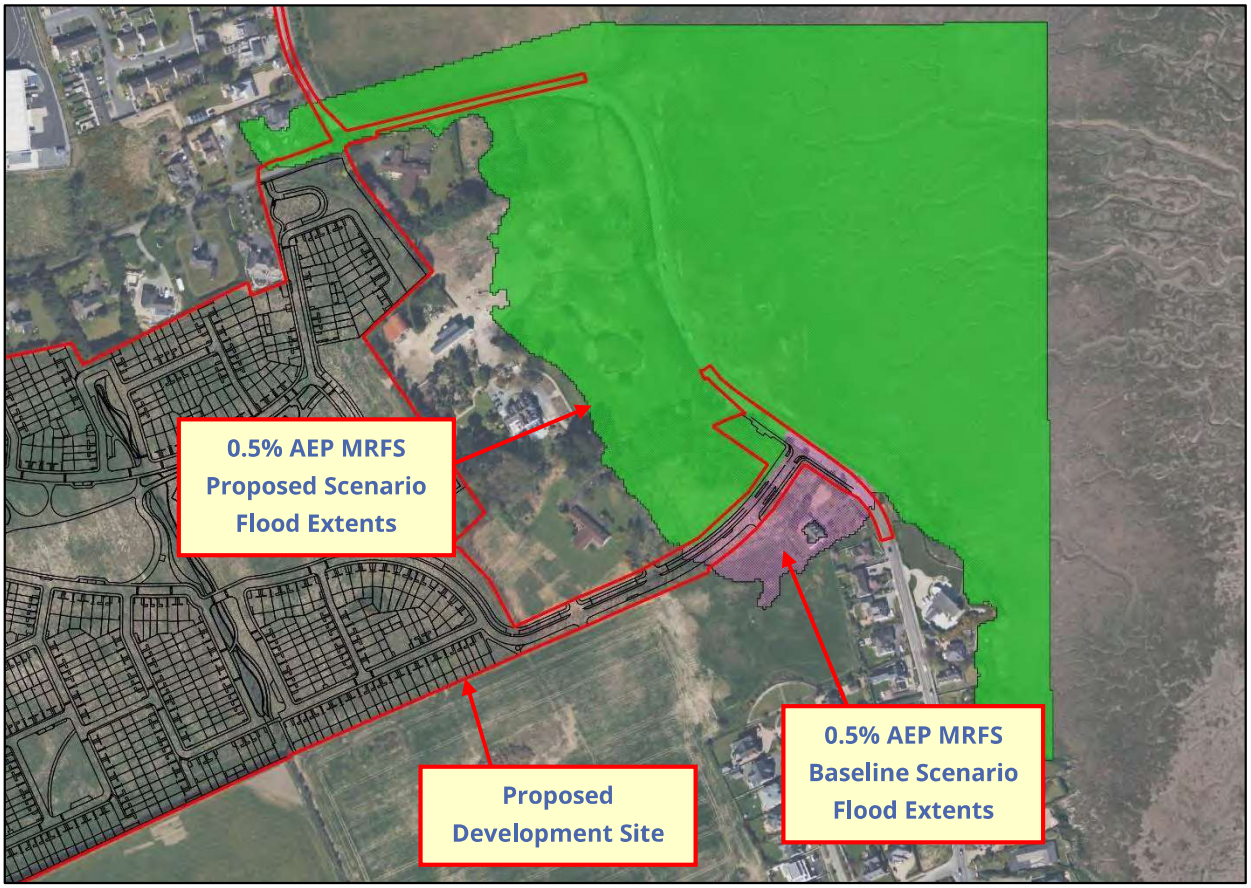


Figure 33 - Baseline v's Proposed Scenario 0.5% AEP MRFS Flood Extents

As illustrated in *Figure 31* above, there is no increase in the extent of tidal flooding as a result of the proposed road embankment for the 0.5% AEP MRFS event. There is a reduction in the predictive tidal flood extents at the specific location shown by magenta hatched area.

7.2. Pluvial Flooding (Overland Flow)

The analysis undertaken as part of this Site Specific Flood Risk Assessment (SSFRA) indicates that areas of the site including the proposed site entrance road may be susceptible to inundation during a 1% AEP (1 in 100 year) and a 0.5% AEP (1 in 200 year) pluvial flood event due to overland flow of surface water runoff.

As discussed in *Section 5.2.1* above, the majority of the surface water runoff within the site is generated from the lands within the site boundary and the site does not provide an important discharge point for adjacent lands. The pluvial flooding occurring within the boundary of the site is due to ponding of rainfall at localised topographically low points within the site as illustrated below in *Figure 34*.

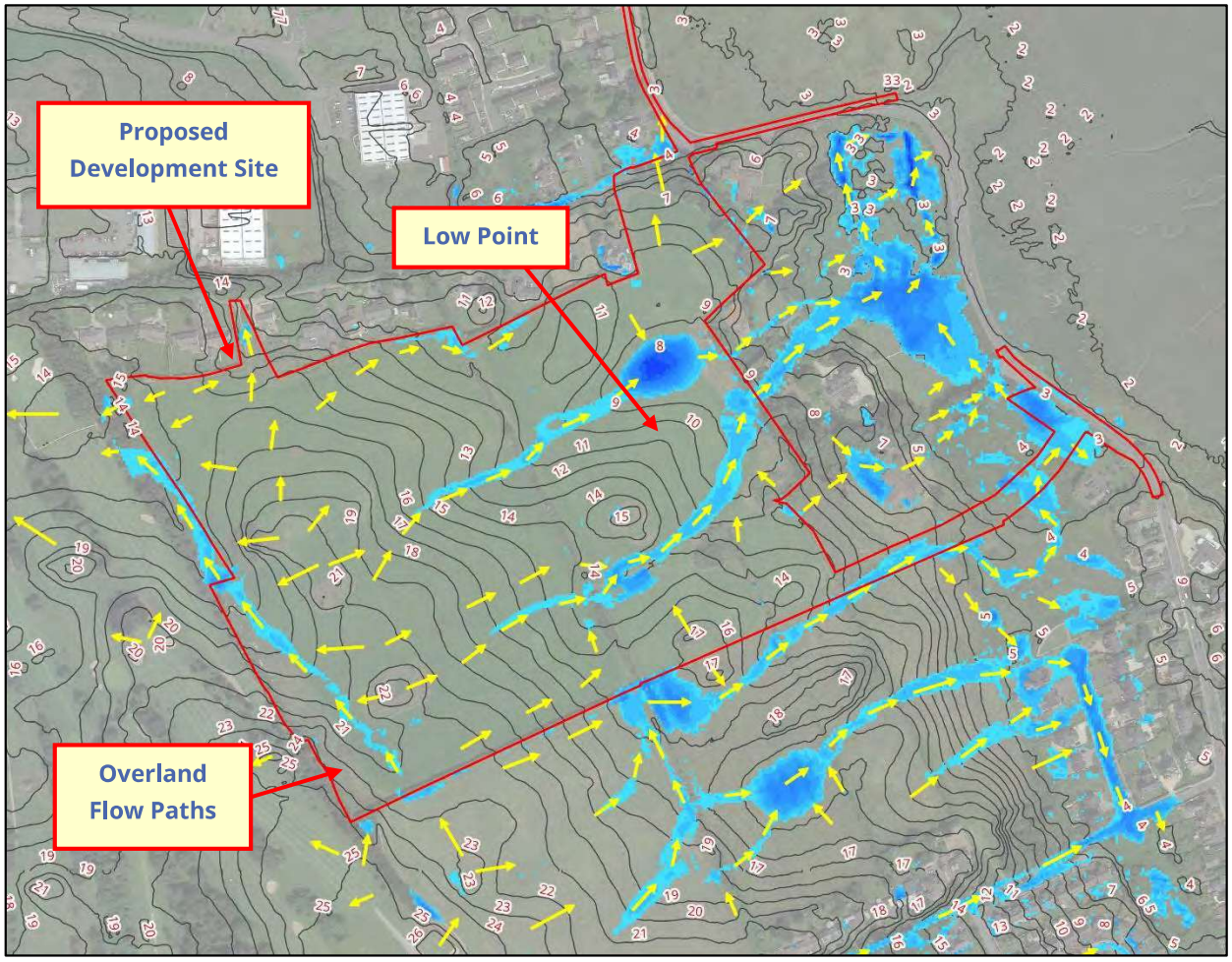


Figure 34 – Baseline Scenario 1% AEP MRFS Pluvial Flood Extents and Overland Flow Paths

7.2.1. Main Site Area

The localised low points within the boundary of the site will be removed as part of the development of the site. Surface water runoff generated within the site boundary shall be incorporated in the proposed development stormwater management system. Runoff shall be attenuated to greenfield runoff rates and discharged to the existing northern drainage channel located beyond the north-eastern boundary of the site.

7.2.2. Proposed Entrance Road Embankment

The proposed road embankment located in the eastern area of the site may result in an increased pluvial flood risk to adjacent lands and property as it has the potential to block and alter the existing undeveloped scenario overland flow path of surface water runoff in this location. The 2D pluvial model was utilised to determine the potential impact of the proposed road embankment on the extent of

pluvial flooding in the vicinity of the site. The model was updated to include the proposed road embankment in the 2D domain as illustrated in *Figure 35* below.

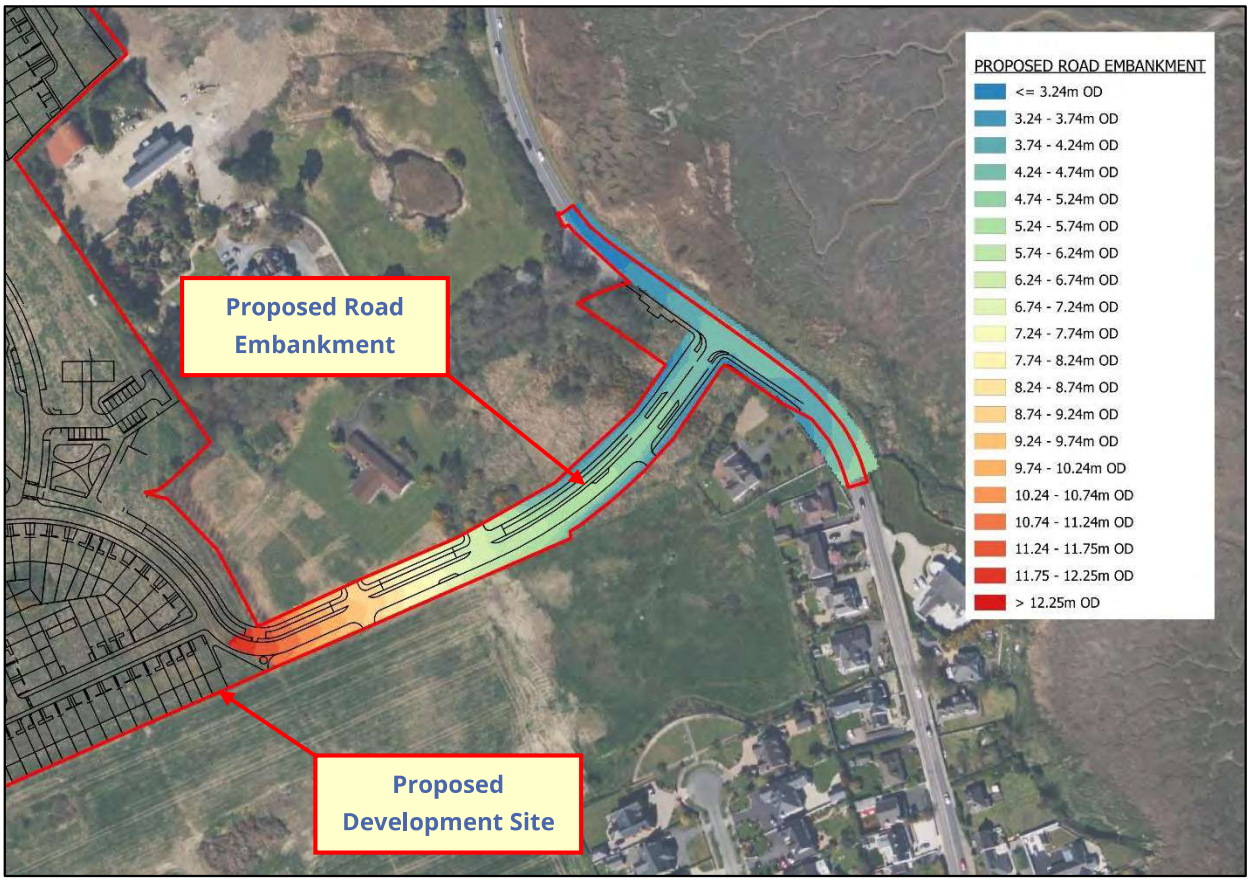


Figure 35 – Proposed Road Embankment included in 2D Domain

7.2.2.1. Modelling Results for Present Day Scenario

The model was run for the 1% AEP (1 in 100 year) and 0.5% AEP (1 in 200 year) Present Day scenario pluvial events. The model was run for 2 hours with a 2 metre grid size. The 1% AEP (1 in 100 year) and 0.5% AEP (1 in 200 year) Present Day event flood pluvial depths as outputted by the model are illustrated in *Figure 36* and *Figure 37* below.

These figures below illustrate a comparison of the undeveloped baseline scenario pluvial flood extents and the proposed road embankment development scenario pluvial flood extents.

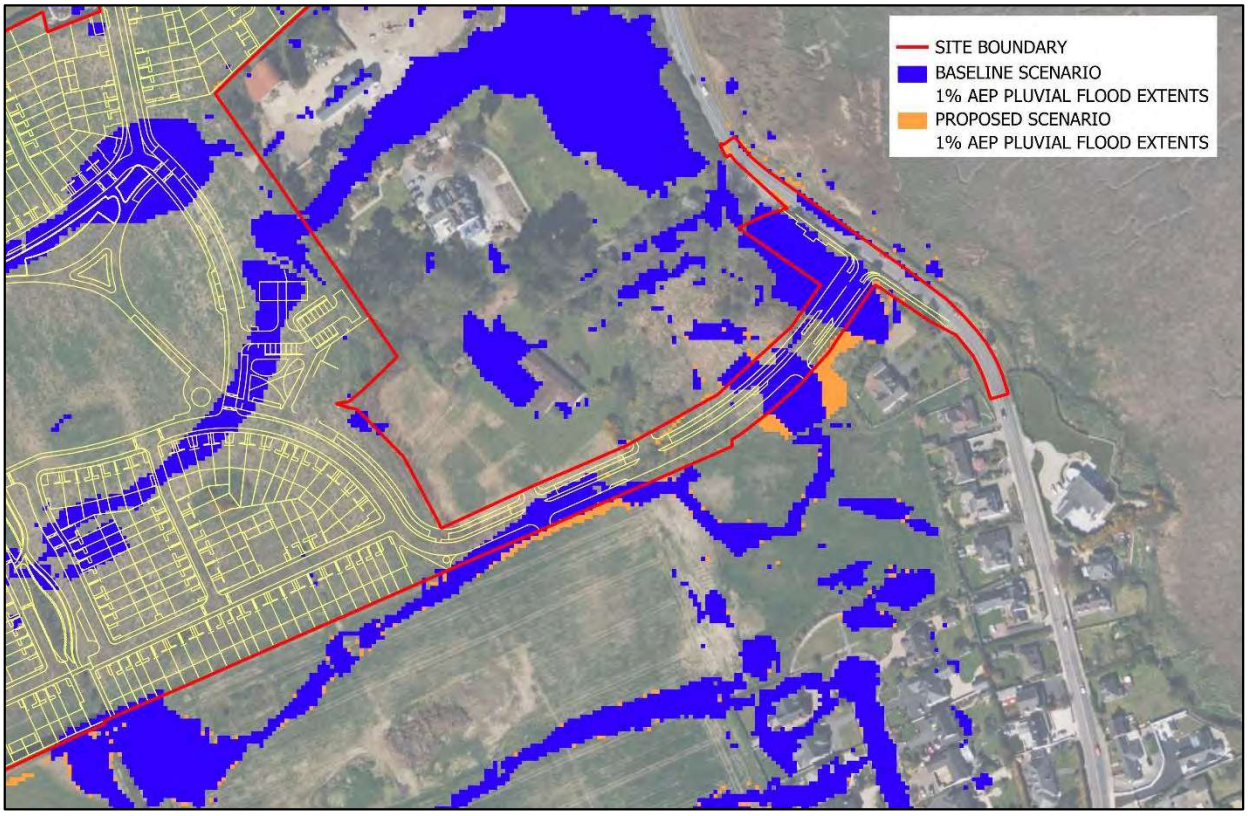


Figure 36 –Baseline v's Proposed Scenario 1% AEP Present Day Flood Extents

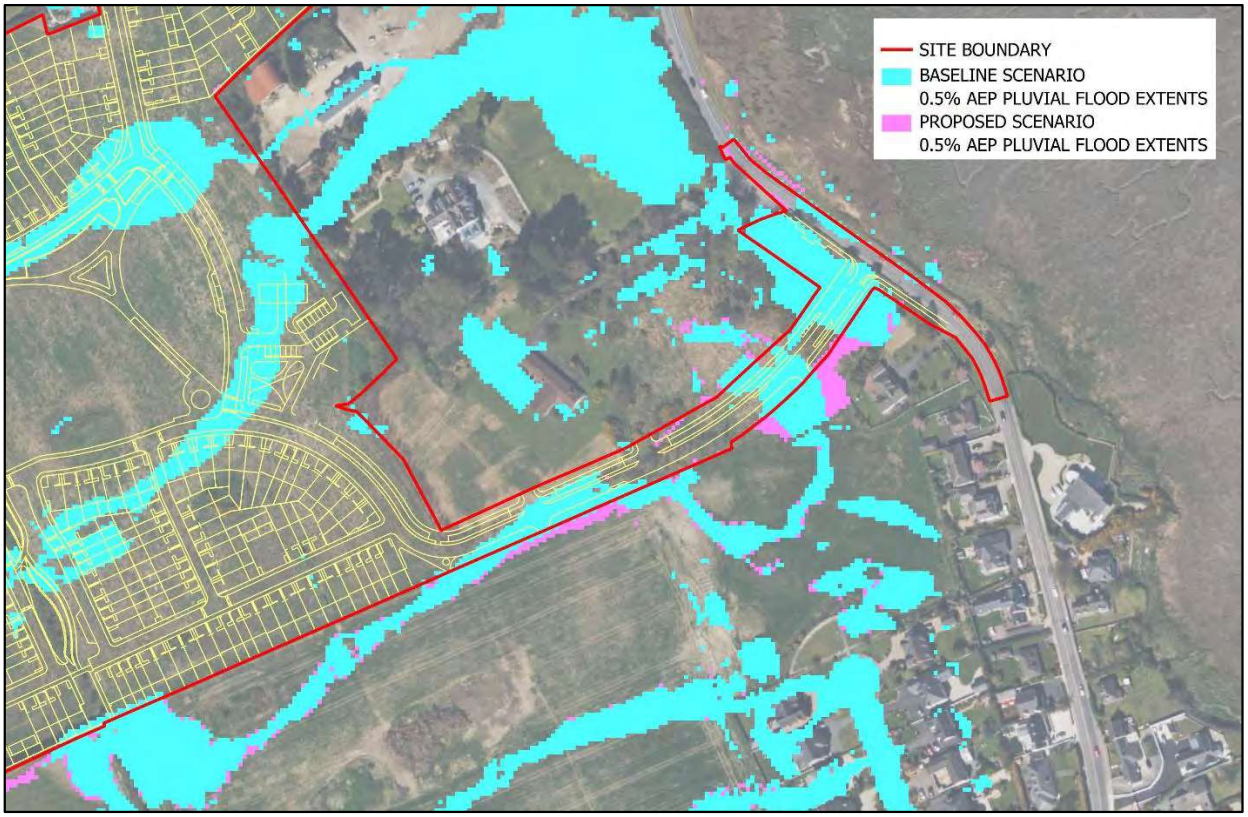


Figure 37 –Baseline v's Proposed Scenario 0.5% AEP Present Day Flood Extents

As illustrated in *Figure 36* and *Figure 37* above, there is an increase in the extent of pluvial flooding as a result of the proposed road embankment for both the 1% AEP (1 in 100 year) (shown by orange hatch area in *Figure 36*) and the 0.5% AEP (1 in 200 year) (shown by magenta hatched area in *Figure 37*) Present Day scenario pluvial event.

7.2.2.2. Modelling Results for MRFS

The model was run for the 1% AEP MRFS pluvial event. The pluvial flood depths as outputted by the model are illustrated in *Figure 38* below.

The figures below illustrate a comparison of the undeveloped baseline scenario pluvial flood extents and the proposed road embankment development scenario pluvial flood extents.

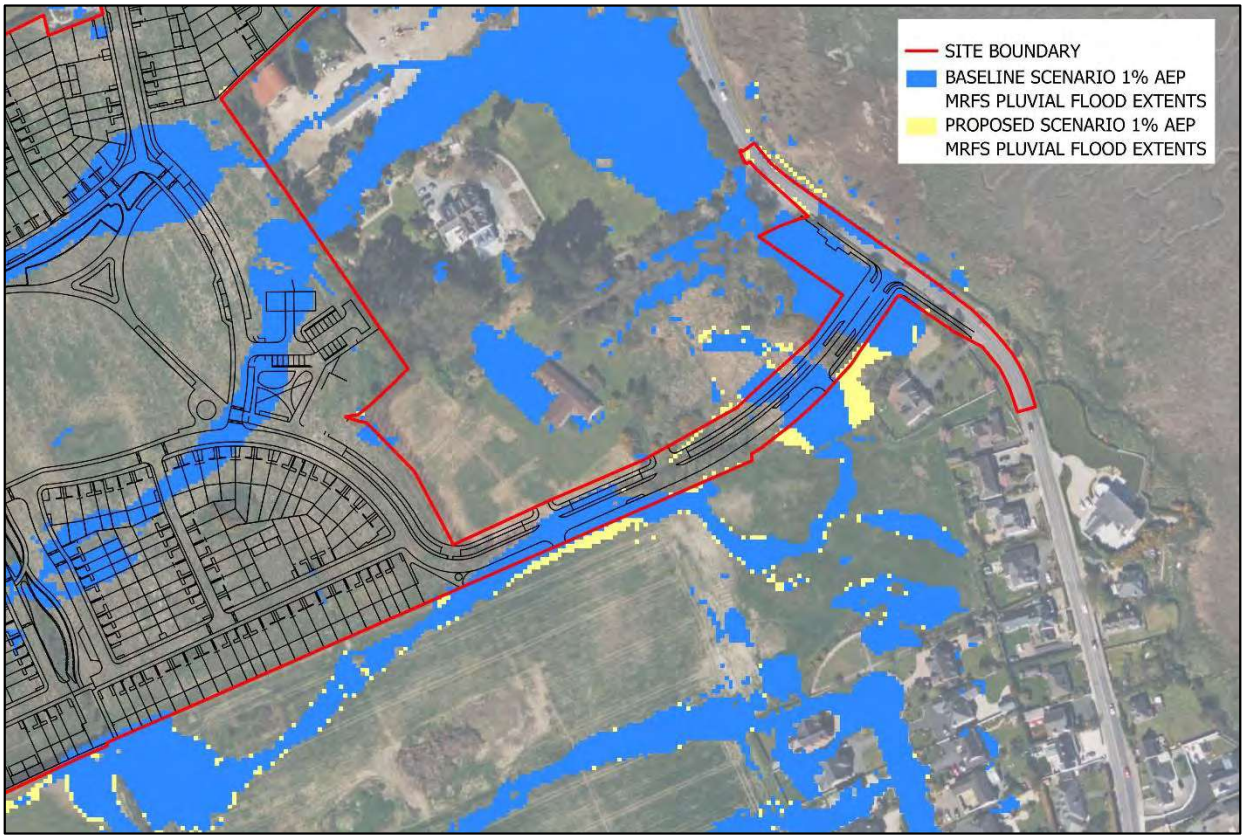


Figure 38 – Baseline v's Proposed Scenario 1% AEP MRFS Flood Extents

As illustrated in *Figure 38* above, there is an increase in the extent of pluvial flooding as a result of the proposed road embankment for the 1% AEP MRFS pluvial event (shown by yellow hatch area in *Figure 38*).

7.2.2.3. Proposed Mitigation Measures

The 2D pluvial modelling undertaken as part of this Site Specific Flood Risk Assessment indicates that the proposed road embankment construction will result in an increased pluvial flood risk to the lands adjacent to the north and to the south of the proposed road. It is therefore proposed to mitigate the increased pluvial flood risk by the inclusion of mitigation measures. These measures are divided up into two locations based on their upstream catchment areas.

Measure 1

- Greenfield pluvial runoff shall be intercepted where it intersects the southern area of the road embankment, as shown in *Figure 39* below. There is no attenuation of this runoff proposed as this is greenfield runoff only.
- The design peak flow at this location has been taken from the baseline scenario pluvial model results for the 1% AEP MRFS, which is **403 l/s**.
- The greenfield pluvial runoff shall be diverted in a northerly direction in a proposed 600mm diameter drainage pipe and will discharge to the existing drainage channel located to the north of the R172 road on the estuary side. The design of this system has been prepared by Donnachadh O'Brien & Associates Consulting Engineers and is shown on the stormwater design drawings prepared by the same. A schematic of this proposed drainage pipe is shown on *Figure 39* below.

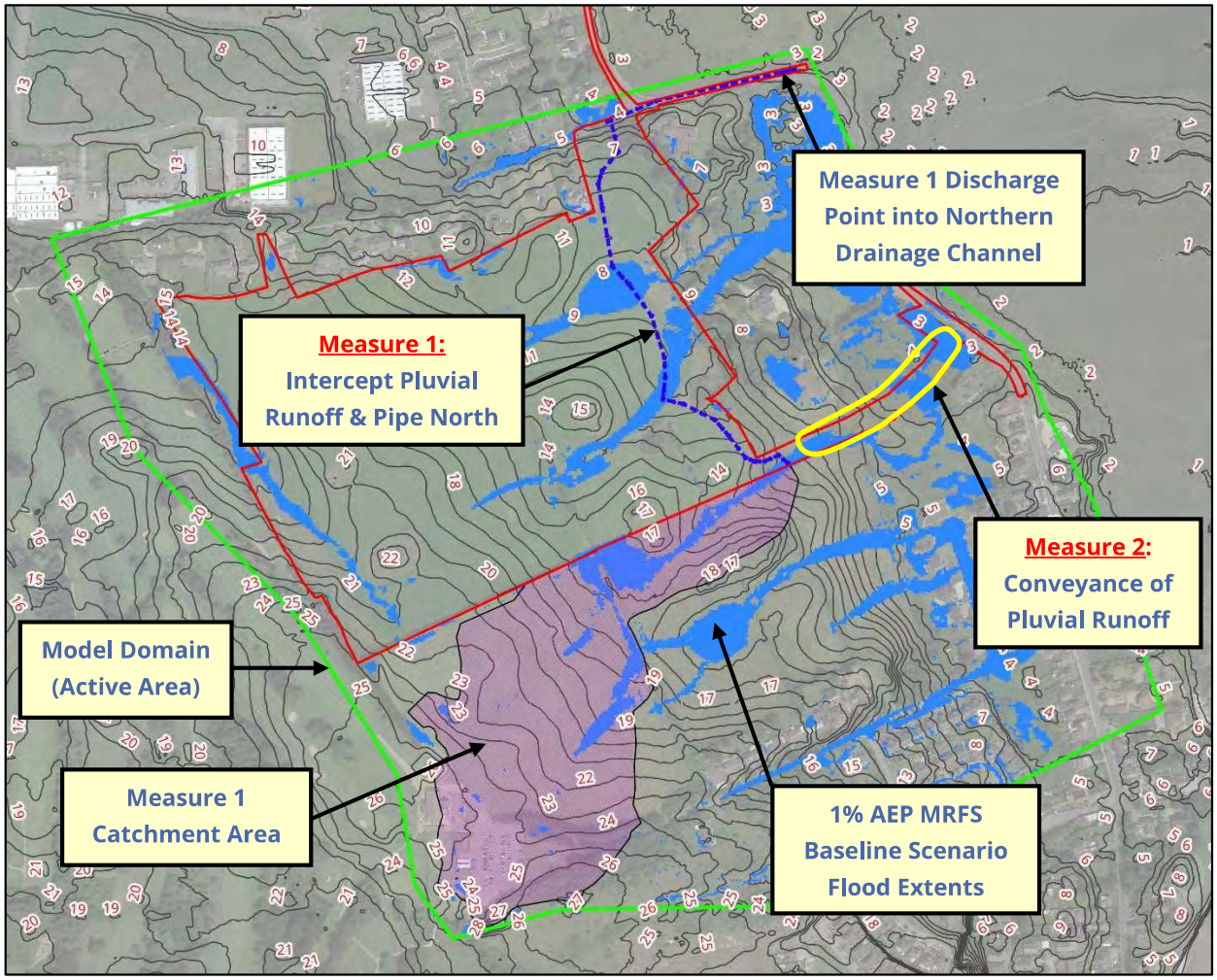


Figure 39 – Proposed Mitigation Measure Locations

Measure 2

- Conveyance pipe culverts and a 300mm (minimum depth) cut off drainage channel shall be constructed as shown below in *Figure 40*:
  - 3 x 450mm pipes, 23.8m in length, non-return valve (Tideflex or similar) on northern side of road.
  - 2 x 450 pipe, 19.7m in length, non-return valve (Tideflex or similar) on northern side.
  - 2 x 300mm pipes under field access entrance, 8.6m in length.
  - 1 x 450mm pipe, 13.2m in length.
  - Drainage channels along toe of embankment on north and south sides.

It is noted that these proposed drainage measures have been checked for potential clashes with the proposed road surface water drainage infrastructure prepared by Donnachadh O'Brien & Associates Consulting Engineers.

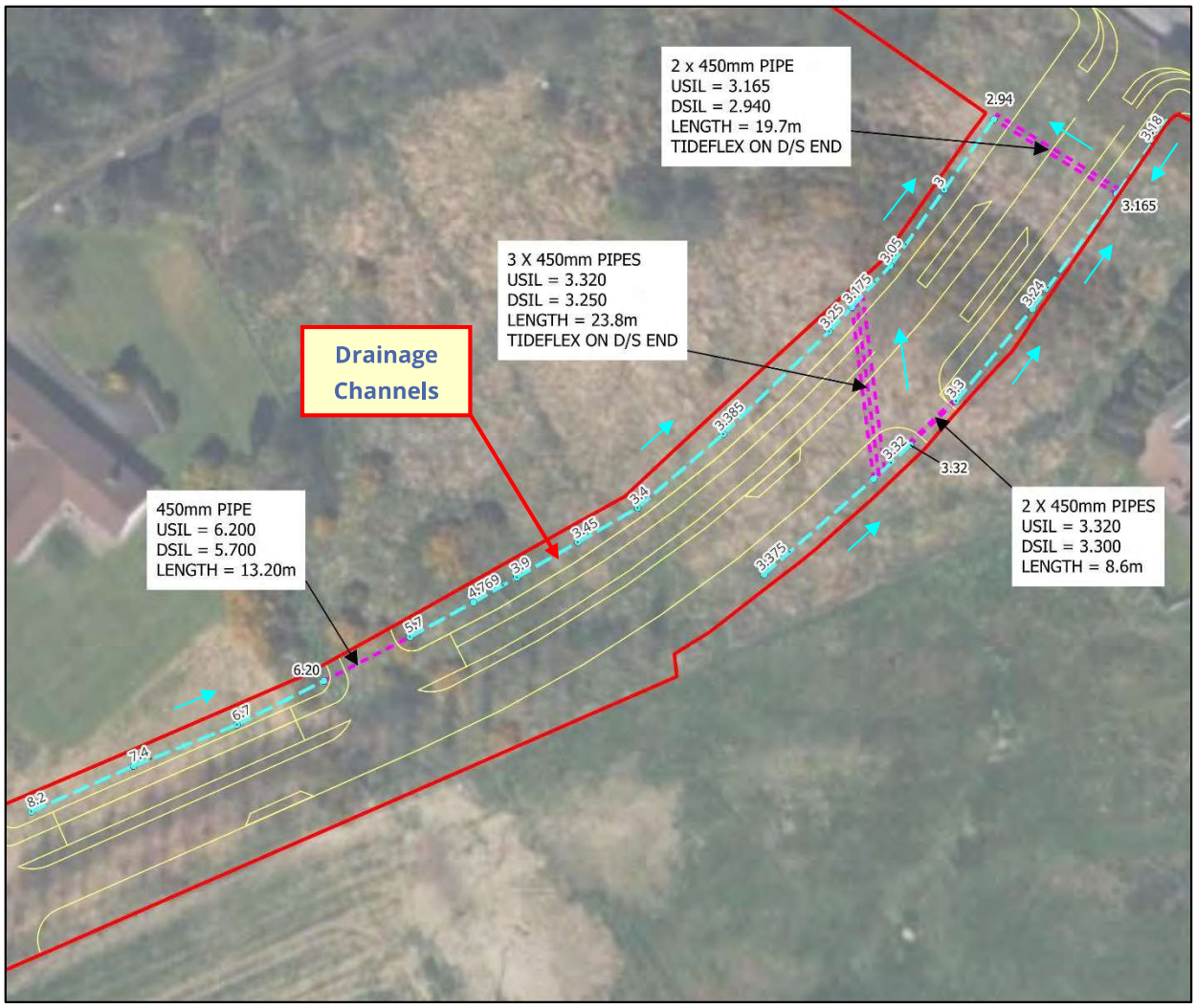


Figure 40 – Proposed Measure 2 Mitigation Measures

The pluvial model was run to include the proposed **Measure 2** mitigation measures for the 1% AEP (1 in 100 year) and 0.5% AEP (1 in 200 year) Present Day scenario pluvial events and the 1% AEP MRFS pluvial event.

Figure 41, Figure 42 and *Figure 43* below show a comparison of these flood extents with the baseline scenario.

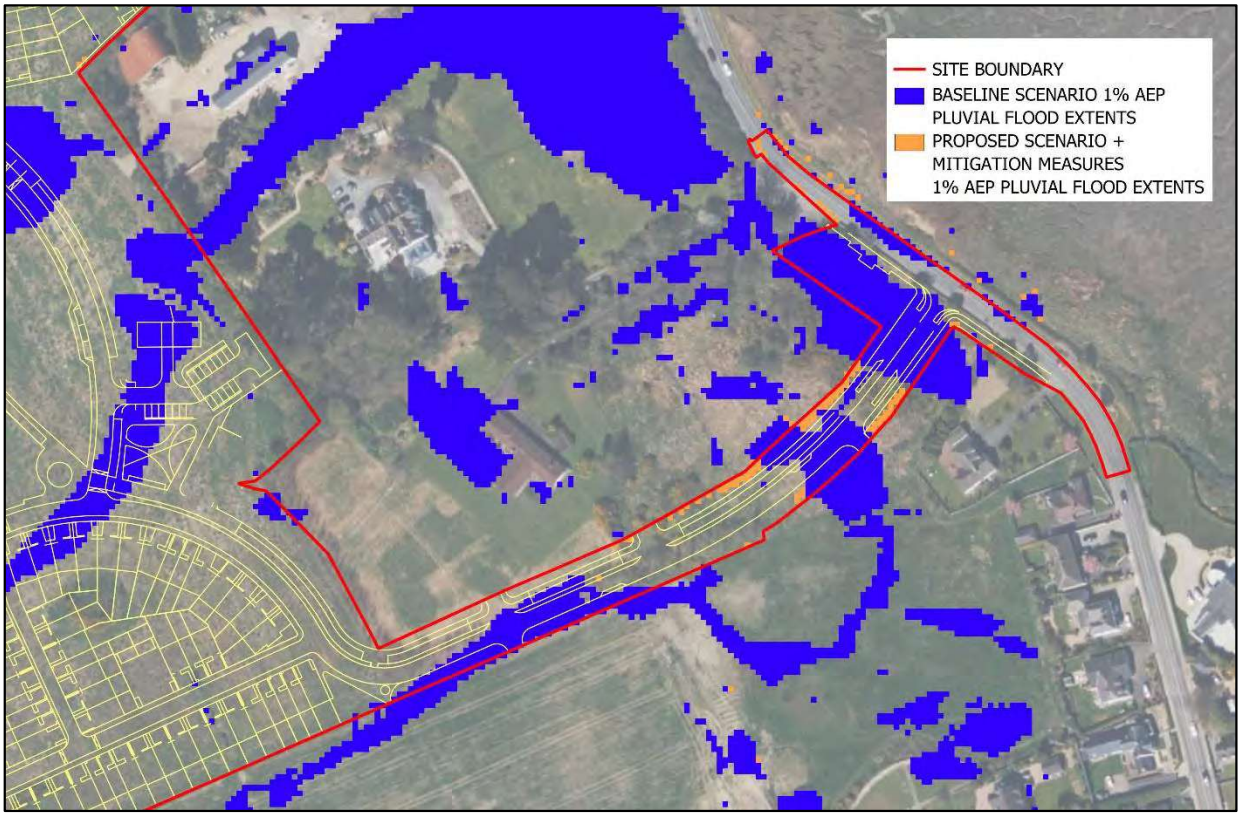


Figure 41 – Baseline v's Proposed + Mitigation Scenario 1% AEP Present Day Flood Extents

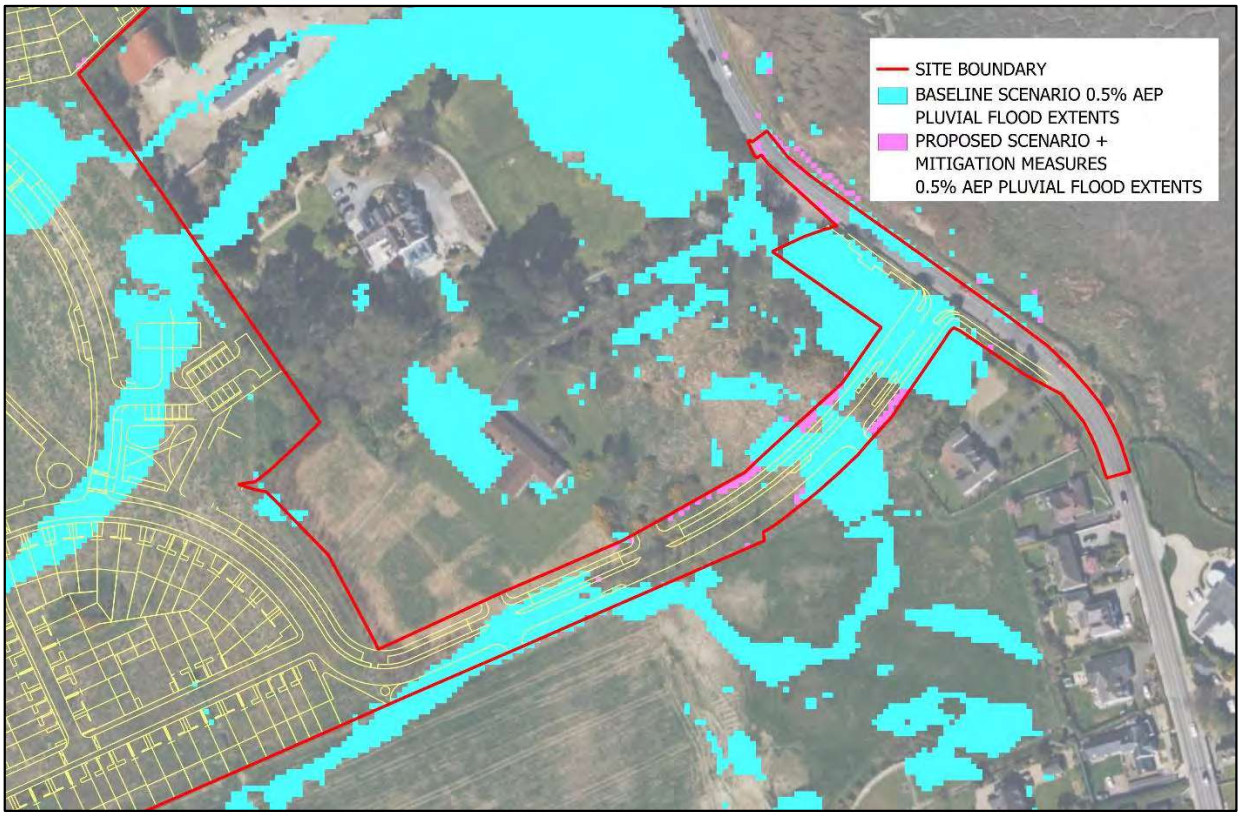


Figure 42 – Baseline v's Proposed + Mitigation Scenario 0.5% AEP Present Day Flood Extents

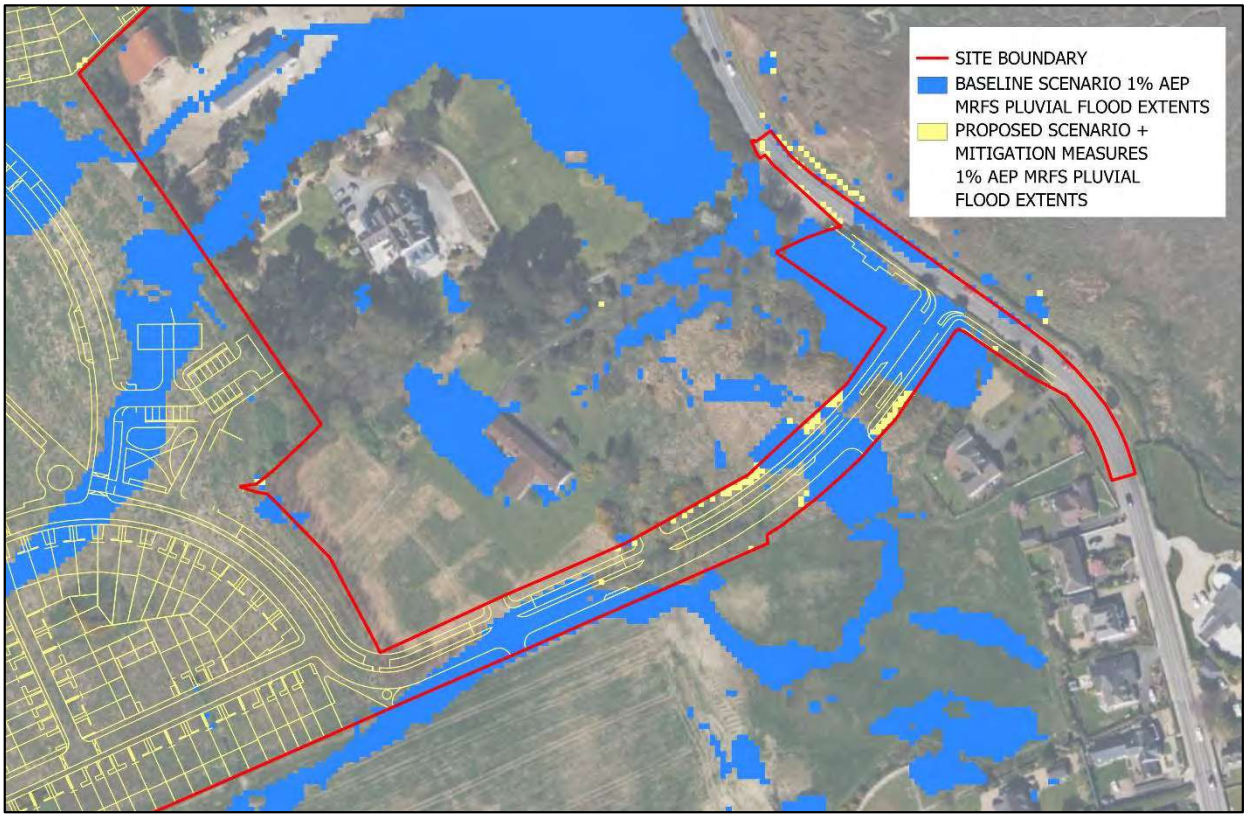


Figure 43 – Baseline v's Proposed Scenario + Mitigation 1% AEP MRFS Flood Extents

There is no increase in the extent of pluvial flooding outside the redline boundary as a result of the proposed road embankment for the 1% AEP and the 0.5% AEP Present Day scenario events and the 1% AEP MRFS event. The extent of pluvial flooding for the unmitigated scenario (*Figure 36, Figure 37* and *Figure 38* above) has been significantly reduced such that the flooding is reduced to a minimal area within the red line boundary with the inclusion of the proposed mitigation measures (see *Figure 41, Figure 42* and *Figure 43* above).

These mitigation measures (Measure 1 and Measure 2) have been adopted and implemented into the infrastructure design of the development for which planning permission is sought.

The proposed scenario pluvial flood extents for the 1% AEP and the 0.5% AEP Present Day scenario events and the 1% AEP MRFS event are shown in *Figure 44*, *Figure 45* and *Figure 46* below.

Figure 44 – Proposed Scenario: 1% AEP Present Day Pluvial Flood Depths

Figure 45 – Proposed Scenario: 0.5% AEP Present Day Pluvial Flood Depths

Figure 46 – Proposed Scenario: 1% AEP MRFS Pluvial Flood Depths

In consideration of implementation of these proposed mitigation measures the pluvial flood risk to and from the proposed development site is considered to be LOW. The development as proposed, and in particular the proposed road embankment, is not predicted to result in an adverse impact to the existing hydrological regime of the area or increase flood risk elsewhere.

8. 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 development as proposed is undefended, this Site Specific Flood Risk Assessment has determined that a portion of the proposed development site (proposed access road embankment) falls within a tidal Flood Zone 'A' and Flood Zone 'B'. The site is accessed from the east, from the Blackrock Road (R172). A new entrance will be provided, with works to the design of the existing road proposed to facilitate safe turning movements. The new entrance design also includes an in-line bus stop on the western side of the R172. Permission was previously granted by ABP for an access at this location to a residential scheme of similar scale (ABP Ref. No. 304782). Vehicular access from Bóthar Maol, a cul de sac, is less suitable from a roads perspective . It is also subject to flooding – tidal Flood Zone 'A' and Flood Zone 'B'. The main access road from the east also provides for future access to adjacent lands.

Table 3.1 of the guidelines lists the vulnerability class of various types of development. The area of the proposed development site located within tidal Flood Zone 'A' and Flood Zone 'B' 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 type and form of development proposed within Flood Zone 'A' is 'Highly Vulnerable Development', therefore development proposals for the site are subject to the Justification Test. It is noted that the proposed road levels have been designed so that it is located within Flood Zone 'C' and also so that it does not increase flood risk elsewhere, which is described in the following section below.

With the proposed works raising the roads levels above flood risk, the access from Blackrock Road was deemed the most appropriate. We also note this access was previously permitted by ABP to serve 483 no. housing units at the same location (ABP Ref. 304782).

Where 'Highly Vulnerable Development' is proposed within a delineated tidal Flood Zone 'A' or Flood Zone 'B', 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 site is zoned as 'Residential' in the Louth County Development Plan 2021-2027 and can be defined as an in-fill development located within the Urban Core and therefore supports the continued renewal and development of the compact urban form in accordance with the key planning objectives.

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 – Tidal flooding is predicted within the area of the proposed entrance road. A hydrological and hydraulic assessment has been completed for the undeveloped (baseline) scenario and also the proposed scenario where the road embankment is constructed. This assessment shows there is no increase in tidal flood risk as a result of the proposed development including the access road.

   A hydrological and hydraulic assessment has been completed to determine the pluvial flood risk to and from the proposed development site. Pluvial flooding is predicted within the area of the site to be developed, including the proposed access road, which is due to localised ponding of rainfall. Surface water runoff generated within the site boundary shall be incorporated in the proposed surface water drainage and attenuation system. Runoff shall be attenuated to greenfield runoff rates and discharged to the field drain located beyond the north-eastern boundary of the site. The pluvial flood risk to the surrounding lands from rainfall runoff generated within the site is therefore considered to be low.

   The proposed access road embankment located in the eastern area of the site may result in an increased pluvial flood risk to surrounding people and property as it blocks an overland flow path of surface water runoff in this location. The 2D pluvial model was utilised to determine the potential impact of the proposed road embankment on the extent of pluvial flooding in the vicinity of the site. It is proposed to mitigate the increased pluvial flood risk by the inclusion of the following measures:

   - **Measure 1:** Greenfield pluvial runoff shall be intercepted where it intersects the southern area of the proposed road embankment. The pluvial runoff shall

be diverted in a northerly direction in a proposed 600mm diameter drainage pipe and will discharge to the existing drainage channel located to the north of the R172 road on the estuary. The design of this system has been prepared by Donnachadh O'Brien & Associates Consulting Engineers and is shown on the stormwater design drawings prepared by the same.

- **Measure 2**: Conveyance pipe culverts and 300mm (minimum depth) cut off drainage channels shall be constructed as follows :
  - 3 x 450mm pipes, 23.8m in length, non-return valve (Tideflex or similar) on northern side of road.
  - 2 x 450 pipe, 19.7m in length, non-return valve (Tideflex or similar) on northern side.
  - 2 x 300mm pipes under field access entrance, 8.6m in length.
  - 1 x 450mm pipe, 13.2m in length.
  - Drainage channels along toe of embankment on north and south sides.

The inclusion of the above measures will ensure the proposed development will not result in an adverse impact to the existing pluvial and hydrological regime in the area and would not result in an increased flood risk elsewhere.

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

Answer – Pluvial flooding identified within the boundary of the site will be removed as part of the development of the site. Surface water runoff generated within the site boundary shall be incorporated in the proposed development stormwater management system. Runoff shall be attenuated to greenfield runoff rates and discharged to the existing northern drainage channel located beyond the north-eastern boundary of the site.

There is no residential development proposed within an extreme Tidal Flood Zone 'A' or Flood Zone 'B'.

The proposed road layout has been designed so that it is located within Flood Zone 'C'. The proposed mitigation measures described in *Section 7.2.2.3* will reduce the impact of the development such that it does not increase flood risk elsewhere.

(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 – The proposed mitigation measures shall ensure residual pluvial flood risks to surrounding people and property are mitigate and managed to an acceptable level and do not result in an increased flood risk to the surrounding lands.

Access to and from the site can be gained during an extreme tidal or pluvial event by utilising the proposed access road. As a precautionary approach, the proposed road levels are to be constructed above the 0.5% AEP MRFS tidal flood level of 4.14m OD. Therefore, access to and from the site shall not be impeded for emergency services during an extreme tidal flood event

(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 development supports achieving a sustainable living environment by locating a residential development with the necessary infrastructure and supporting social and community facilities.

9. Summary Conclusions and Recommendations

In consideration of the findings of this Site Specific Flood Risk Assessment and analysis the following conclusions and recommendations are made in respect of the proposed development site:

Initial Flood Risk Assessment

- 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 development site has been screened, scoped and assessed for flood risk in accordance with the above guidelines.

Detailed Flood Risk Assessment

- The primary flood risk to the proposed development site can be attributed to tidal flood event in Dundalk Bay (Irish Sea). Secondary flood risk can be attributed to a pluvial flood event due to overland surface water flow from higher ground to the west and south. The site is not at risk of fluvial or groundwater flooding.
- A detailed assessment of the tidal flood risk has been undertaken for the site. A 2-D tidal model has been undertaken in consideration of an extreme 0.5% AEP (1 in 200 year) and 0.1% AEP (1 in 1000 year) rainfall Present Day scenario event and an extreme 0.5% AEP (1 in 200 year) Mid-Range Future Scenario event.
- The tidal analysis indicates that the proposed access road may be at risk of tidal flood inundation during a 0.5% AEP (1 in 200 year) and 0.1% AEP (1 in 1000 year) tidal event for the Present Day scenario and 0.5% AEP (1 in 200 year) Mid-Range Future Scenario (MRFS).
- In consideration of the findings of this Site Specific Flood Risk Assessment, and in the context of 'The Planning System & Flood Risk Management Guidelines – 2009' the proposed access road falls within a delineated tidal Flood Zone 'A' and Flood Zone 'B'.
- A detailed assessment of the pluvial flood risk has been undertaken for the site. A 2-D surface water runoff (pluvial) model has been undertaken in consideration of an extreme 1% AEP (1 in 100 year) and 0.5% AEP (1 in 200 year) rainfall Present Day scenario event and an extreme 1% AEP (1 in 100 year) Mid-Range Future Scenario event.
- The pluvial analysis indicates areas of the proposed development site may be at risk of tidal flood inundation during an extreme 1% AEP (1 in 100 year) and 0.5% AEP (1 in 200 year) rainfall

Present Day scenario event and an extreme 1% AEP (1 in 100 year) Mid-Range Future Scenario event.

Assessment of Hydrological Impact of Proposed Development

- It is proposed to construct the development within an area of tidal and pluvial flood risk. The hydrological impact of this was assessed using the tidal and pluvial hydraulic models.
- The 2D tidal model was updated to include the proposed road embankment. The model results show there is no increase in the extent of tidal flooding as a result of the proposed road embankment for the 0.5% AEP and the 0.1% AEP Present Day scenario events and the 0.5% AEP MRFS event.
- The 2D pluvial model was updated to include the proposed road embankment. The model results show there is an increase in the extent of pluvial flooding as a result of the proposed road embankment for the 0.5% AEP and the 0.1% AEP Present Day scenario events and the 0.5% AEP MRFS event.

Recommendations

- Measure 1: Greenfield pluvial runoff shall be intercepted where it intersects the southern area of the proposed road embankment. The pluvial runoff shall be diverted in a northerly direction in a proposed 600mm diameter drainage pipe and will discharge to the existing drainage channel located to the north of the R172 road. The design of this system has been prepared by Donnachadh O'Brien & Associates Consulting Engineers and is shown on the stormwater design drawings prepared by the same.
- Measure 2: Conveyance pipe culverts and 300mm (minimum depth) cut off drainage channels shall be constructed as follows:
  - 3 x 450mm pipes, 23.8m in length, non-return valve (Tideflex or similar) on northern side of road.
  - 2 x 450 pipe, 19.7m in length, non-return valve (Tideflex or similar) on northern side.
  - 2 x 300mm pipes under field access entrance, 8.6m in length.
  - 1 x 450mm pipe, 13.2m in length.
  - Drainage channels along toe of embankment on north and south sides.

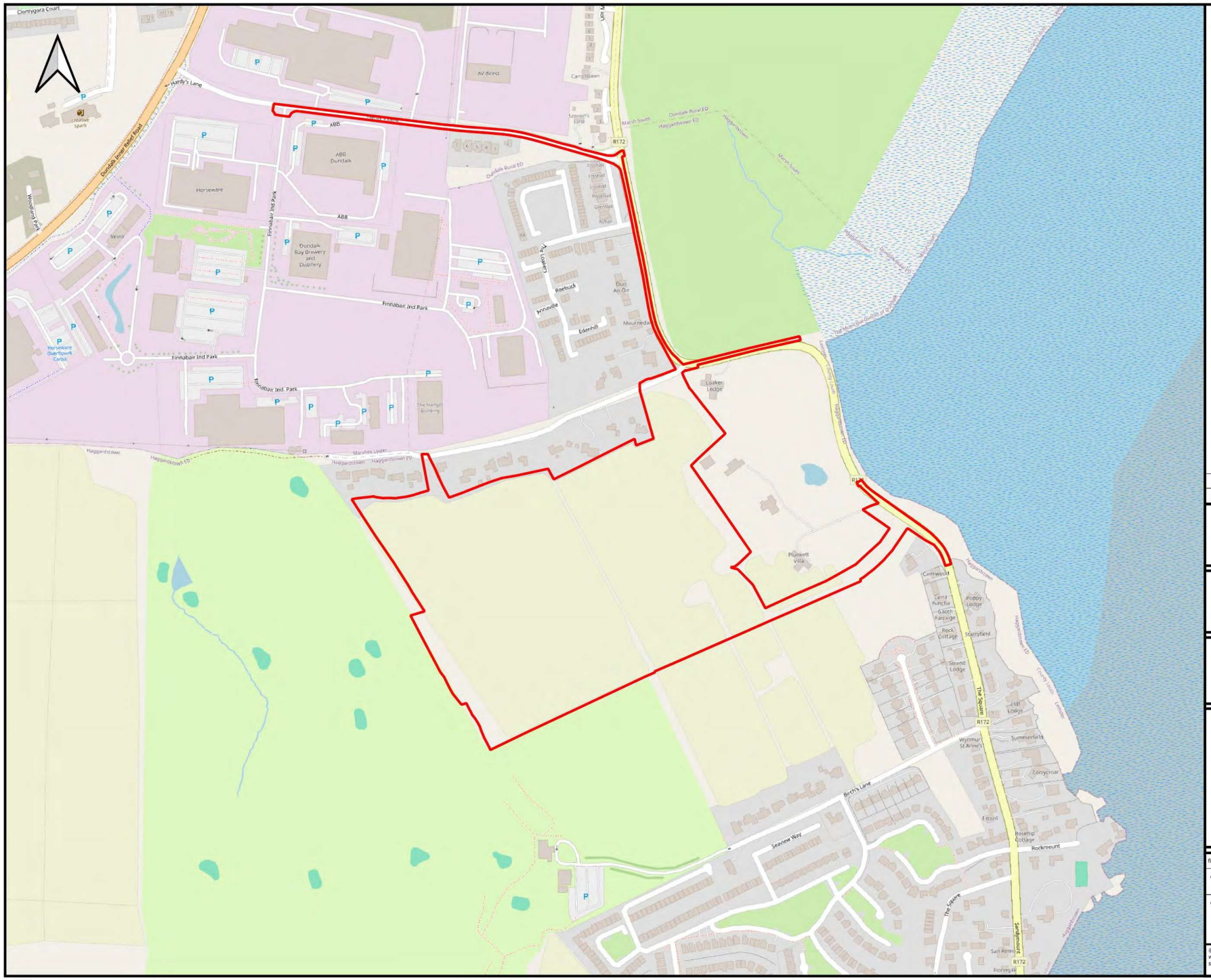
Conclusions

- The proposed development is considered to comply with the requirements of the Justification Test for development management.
- In consideration of the assessment and analysis undertaken as part of this SSFRA and implementation of the presented recommendations, the flood risk to and from the development as proposed is considered to be LOW. The development as proposed is not expected to result in an adverse impact to the hydrological regime of the area or increase flood risk elsewhere and is therefore considered to be appropriate from a flood risk perspective.

Appendices

Appendix A. Drawings

IE3047-001-A	Site Location
IE3047-002-A	Baseline 0.5% AEP and 0.1% AEP Present Day Tidal Flood Extent Mapping
IE3047-003-A	Baseline 0.5% AEP MRFS Tidal Flood Extent Mapping
IE3047-004-A	Proposed 0.5% AEP and 0.1% AEP Present Day Tidal Flood Extent Mapping
IE3047-005-A	Proposed 0.5% AEP MRFS Tidal Flood Extent Mapping



LEGEND

SITE BOUNDARY

rev.	date	amendment	drn	ckd
A	09.12.24	INFORMATION	NOM	PMS

PROPOSED DEVELOPMENT SITE
HAGGARDSTOWN, BLACKROCK, CO. LOUTH

SITE SPECIFIC FLOOD RISK ASSESSMENT

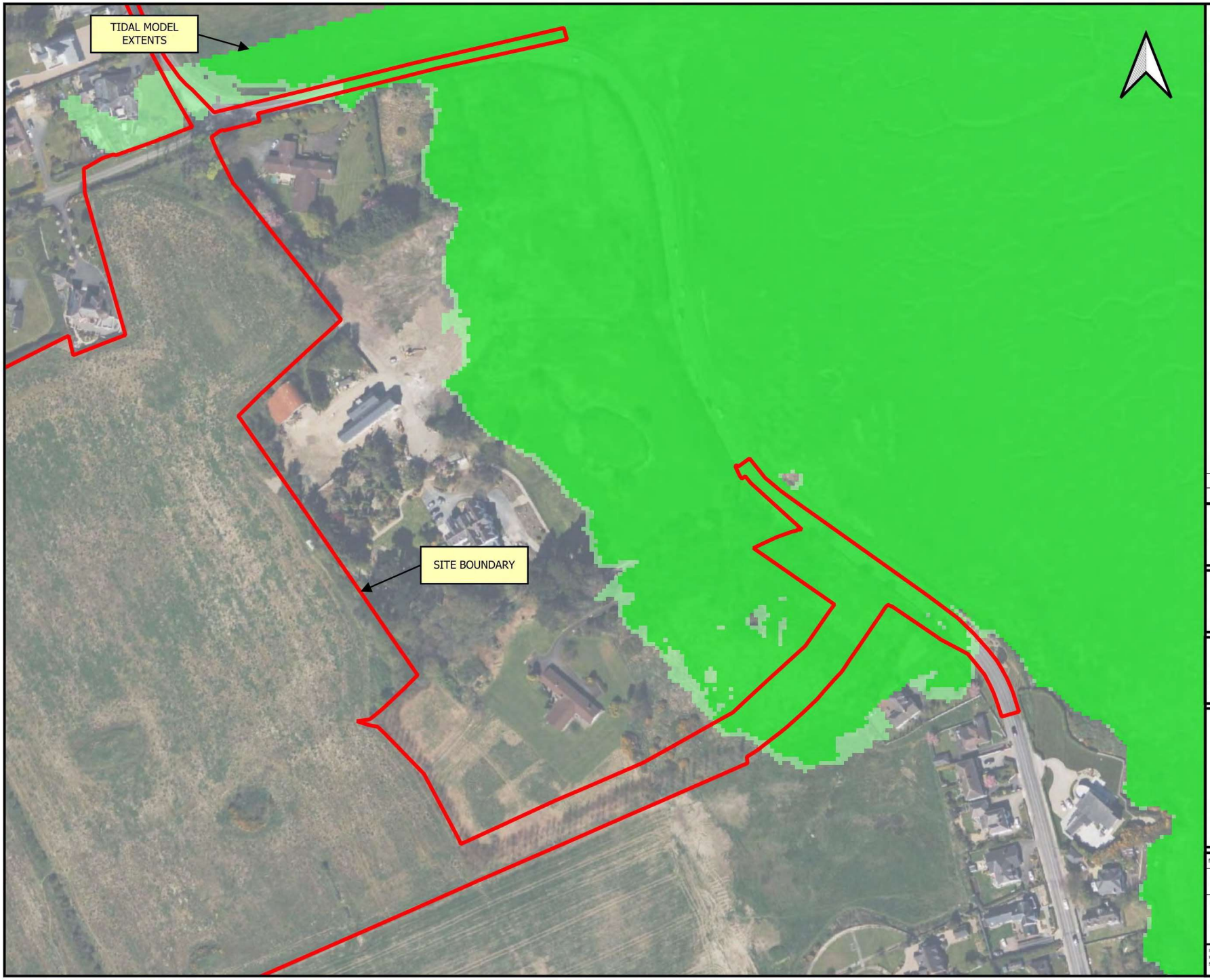
SITE LOCATION PLAN

IE CONSULTING
WATER-ENVIRONMENTAL-CIVIL

CARLOW OFFICE:
INNOVATION CENTRE
GREEN ROAD
CARLOW R95 W248

NEWRY OFFICE:
7 LINENHALL
WIN BUSINESS PARK
NEWRY BT35 6PH

file location: N:\IE3047\DRAWINGS	scale: 1:7,500	A4
drawing status: PLANNING	datum: MALIN	
	drawn: NOM	
drawing no. IE3047-001	rev: A	checked: PMS
		approved: PMS
		date: 09/12/2024



LEGEND

- SITE BOUNDARY
- 1 IN 200 YEAR TIDAL EXTENTS (FLOOD ZONE 'A')
- 1 IN 1000 YEAR TIDAL EXTENTS (FLOOD ZONE 'B')

rev.	date	amendment	drn	ckd
A	09.12.24	INFORMATION	NOM	PMS

PROPOSED DEVELOPMENT SITE
HAGGARDSTOWN, BLACKROCK, CO. LOUTH

SITE SPECIFIC FLOOD RISK ASSESSMENT

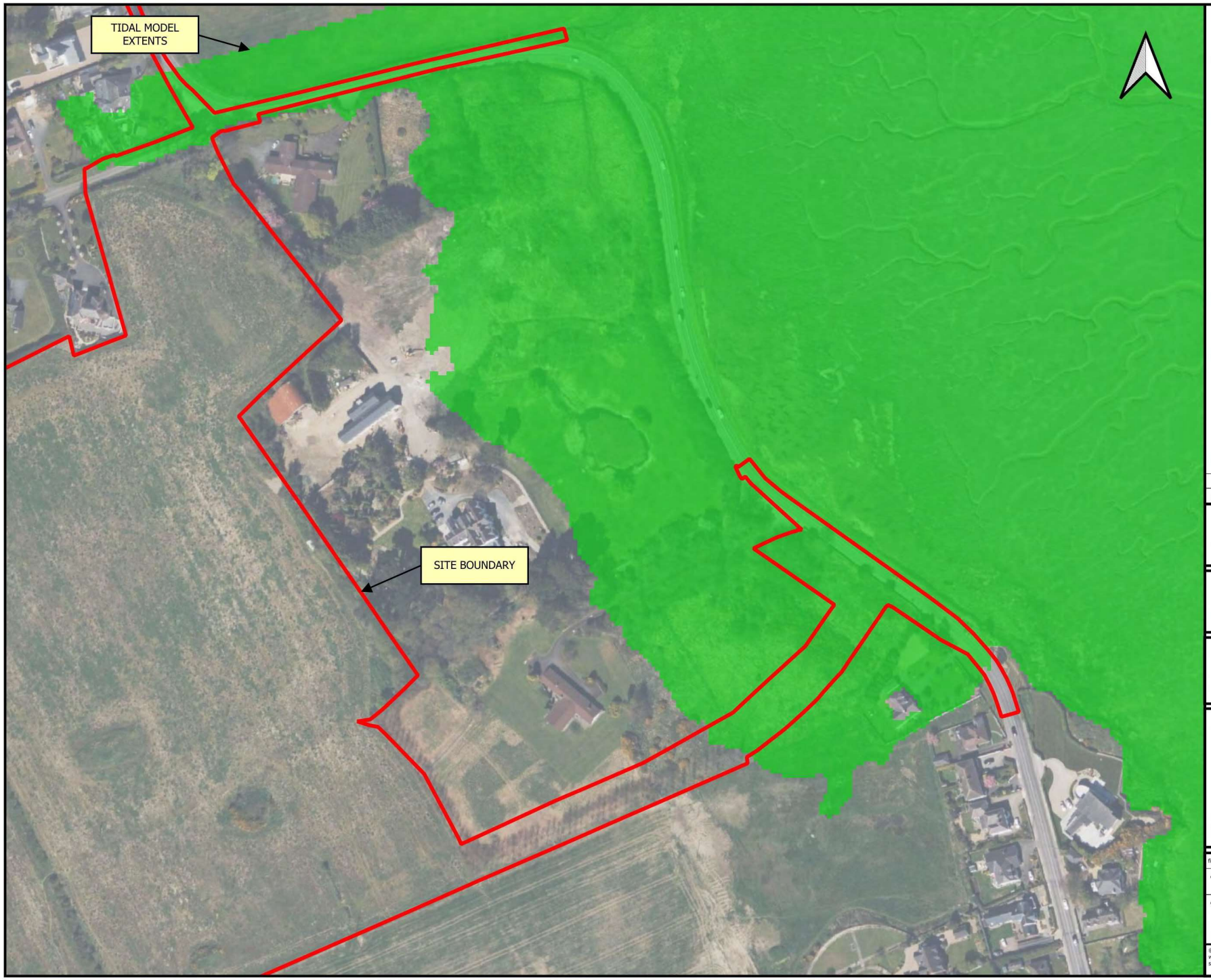
BASELINE RESULTS
1 IN 200 YEAR (0.5% AEP) & 1 in 1000 YEAR
(0.1% AEP) PRESENT DAY TIDAL FLOOD EXTENTS

IE CONSULTING
WATER-ENVIRONMENTAL-CIVIL

CARLOW OFFICE:
INNOVATION CENTRE
GREEN ROAD
CARLOW R95 W248

NEWRY OFFICE:
7 LINENHALL
WIN BUSINESS PARK
NEWRY BT35 6PH

file location: N:\IE3047\DRAWINGS	scale: 1:2,500	A4
drawing status: PLANNING	datum: MALIN	
	drawn: NOM	
drawing no. IE3047-002 rev: A	checked: PMS	
	approved: PMS	
	date: 09/12/2024	



LEGEND

- SITE BOUNDARY
- 1 IN 200 YEAR MRFS TIDAL EXTENTS

rev.	date	amendment	drn	ckd
A	09.12.24	INFORMATION	NOM	PMS

PROPOSED DEVELOPMENT SITE
HAGGARDSTOWN, BLACKROCK, CO. LOUTH

SITE SPECIFIC FLOOD RISK ASSESSMENT

BASELINE RESULTS
1 IN 200 YEAR (0.5% AEP) MID-RANGE FUTURE SCENARIO (MRFS) TIDAL FLOOD EXTENTS

IE CONSULTING
WATER-ENVIRONMENTAL-CIVIL

CARLOW OFFICE:
INNOVATION CENTRE
GREEN ROAD
CARLOW R95 W248

NEWRY OFFICE:
7 LINENHALL
WIN BUSINESS PARK
NEWRY BT35 6PH

file location: N:\IE3047\DRAWINGS		scale: 1:2,500 A4
drawing status: PLANNING		datum: MALIN
		drawn: NOM
drawing no. IE3047-003	rev: A	checked: PMS
		approved: PMS
		date: 09/12/2024

LEGEND

- SITE BOUNDARY
- 1 IN 200 YEAR TIDAL EXTENTS (FLOOD ZONE 'A')
- 1 IN 1000 YEAR TIDAL EXTENTS (FLOOD ZONE 'B')

rev.	date	amendment	drn	ckd
A	09.12.24	INFORMATION	NOM	PMS

PROPOSED DEVELOPMENT SITE
HAGGARDSTOWN, BLACKROCK, CO. LOUTH

SITE SPECIFIC FLOOD RISK ASSESSMENT

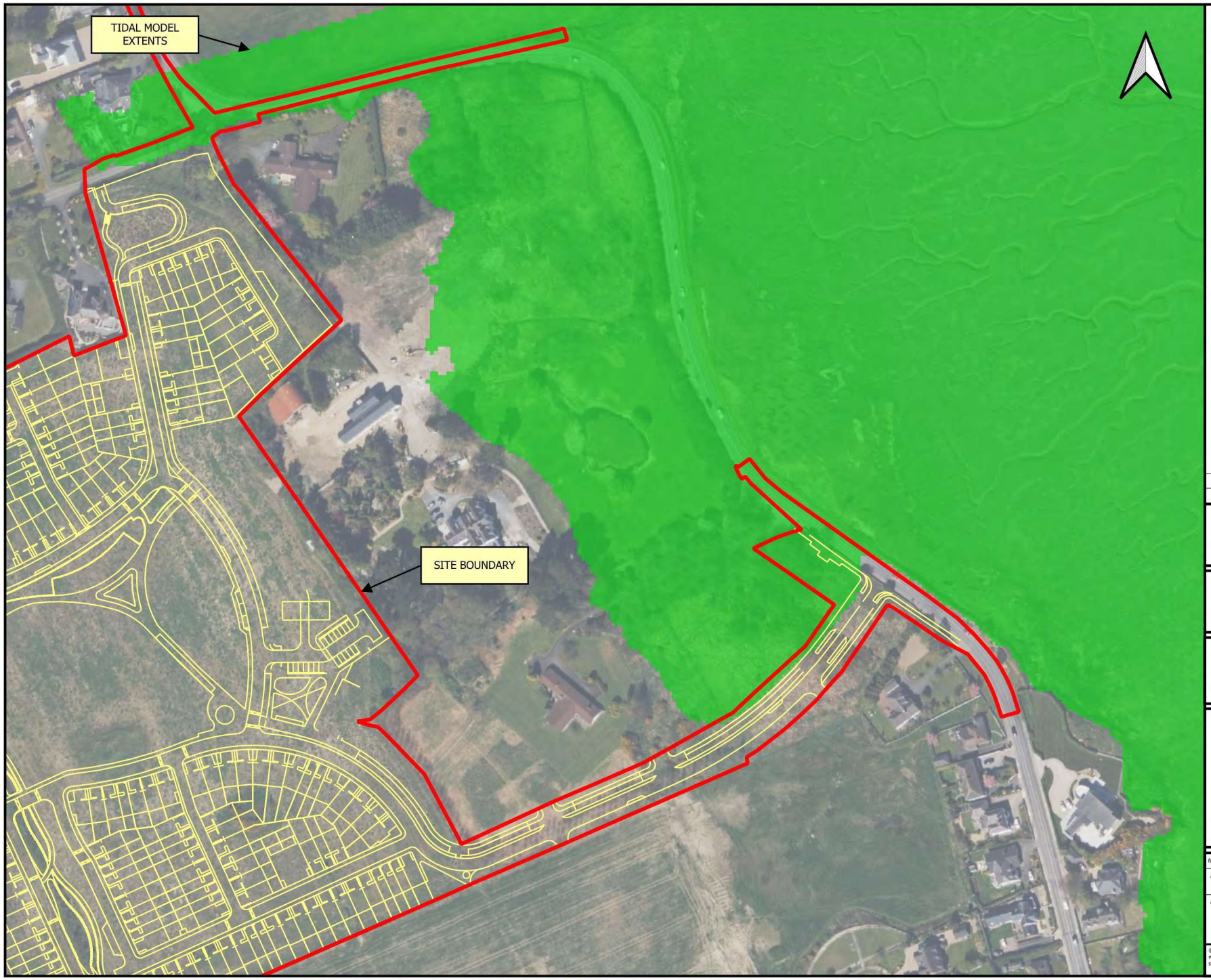
PROPOSED SCENARIO
1 IN 200 YEAR (0.5% AEP) & 1 in 1000 YEAR
(0.1% AEP) PRESENT DAY TIDAL FLOOD EXTENTS

IE CONSULTING
WATER-ENVIRONMENTAL-CIVIL

CARLOW OFFICE:
INNOVATION CENTRE
GREEN ROAD
CARLOW R95 W248

NEWRY OFFICE:
7 LINENHALL
WIN BUSINESS PARK
NEWRY BT35 6PH

file location: N:\IE3047\DRAWINGS	scale: 1:2,500	A4
drawing status: PLANNING	datum: MALIN	
	drawn: NOM	
drawing no. IE3047-004 rev: A	checked: PMS	
	approved: PMS	
	date: 09.12.2024	



LEGEND

- SITE BOUNDARY
- 1 IN 200 YEAR MRFS TIDAL EXTENTS

rev.	date	amendment	drn	ckd
A	09.12.24	INFORMATION	NOM	PMS

PROPOSED DEVELOPMENT SITE
HAGGARDSTOWN, BLACKROCK, CO. LOUTH

SITE SPECIFIC FLOOD RISK ASSESSMENT

PROPOSED SCENARIO
1 IN 200 YEAR (0.5% AEP) MID-RANGE FUTURE SCENARIO (MRFS) TIDAL FLOOD EXTENTS

IE CONSULTING
WATER-ENVIRONMENTAL-CIVIL

CARLOW OFFICE:
INNOVATION CENTRE
GREEN ROAD
CARLOW R95 W248

NEWRY OFFICE:
7 LINENHALL
WIN BUSINESS PARK
NEWRY BT35 6PH

file location: N:\IE3047\DRAWINGS	scale: 1:2,500	A4
drawing status: PLANNING	datum: MALIN	
	drawn: NOM	
drawing no. IE3047-005 rev: A	checked: PMS	
	approved: PMS	
	date: 09/12/2024	

Appendix B. Met Éireann Rainfall Data

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 307316, Northing: 304306,

	Interval		Years												
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.6,	3.4,	3.9,	4.6,	5.0,	5.4,	6.5,	7.7,	8.5,	9.7,	10.6,	11.4,	12.5,	13.4,	14.1,	N/A ,
10 mins	3.6,	4.8,	5.4,	6.4,	7.0,	7.5,	9.1,	10.8,	11.9,	13.5,	14.8,	15.9,	17.4,	18.6,	19.6,	N/A ,
15 mins	4.2,	5.6,	6.4,	7.5,	8.3,	8.8,	10.7,	12.7,	14.0,	15.8,	17.4,	18.6,	20.5,	21.9,	23.1,	N/A ,
30 mins	5.5,	7.4,	8.3,	9.7,	10.6,	11.3,	13.5,	16.0,	17.6,	19.7,	21.6,	23.1,	25.2,	26.9,	28.3,	N/A ,
1 hours	7.3,	9.6,	10.8,	12.5,	13.6,	14.4,	17.2,	20.1,	22.0,	24.6,	26.8,	28.5,	31.1,	33.0,	34.7,	N/A ,
2 hours	9.7,	12.5,	14.0,	16.1,	17.4,	18.5,	21.7,	25.3,	27.5,	30.6,	33.2,	35.2,	38.3,	40.6,	42.4,	N/A ,
3 hours	11.4,	14.6,	16.3,	18.6,	20.2,	21.3,	25.0,	28.9,	31.4,	34.8,	37.7,	39.9,	43.2,	45.7,	47.8,	N/A ,
4 hours	12.8,	16.3,	18.1,	20.7,	22.3,	23.6,	27.6,	31.8,	34.5,	38.1,	41.2,	43.6,	47.1,	49.8,	52.0,	N/A ,
6 hours	15.0,	19.1,	21.1,	24.0,	25.8,	27.3,	31.7,	36.4,	39.3,	43.3,	46.7,	49.3,	53.2,	56.1,	58.5,	N/A ,
9 hours	17.7,	22.3,	24.6,	27.8,	29.9,	31.5,	36.4,	41.6,	44.8,	49.2,	53.0,	55.8,	60.1,	63.3,	65.9,	N/A ,
12 hours	19.9,	24.9,	27.4,	30.9,	33.1,	34.8,	40.1,	45.7,	49.2,	53.9,	58.0,	61.0,	65.5,	68.9,	71.6,	N/A ,
18 hours	23.4,	29.1,	31.8,	35.8,	38.3,	40.2,	46.1,	52.3,	56.1,	61.3,	65.7,	69.0,	74.0,	77.7,	80.6,	N/A ,
24 hours	26.3,	32.4,	35.5,	39.7,	42.5,	44.5,	50.9,	57.5,	61.6,	67.2,	71.9,	75.4,	80.6,	84.6,	87.7,	98.3,
2 days	32.9,	39.8,	43.1,	47.8,	50.7,	52.9,	59.7,	66.7,	71.0,	76.7,	81.5,	85.1,	90.5,	94.4,	97.6,	108.2,
3 days	38.4,	45.9,	49.5,	54.5,	57.7,	60.0,	67.1,	74.5,	79.0,	84.9,	89.9,	93.7,	99.1,	103.2,	106.4,	117.2,
4 days	43.3,	51.4,	55.2,	60.5,	63.8,	66.3,	73.8,	81.5,	86.1,	92.3,	97.5,	101.3,	106.9,	111.1,	114.4,	125.4,
6 days	52.2,	61.1,	65.4,	71.2,	74.8,	77.5,	85.6,	93.8,	98.8,	105.4,	110.9,	114.9,	120.8,	125.2,	128.7,	140.2,
8 days	60.2,	69.9,	74.5,	80.8,	84.6,	87.5,	96.2,	104.9,	110.2,	117.1,	122.8,	127.0,	133.2,	137.8,	141.4,	153.3,
10 days	67.7,	78.1,	83.0,	89.6,	93.7,	96.8,	105.9,	115.0,	120.6,	127.8,	133.8,	138.2,	144.6,	149.3,	153.1,	165.3,
12 days	74.8,	85.8,	91.0,	98.0,	102.3,	105.5,	115.0,	124.6,	130.3,	137.8,	144.0,	148.6,	155.2,	160.1,	164.0,	176.6,
16 days	88.2,	100.3,	106.0,	113.6,	118.3,	121.7,	132.0,	142.3,	148.5,	156.5,	163.0,	167.9,	174.9,	180.0,	184.1,	197.4,
20 days	100.8,	114.0,	120.0,	128.2,	133.2,	136.9,	147.9,	158.7,	165.3,	173.7,	180.6,	185.7,	193.0,	198.4,	202.7,	216.5,
25 days	115.9,	130.2,	136.7,	145.5,	150.9,	154.8,	166.5,	178.1,	185.0,	193.9,	201.2,	206.5,	214.2,	219.9,	224.4,	238.8,

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