Flood Risk Assessment

Proposed Large Residential Development (LRD) at Old Slane Road, Mell/Tullyallen, Drogheda, Co. Louth

May 2024

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Client Name: Lagan Homes
Document Reference: 23-067r.004 Flood Risk Assessment
Project Number: 23-067

Quality Assurance – Approval Status

This document has been prepared and checked in accordance with
Waterman Group's IMS (BS EN ISO 9001: 2015 and BS EN ISO 14001: 2015)

Issue	Date	Prepared by	Checked by	Approved by
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Comments

Disclaimer

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1. Introduction

1.1 Context

This Flood Risk Assessment has been prepared by Waterman Moylan as part of the documentation in support of a planning application for a proposed Large Residential Development (LRD) located off the Slane Road, east of Drogheda, in Mell/Tullyallen, Drogheda, Co. Louth.

A previous proposal by the Applicant to develop the subject site received a decision to grant permission from An Bord Pleanála in February 2022 (reference no. ABP-311678-21). The first 30 no. units of the permitted development are under construction under that planning grant. This application proposes a revised site layout for the remainder of the site, with roads, drainage, watermains and other utilities to tie into the infrastructure currently under construction as part of the first 30 no. units.

In general, the strategy for the roads layout, foul and surface water drainage, and water supply remain very similar to the approved Strategic Housing Development (SHD).

This Flood Risk Assessment has been carried out in accordance with the *DEHLG/OPW Guidelines on the Planning Process and Flood Risk Management* published in November 2009. This assessment identifies the risk of flooding at the site from various sources and sets out possible mitigation measures against the potential risks of flooding. Sources of possible flooding include coastal, fluvial, pluvial (direct heavy rain), groundwater and human/mechanical errors. This report provides an assessment of the subject site for flood risk purposes only.

1.2 Site Description

The subject site is located in Mell/Tullyallen, Drogheda, Co. Louth. The site location is indicated on the Figure below:

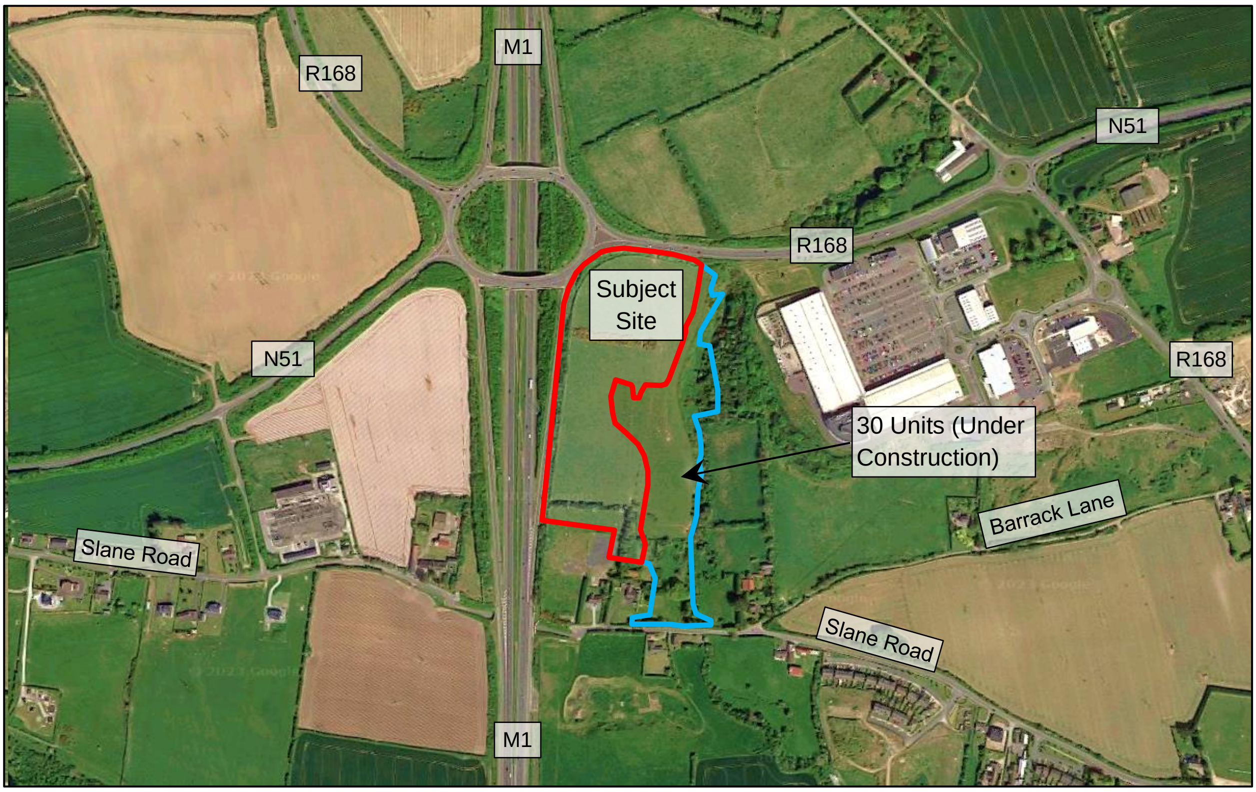


Figure 1 | *Site Location (Source: Google Maps)*

The site is currently greenfield. Topographic survey data indicates that the site falls generally from north-west to south-east, with a high point of approximately 32.8m OD Malin at the north-west corner of the site of the site and a low point of approximately 18.8m OD Malin at the south-east of the site. The lands continue to fall towards the south-east beyond the redline and within the 30-units development currently under construction, to a low point of approximately 10.0m OD Malin. There is a stream flowing in a southerly direction along the eastern boundary of the site, draining land to the north and crossing under the R168 Road. The stream crosses the Slane Road at Dry Bridge, discharging into the Boyne River approximately 650m south of the site.

In the Louth County Development Plan 2021-2027, the subject site is zoned "A2 New Residential", as shown in the extract below:

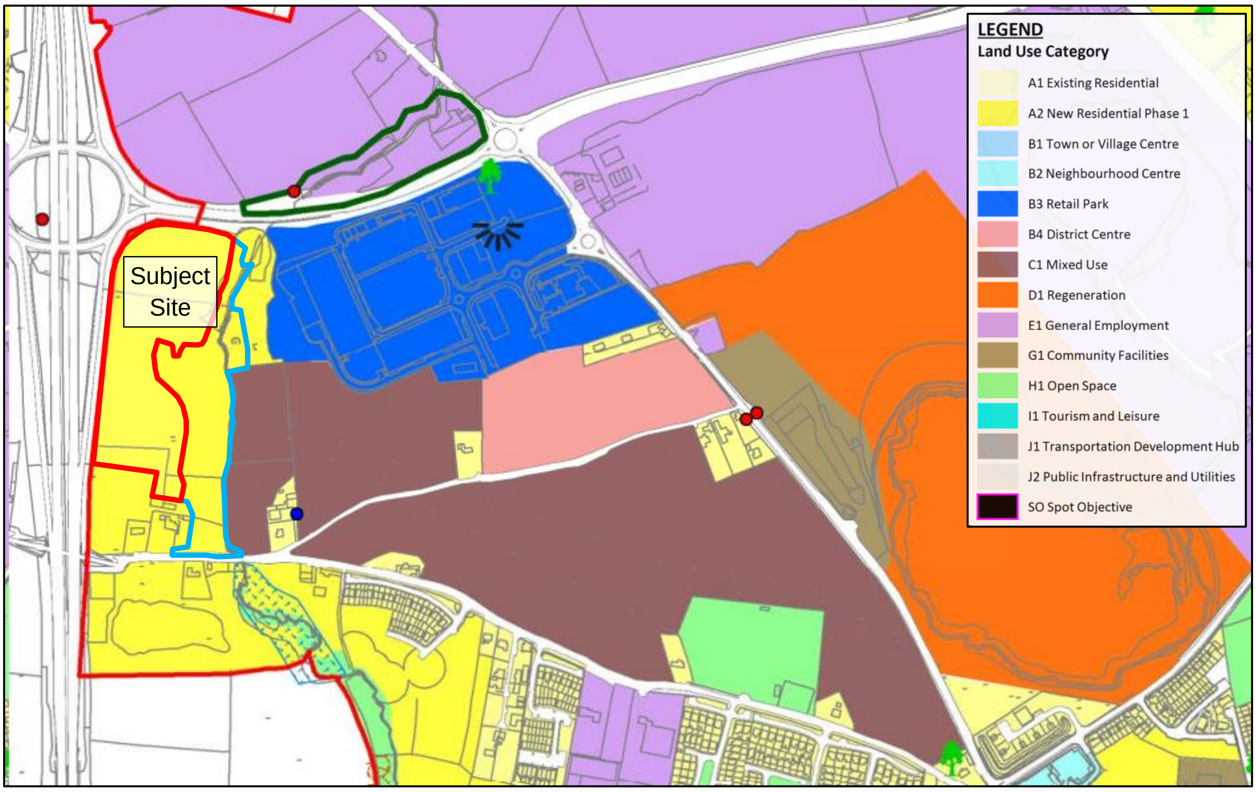


Figure 2 | *Louth Development Plan Zoning Map*

1.3 Proposed Development

The proposed development consists of 207 no. residential units, in addition to the permitted 30 no. units already under construction, as set out in the schedule of accommodation below:

Description	1-Bed	2-Bed	3-Bed	4-Bed	Total No. of Residential Units
Permitted Development (Under Construction)	-	-	27	3	30
Proposed Development	20	47	120	20	207
Total	**20**	**47**	**147**	**23**	**237**

Table 1 | *Schedule of Accommodation*

The site will accommodate car parking spaces, bicycle parking spaces, storage, services and plant areas, and landscaping. The proposed application includes all site landscaping works, green roofs, substations, boundary treatments, lighting, servicing, signage, and associated and ancillary works, including site development works and services above and below ground.

1.3.1 Riparian Corridor

There is a 20m riparian corridor at the east of the site adjacent to the existing stream. No houses, roads or infrastructure are proposed within this riparian corridor.

1.4 Guidelines and Resources

The Department of Environment, Heritage and Local Government (DEHLG) and the Office of Public Works (OPW) published the adopted version of the document "The Planning System and Flood Risk Management Guidelines for Planning Authorities" in November 2009.

These Guidelines provide guidance on flood risk and development. A precautionary approach is recommended when considering flood risk management in the planning system. The core principle of the guidelines is to adopt a risk-based sequential approach to managing flood risk and to avoid development in areas that are at risk. The sequential approach is based on the identification of flood zones for river and coastal flooding.

This approach is based on the identification of flood zones for river and coastal flooding. "Flood Zones" are geographical areas used to identify areas at various levels of flood risk. There are three flood zones defined:

- Flood Zone A: (high probability of flooding) is for lands where the probability of flooding is greatest (greater than 1% or 1-in-100 for river flooding and 0.5% or 1-in-200 for coastal flooding).
- Flood Zone B: (moderate probability of flooding) refers to lands where the probability of flooding is moderate (between 0.1% or 1-in-1,000 and 1% or 1-in-100 for river flooding and between 0.1% or 1-in-1,000 and 0.5% or 1-in-200 for coastal flooding).
- Flood Zone C: (low probability of flooding) refers to lands where the probability of flooding is low (less than 0.1% or 1-in-1,000 for both river and coastal flooding).

Once a flood zone has been identified, the guidelines set out the different types of development appropriate to each zone. Exceptions to the restriction of development due to potential flood risks are provided for through the use of the Justification Test, where the planning need and the sustainable management of flood risk to an acceptable level must be demonstrated. This recognises that there will be a need for future development in existing towns and urban centres that lie within flood risk zones, and that the avoidance of all future development in these areas would be unsustainable.

Planning Authorities are required to introduce flood risk assessment as an integral and leading element of their development planning functions.

Volume 5 of the Louth County Development Plan 2021-2027 includes a Strategic Flood Risk Assessment for the area, which was informed by the DEHLG/OPW 2009 Guidelines for Planning Authorities.

The following guidelines and resources were referred to in preparing this flood risk assessment:

- The Planning System and Flood Risk Management Guidelines for Planning Authorities, 2009 (DEHLG/OPW)
- Louth County Development Plan 2021-2027, Volume 5: Strategic Flood Risk Assessment
- Fingal East Meath Flood Risk Assessment and Management Study (FEM FRAMS)
- The OPW's National Flood Hazard Map

- Geological Survey Ireland (GSI) datasets

1.5 Assessment Methodology

This Flood Risk Assessment report follows the guidelines set out in the Guidelines on the Planning Process and Flood Risk Management. The components to be considered in the identification and assessment of flood risk are as per Table A1 of the above guidelines:

- Tidal – flooding from high sea levels
- Fluvial – flooding from water courses
- Pluvial – flooding from rainfall / surface water
- Groundwater – flooding from springs / raised groundwater
- Human/mechanical error – flooding due to human or mechanical error

Each component will be investigated from a Source, Pathway and Receptor perspective, followed by an assessment of the likelihood of a flood occurring and the possible consequences.

1.5.1 Assessing Likelihood

The likelihood of flooding falls into three categories of low, moderate, and high, which are described in the OPW Guidelines as follows:

Flood Risk Components	**Likelihood: % chance of occurring in a year**		
	Low	***Moderate***	***High***
Tidal	*Probability < 0.1%*	*0.5% > Probability > 0.1%*	*Probability > 0.5%*
Fluvial	*Probability < 0.1%*	*1% > Probability > 0.1%*	*Probability > 1%*
Pluvial	*Probability < 0.1%*	*1% > Probability > 0.1%*	*Probability > 1%*

Table 2 **|** *From Table A1 of "DEHLG/OPW Guidelines on the Planning Process and Flood Management"*

For groundwater and human/mechanical error, the limits of probability are not defined and therefore professional judgment is used. However, the likelihood of flooding is still categorized as low, moderate, and high for these components.

From consideration of the likelihoods and the possible consequences a risk is evaluated. Should such a risk exist, mitigation measures will be explored, and the residual risks assessed.

1.5.2 Assessing Consequence

There is not a defined method used to quantify a value for the consequences of a flooding event. Therefore, to determine a value for the consequences of a flooding event, the elements likely to be adversely affected by such flooding will be assessed, with the likely damage being stated, and professional judgement will be used to determine a value for consequences. Consequences will also be categorized as low, moderate, and high.

1.5.3 Assessing Risk

Based on the determined 'likelihood' and 'consequences' values of a flood event, the following 3x3 Risk Matrix will then be referenced to determine the overall risk of a flood event.

		Consequences		
		Low	***Moderate***	***High***
Likelihood	**Low**	*Extremely Low Risk*	*Low Risk*	*Moderate Risk*
	Moderate	*Low Risk*	*Moderate Risk*	*High Risk*
	High	*Moderate Risk*	*High Risk*	*Extremely High Risk*

Table 3 **|** *3x3 Risk Matrix*

2. Sequential Test

2.1 General

A sequential approach to planning is a key tool in ensuring that a development, particularly any new development, is first and foremost directed towards land that is at low risk of flooding. The sequential approach is set out in “The Planning System and Flood Risk Management Guidelines for Planning Authorities, 2009” and is referred to in the Louth County Development Plan 2021-2027, Volume 5: Strategic Flood Risk Assessment.

The sequential approach is illustrated in the Figure below:

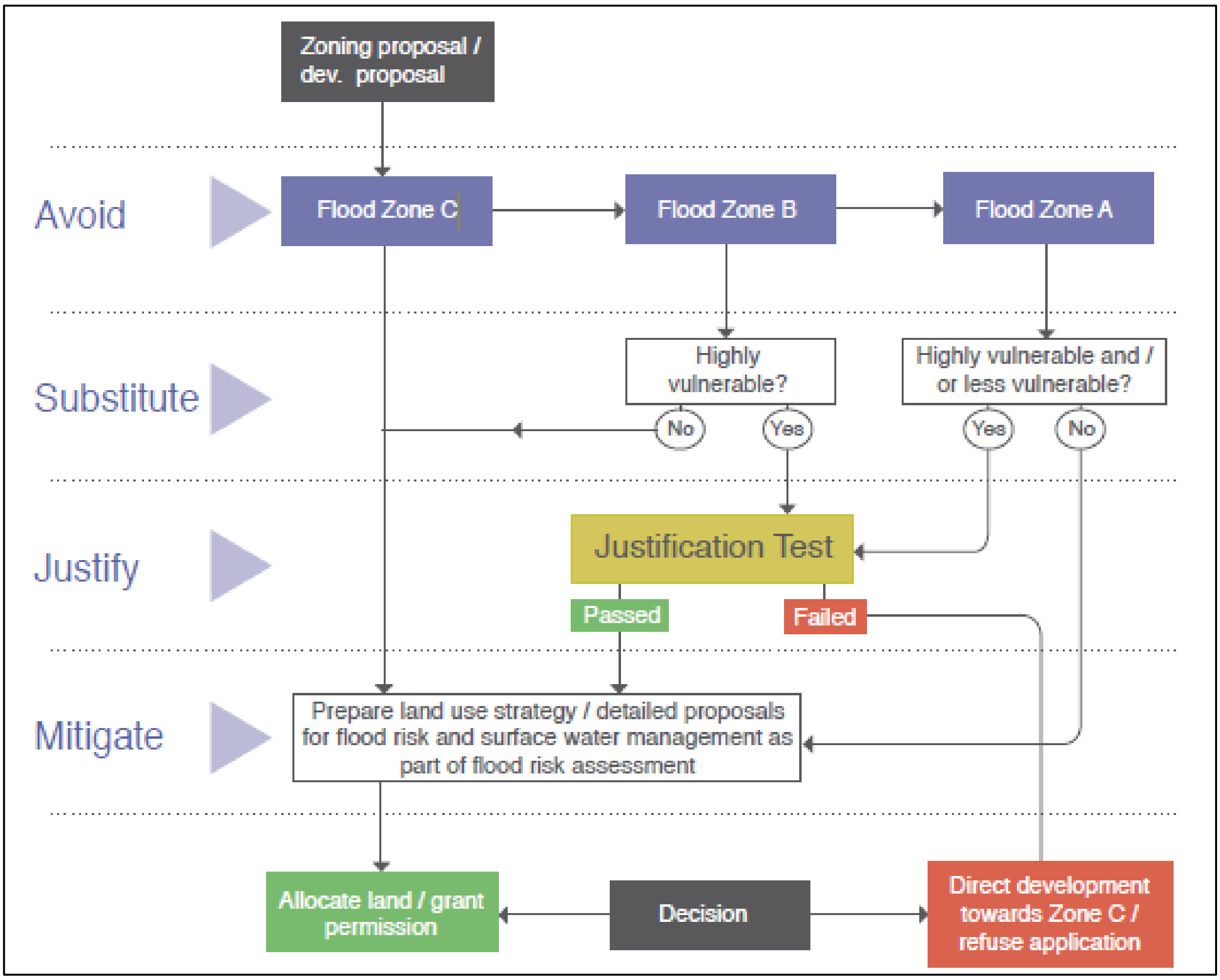


***Figure 3** | Sequential Approach*

2.2 Establish Flood Zone

The first step of the sequential test is to establish the flood zone within which the site lies.

The subject site is in Flood Zone C, as it is outside the 1-in-1,000-year flood zone for both tidal and fluvial flooding – refer to Sections 3 and 4, below, for further information on tidal and fluvial flooding, respectively.

2.3 Establish Vulnerability Class

The next step is to establish the vulnerability class of the proposal. The Table below, taken from the OPW's "Planning and Flood Risk Management Guidelines for Planning Authorities, 2009" document, lists the vulnerability classes assigned to various land uses and types of development:

Vulnerability Class	**Land Uses and Types of Development which include*:**
Highly vulnerable development (including essential infrastructure)	Garda, ambulance and fire stations and command centres required to be operational during flooding; Hospitals; Emergency access and egress points; Schools; Dwelling houses, student halls of residence and hostels; Residential institutions such as residential care homes, children's homes and social services homes; Caravans and mobile home parks; Dwelling houses designed, constructed or adapted for the elderly or other people with impaired mobility; and Essential infrastructure, such as primary transport and utilities distribution, including electricity generating power stations and sub-stations, water and sewage treatment, and potential significant sources of pollution (SEVESO sites, IPPC sites, etc.) in the event of flooding.
Less vulnerable development	Buildings used for: retail, leisure, warehousing, commercial, industrial and non-residential institutions; Land and buildings used for holiday or short-let caravans and campong, subject to specific warning and evacuation plans; Land and buildings used for agriculture and forestry; Waste treatment (except landfill and hazardous waste); Mineral working and processing; and Local transport infrastructure.
Water-compatible development	Flood control infrastructure; Docks, marinas and wharves; Navigation facilities; Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location; Water-based recreation and tourism (excluding sleeping accommodation); Lifeguard and coastguard stations; Amenity open space, outdoor sports and recreation and essential facilities such as changing rooms; and Essential ancillary sleeping or residential accommodation for staff required by uses in this category (subject to a specific warning and evacuation plan).

*Uses not listed here should be considered on their own merits

Table 4 | *Vulnerability Classification of Different Types of Development*

The proposed development is a residential development, and is therefore considered highly vulnerable development.

2.4 Assess Justification Test Requirement

The Table below outlines the matrix of vulnerability based on the Flood Zone:

Description	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 5 | *Vulnerability Matrix*

Given that the subject site is within Flood Zone C, no justification test is required for the development, and development is considered appropriate.

3. Tidal Flooding

3.1 Source

Tidal flooding occurs when normally dry, low-lying land is flooded by seawater. The extent of tidal flooding is a function of the elevation inland flood waters penetrate, which is controlled by the topography of the coastal land exposed to flooding.

3.2 Pathway

The site is approximately 9.5km west of the nearest coastline at Baltray Beach. The Dublin Coastal Protection Project indicated that the 2002 high tide event reached 2.95m OD Malin. The lowest proposed ground finished floor level on the site is 17.5m OD Malin (the southernmost house of the approved 30 units under construction), well above the historic high tide event.

The Boyne River is located approximately 550m south of the subject site, and a tributary stream flows along the eastern boundary of the site. Both the river and the tributary stream are tidally influenced.

Coastal Flood Extent Maps, developed as part of the Catchment Flood Risk Assessment and Management (CFRAM) Study, have been consulted as part of this assessment. These maps outline existing and potential flood hazard and risk areas which are being incorporated into a Flood Risk Management Plan. The maps include a High-End Future Scenario model, which takes into account the potential effects of climate change by modelling with an increase in rainfall of 30% and sea level rise of 1,000mm. An extract of the CFRAM High-End Future Scenario Coastal Flood Extents Map is shown in the Figure below:

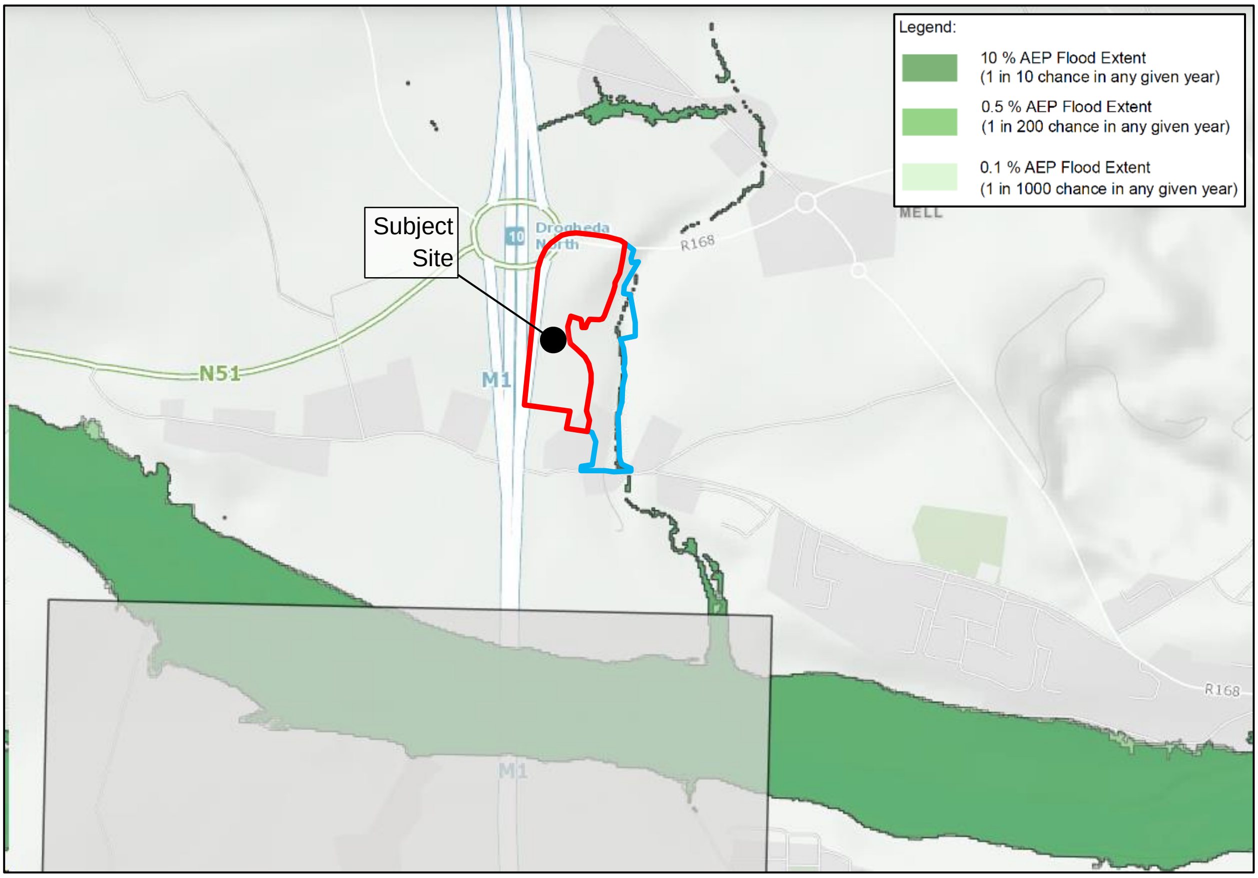


Figure 4 | *Extract of CFRAM Coastal Flood Extents Map (High-End Future Scenario)*

High probability flood events, as shown in the above map, are defined as having approximately a 1-in-10 chance of occurring or being exceeded in any given year (10% Annual Exceedance Probability), medium probability flood events are defined as having an AEP of 0.5% (1-in-200-year storm), while low probability events are defined having an AEP of 0.1% (1-in-1,000-year storm).

The map indicates that the stream at the eastern boundary of the site has a small flood plain, which even in the 1-in-1,000-year high-end future scenario does not flood its banks onto the site. The subject development is not at risk of flooding for the 1-in-1,000-year event.

Given that the site is located 9.5km inland from the Irish Sea, that there is at least a 14.5m level difference between the subject lands and the high tide, and given that the development is outside of the 1-in-1,000-year tidal flood plain, it is evident that a pathway does not exist between the source and the receptor. A risk from tidal flooding is therefore extremely low and no flood mitigation measures need to be implemented.

4. Fluvial Flooding

4.1 Source

Fluvial flooding occurs when a river's flow exceeds its capacity, typically following excessive rainfall, though it can also result from other causes such as heavy snow melt and ice jams.

4.2 Pathway

The Boyne River is located approximately 550m south of the subject site, and a tributary stream flows along the eastern boundary of the site. Fluvial flood extent maps, developed as part of the Catchment Flood Risk Assessment and Management (CFRAM) Study and made available on the OPW's National Flood Information Portal, have been consulted as part of this assessment. These maps outline existing and potential flood hazard and risk areas which are being incorporated into a Flood Risk Management Plan. The maps include a High-End Future Scenario model, which takes into account the potential effects of climate change by modelling with an increase in rainfall of 30% and sea level rise of 1,000mm. An extract of the CFRAM High-End Future Scenario Fluvial Flood Extents Map is shown in the Figure below:

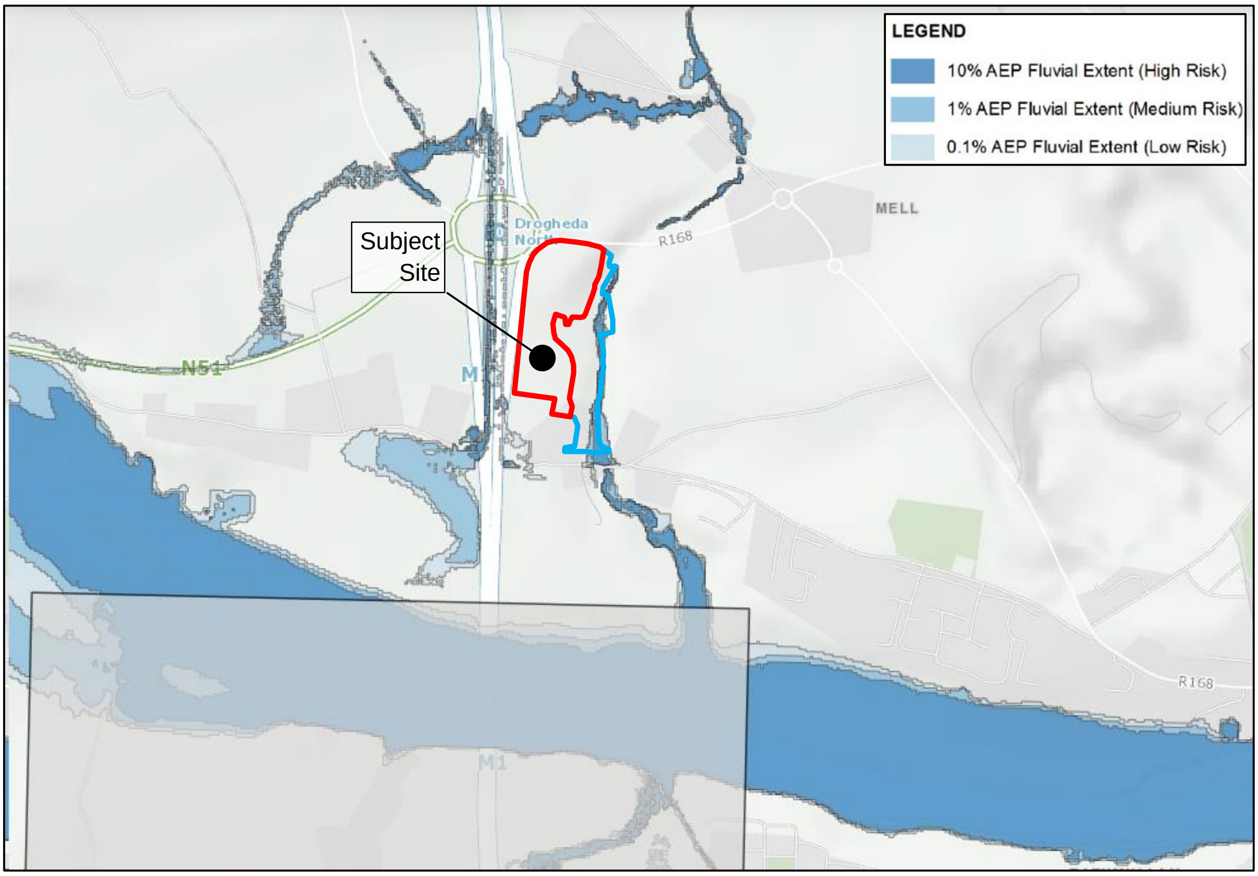
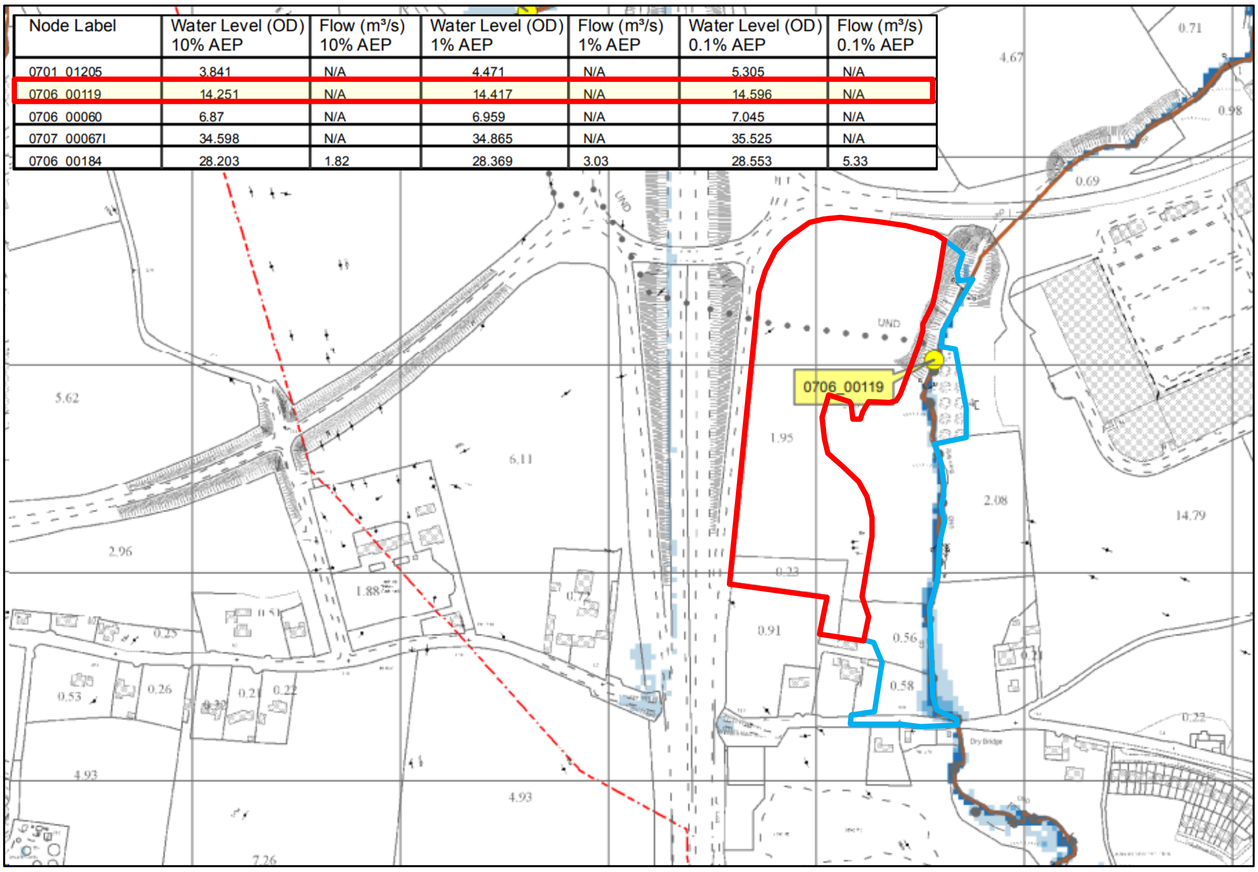


Figure 5 | *Extract of CFRAM Fluvial Flood Extents Map (High-End Future Scenario)*

High probability flood events, as shown in the above map, are defined as having approximately a 1-in-10 chance of occurring or being exceeded in any given year (10% Annual Exceedance Probability), medium probability flood events are defined as having an AEP of 1% (1-in-100-year storm), while low probability events are defined having an AEP of 0.1% (1-in-1,000-year storm).

The stream at the eastern boundary of the site has deep banks with steep sides, ensuring that it has a small flood plain even in the 1-in-1,000-year high-end future scenario. No development is proposed within the 1-in-1,000-year flood plain, with the proposed 20m riparian corridor ensuring that all development is well outside the flood plain of the stream.

The flood map also includes nodes with flood levels (modelled for the current scenario), as shown in the Figure below:



Node Label	Water Level (OD) 10% AEP	Flow (m^3/s) 10% AEP	Water Level (OD) 1% AEP	Flow (m^3/s) 1% AEP	Water Level (OD) 0.1% AEP	Flow (m^3/s) 0.1% AEP
0701_01205	3.841	N/A	4.471	N/A	5.305	N/A
0706_00119	14.251	N/A	14.417	N/A	14.596	N/A
0706_00060	6.87	N/A	6.959	N/A	7.045	N/A
0707_00067I	34.598	N/A	34.865	N/A	35.525	N/A
0706_00184	28.203	1.82	28.369	3.03	28.553	5.33

Figure 6 **|** *Extract of CFRAM Fluvial Flood Extents Map (Current Scenario)*

The 0.1% AEP flood level is 14.596m OD Malin. The lowest proposed ground finished floor level on the site is the southernmost house of the approved 30 units under construction, with a finished floor level of 17.5m OD Malin. The lowest FFL is therefore 2.9m above the 1,000-year flood level.

Given that the site is outside of the 1-in-1,000-year flood plain and is above the 1,000-year flood level, it is evident that a pathway does not exist between the source and the receptor. A risk from fluvial flooding is therefore extremely low and no flood mitigation measures need to be considered.

5. Pluvial Flooding

5.1 Source

Pluvial flooding occurs when heavy rainfall creates a flood event independent of an overflowing water body. Pluvial flooding can happen in any urban area, including higher elevation areas that lie above coastal and river floodplains.

5.2 Pathway & Receptors

During periods of extreme prolonged rainfall, pluvial flooding may occur through the following pathways:

	Pathway	Receptor
1	Surcharging of the proposed internal drainage systems during heavy rain events leading to internal flooding	Proposed development – properties and roads
2	Surcharging from the existing surrounding drainage system leading to flooding within the subject site by surcharging surface water pipes	Proposed development – properties and roads
3	Surface water discharging from the subject site to the existing drainage network leading to downstream flooding	Downstream properties and roads
4	Overland flooding from surrounding areas flowing onto the subject site	Proposed development – properties and roads
5	Overland flooding from the subject site flowing onto surrounding areas	Downstream properties and roads

Table 6 | *Pathways and Receptors*

5.3 Likelihood

The likelihood of each of the 5 pathway types are addressed individually as follows:

5.3.1 Surcharging of the proposed on-site drainage systems:

The proposed on-site surface water drainage sewers have been designed to accommodate flows from a 5-year return event, which indicates that on average the internal system may surcharge during rainfall events with a return period in excess of five years. Therefore, the likelihood surcharging of the on-site drainage system is considered high.

5.3.2 Surcharging from the existing surrounding drainage system:

The OPW's National Flood Hazard Maps, extracted below, have been consulted to identify recorded instances of flooding in the vicinity of the site.

The nearest recorded flood events occurred approximately 900m east of the site at the R168, with one flood event having occurred in 2002 and another in 2011. There is a recurring flood approximately 650m north of the site at Dunedin, Monkstown. In 2011 there was flooding in Deansgrange Village, approximately 1.1km south-west of the site. None of the historic flood events impacted the subject site.

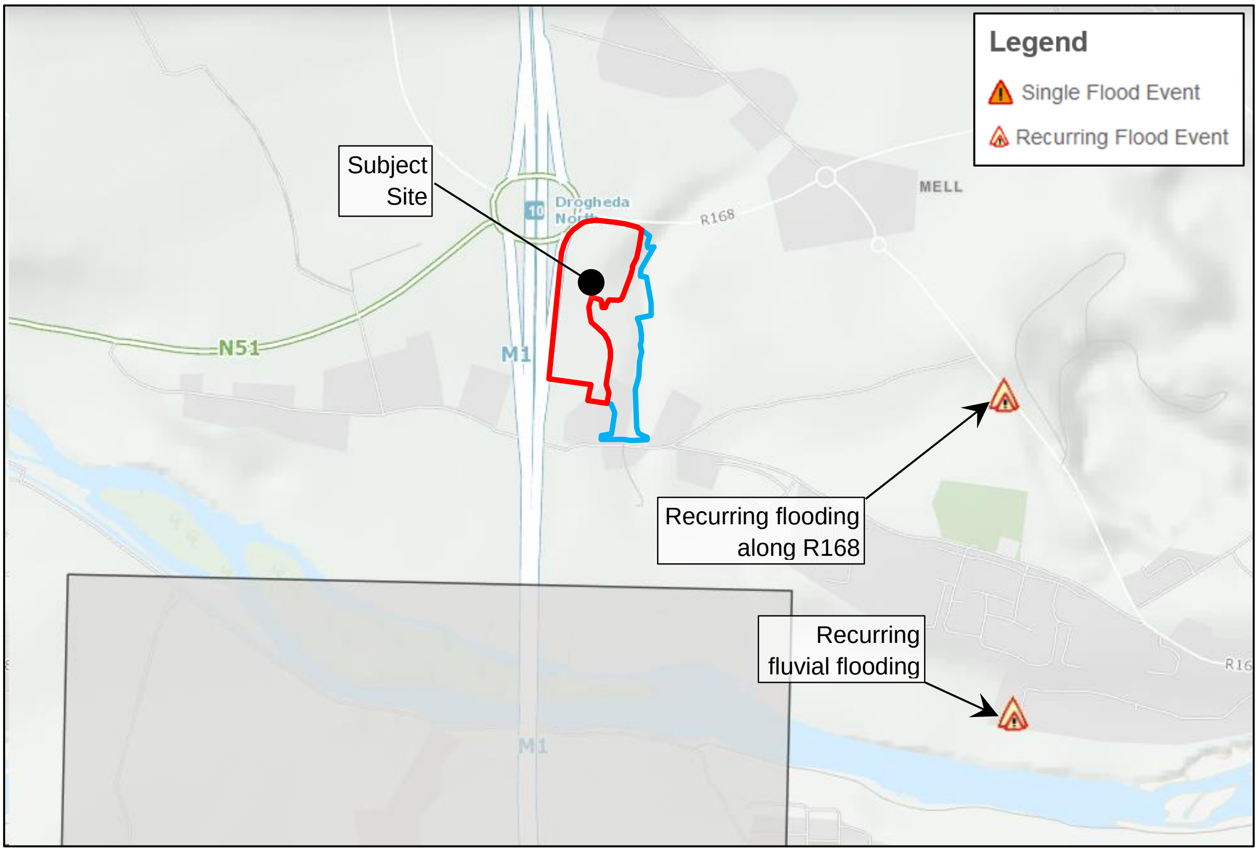


Figure 7 | *Extract from the OPW's Past Flood Events Map*

With no history of flooding in the area due to surcharging impacting the subject site, the likelihood of such flooding occurring is considered low.

5.3.3 Surface water discharge from the subject site:

Due to the increase in hard standing area as a result of the proposed development, there is an increased likelihood of surface water discharge from the site leading to downstream flooding. As such, the likelihood can be considered moderate.

5.3.4 Overland flooding from surrounding areas:

With no recorded flood events in the immediate area that could have an impact on the subject site, as per the OPW records referred to above, it is considered that there is a low likelihood of flooding from surrounding areas.

5.3.5 Overland flooding from the subject site:

Due to the increase in hard standing area as a result of the proposed development, there is an increased likelihood of overland flooding from the site leading to downstream flooding. As such, the likelihood can be considered moderate.

5.4 Consequence

Surface water flooding would result in damage to roads and landscaped areas, and could impact the ground floor levels of buildings. The consequences of pluvial flooding are considered moderate.

5.5 Risk

The risk of each of the 5 pathway types is addressed individually as follows:

5.5.1 Surcharging of the proposed on-site drainage systems:

With a high likelihood and moderate consequence of flooding the site from surcharging the on-site drainage system, the resultant risk is high.

5.5.2 Surcharging from the existing surrounding drainage system:

With a low likelihood and moderate consequence of flooding the site from the existing surface water network, the resultant risk is low.

5.5.3 Surface water discharge from the subject site:

With a moderate likelihood and moderate consequence of surface water discharge from the subject site, the resultant risk is moderate.

5.5.4 Overland flooding from surrounding areas:

With a low likelihood and moderate consequence of overland flooding from the surrounding areas, the resultant risk is low.

5.5.5 Overland flooding from the subject site:

With a moderate likelihood and moderate consequence of overland flooding from the subject site, the resultant risk is moderate.

5.6 Flood Risk Management

The following are flood risk management strategies proposed to minimise the risk of pluvial flooding for each risk:

5.6.1 Surcharging of the proposed on-site drainage systems:

The risk of flooding is minimised with adequate sizing of the on-site surface water network and SuDS devices. Open grassed areas with low level planting and roadside trees act as soft scape and will significantly slow down and reduce the amount of surface water runoff from the site. Permeable paving in driveways will provide some treatment volume, with underlying perforated pipes connecting to the storm water sewer network.

These proposed source and site control devices will intercept and slow down the rate of runoff from the site to the on-site drainage system, reducing the risk of surcharging.

Furthermore, a hydro-brake or similar approved flow control device will provide a runoff limited to the greenfield equivalent runoff rate, with excess storm water to be attenuated in an underground tank. This tank is designed to accommodate flows from the subject site, with sufficient volume for the 1-in-100-year storm (accounting for a 20% increase due to climate change), to limit the runoff from the site and minimise the discharge rate into receiving waters.

As a result of these proposed measures, the likelihood of surcharging of the proposed on-site drainage systems is low.

5.6.2 Surcharging from the existing surrounding drainage system:

The risk of flooding due to surcharging of the existing surface water network is minimised with overland flood routing towards the existing stream at the east of the site, and away from the buildings.

The risk to the buildings is mitigated by setting finished floor levels at least 200mm above the adjacent road channel line.

5.6.3 Surface water discharge from the subject site:

Surface water discharge from the subject site is intercepted and slowed down through the use of source control devices, as described in Section 5.6.1 above, minimising the risk of pluvial flooding from the subject site. Surface water discharge from the site is restricted by a flow control device to the greenfield equivalent rate, with sufficient attenuation storage provided for the 1-in-100-year storm, accounting for a 20% increase due to climate change. As such, the rate at which surface water discharges from the subject site will not be increased as a result of the proposed development.

5.6.4 Overland flooding from surrounding areas:

The risk from overland flooding from surrounding areas is low. Overland flood routing and raised finished floor levels will provide protection for the proposed building, as described in Section 5.6.2 above.

5.6.5 Overland flooding from the subject site:

The risk of overland flooding from the subject site is minimised by providing SuDS features to intercept and slow down the rate of runoff from the site to the existing surface water sewer system, as described in Section 5.6.1 above. Sufficient attenuation is provided for the 1-in-100-year storm, accounting for a 20% increase due to climate change. Thus, even under extreme storm conditions, the surface water can be attenuated without causing flooding downstream.

5.7 Residual Risk

As a result of the design measures detailed above in Section 5.6, there is a low residual risk of flooding from each of the surface water risks.

6. Groundwater

6.1 Source

Groundwater flooding occurs when the water table rises above the ground surface. This typically happens during periods with prolonged rainfall which exceeds the natural underground drainage system's capacity.

6.2 Pathway

The pathway for groundwater flooding is from the ground. Note that although groundwater flooding is typically considered to be when the water table rises above the ground surface, underground services and building foundations could also be affected by high water tables that do not reach the ground surface.

6.3 Receptor

The receptors for ground water flooding would be underground services and the ground floor of the building.

6.4 Likelihood

Geological Survey Ireland (GSI) produces a wide range of datasets, including groundwater vulnerability mapping. From the GSI groundwater vulnerability map, extracted below, the site lies within an area with moderate to high groundwater vulnerability.

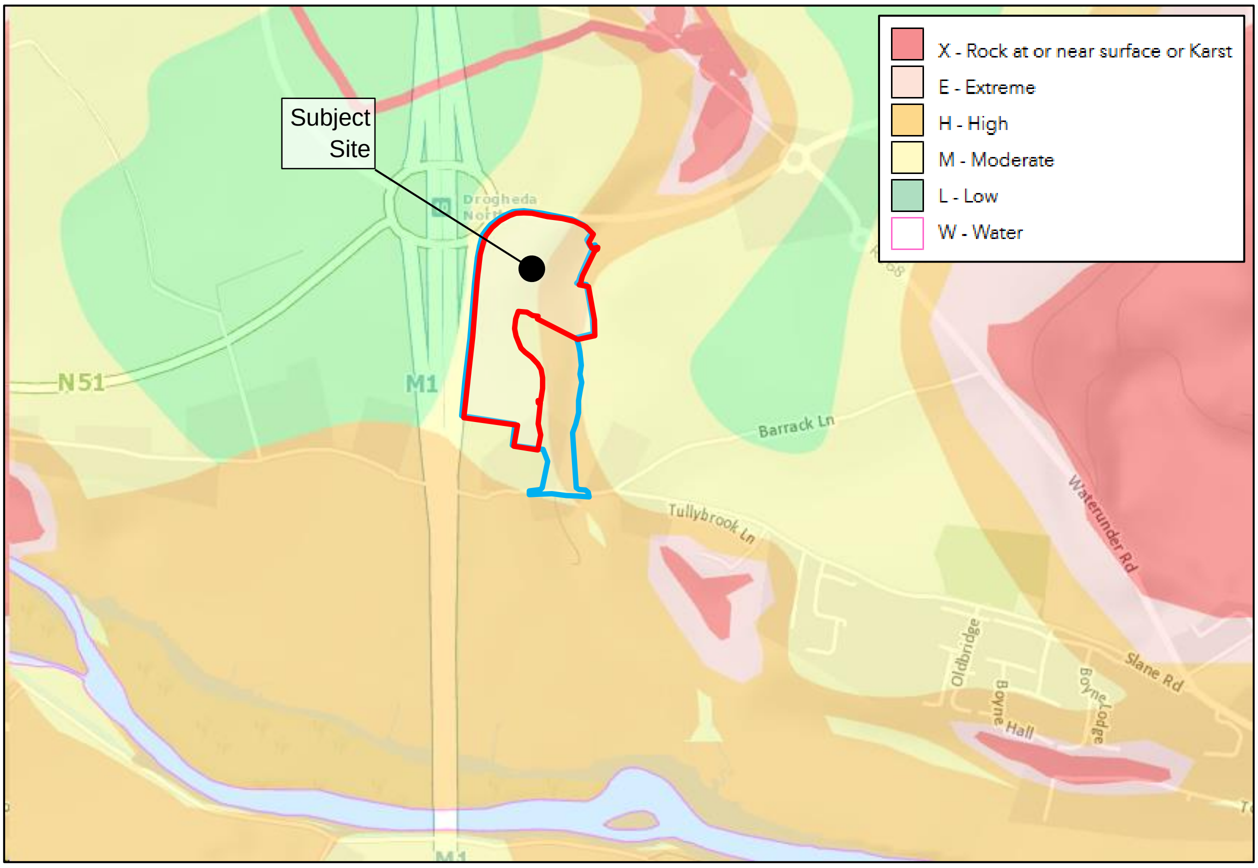


Figure 8 | *Extract of Groundwater Vulnerability Map*

With the site falling within an area with moderate to high groundwater vulnerability, the likelihood of groundwater rising through the ground and causing potential flooding on site during prolonged wet periods is high.

6.5 Consequence

The consequence of ground water flooding would be some minor temporary seepage of ground water through the ground around the proposed buildings. Underground services could be inundated from high water tables. Therefore, the consequence of ground water flooding occurring at the proposed development is considered moderate.

6.6 Risk

With a high likelihood and moderate consequences of flooding due to groundwater, the risk is considered high.

6.7 Flood Risk Management

The finished floor levels have been set above the adjacent road channel level, as described in Section 5.6. This will ensure that any ground water does not flood into the buildings.

The buildings' design will incorporate suitable damp proof membranes to protect against damp and water ingress from below ground level. Any penetrations through the slab must also be appropriately sealed to prevent ingress of groundwater.

In the event of ground water flooding on site, this water can escape from the site via the overland flood routing, as described in Section 5.6.

6.8 Residual Risk

There is a low residual risk of flooding from ground water.

7. Human/Mechanical Errors

7.1 Source

The subject site will be drained by an internal private storm water drainage system outfalling to the existing drainage network. The internal surface water network is a source of possible flooding were it to become blocked.

7.2 Pathway

If the public drainage network in the vicinity of the site or if the proposed internal drainage system were to block this could lead to possible flooding within the private areas.

7.3 Receptor

The receptors for flooding due to human/mechanical error would be the ground floors of the buildings, with possible flooding at neighbouring buildings.

7.4 Likelihood

There is a high likelihood of flooding on the subject site if the surface water network were to become blocked.

7.5 Consequence

The surface water network would surcharge and overflow through gullies and manhole lids. It is, therefore, considered that the consequences of such flooding are moderate.

7.6 Risk

With a high likelihood and moderate consequence, there is a high risk of surface water flooding should the surface water network block.

7.7 Flood Risk Management

As described in Section 5.6, finished floor level has been designed to be above the adjacent road network which will reduce the risk of flooding if the public surface water network were to block. In the event of the surface water system surcharging, much of the surface water can still escape from the site by overland flood routing, as described in Section 5.6, without causing damage to the proposed buildings.

The surface water network (drains, gullies, manholes, AJs, attenuation system) will need to be regularly maintained and where required cleaned out. A suitable maintenance regime of inspection and cleaning should be incorporated into the safety file/maintenance manual for the development.

7.8 Residual Risk

As a result of the flood risk management outlined above, there is a low residual risk of overland flooding from human / mechanical error.

8. Conclusions and Recommendations

The subject lands have been analysed for risks from tidal flooding from the Irish Sea, fluvial flooding from the Boyne River, pluvial flooding, ground water and failures of mechanical systems. The table below presents the various residual flood risks involved:

Source	Pathway	Receptor	Likelihood	Consequence	Risk	Mitigation Measure	Residual Risk
Tidal	*Irish Sea*	*Proposed development*	*Extremely low*	*None*	*Negligible*	*None*	Extremely low
Fluvial	*Boyne River*	*Proposed development*	*Extremely low*	*None*	*Negligible*	*None*	Extremely low
Pluvial	*Private & Public Drainage Network*	*Proposed development, downstream properties and roads*	*Ranges from low to high*	*Moderate*	*Ranges from low to high*	*Appropriate drainage, SuDS and attenuation design, setting of floor level, overland flood routing*	Low
Ground Water	*Ground*	*Underground services, ground level of building*	*High*	*Moderate*	*High*	*Appropriate setting of floor level, flood routing, damp proof membranes*	Low
Human/ Mechanical Error	*Drainage network*	*Proposed development*	*High*	*Moderate*	*High*	*Setting of floor level, overland flood routing, regular inspection of SW network*	Low

Table 7 **|** *Summary of the Flood Risks from the Various Components*

As indicated in the above table, the various sources of flooding have been reviewed, and the risk of flooding from each source has been assessed. Where necessary, mitigation measures have been proposed. As a result of the proposed mitigation measures, the residual risk of flooding from any source is low.

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