Waterman Moylan
Engineering Consultants




# Flood Risk Assessment

## Residential Development at Auburn, Malahide Road

March 2021

**Waterman Moylan Consulting Engineers Limited**

Block S, East Point Business Park, Alfie Byrne Road, Dublin D03 H3F4
www.waterman-moylan.ie

Waterman Moylan
Engineering Consultants

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## 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 |
|---|---|---|---|---|
| 1 | 14 July 2020 | Stephen Dent-Neville | Mark Duignan | Mark Duignan |
| 2 | 31 March 2021 | Robert Walpole | Stephen Dent-Neville | Mark Duignan |

**Comments**

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## Disclaimer

# Contents

## Figures



## Tables

# 1. Introduction

This Flood Risk Assessment has been prepared by Waterman Moylan as part of the documentation in support of a Strategic Housing Development (SHD) planning application for a proposed residential development in lands around Auburn House in Malahide, Co. Dublin.

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.

## 1.1 Site Description

The subject site is defined as a greenfield site, though there are currently several buildings on the site including Auburn House, an eighteenth century three-storey mansion located within a wooded demesne, stables and a house known as “Little Auburn”.

A topographic survey of the area indicated that the site is very flat with only local high points. The site lies generally at a level of between 9m and 11m OD Malin, with a local high point near the north-east of the site of 12.45m OD Malin.

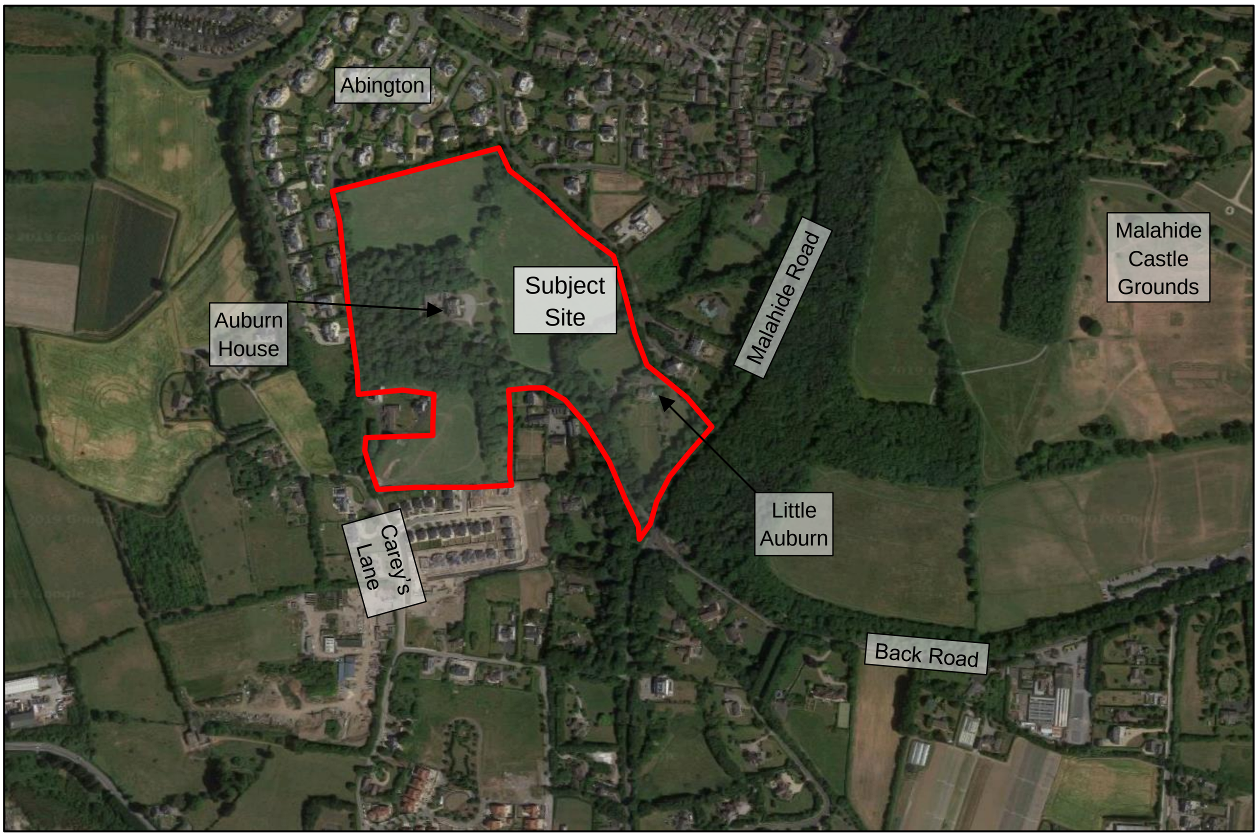


***Figure 1*** **|** *Site Location (Source: Google Maps)*

There is an existing surface water drain along the northern and eastern boundary of the site (within the Abington development) which discharges to an existing culvert under the Malahide Road close to the entrance to the site at the junction with Back Road. This drain is very flat at an estimated average gradient of 1/1,000 over its 700-metre length along the north-eastern boundary and through the lands to the entrance of the site.

## 1.2 Proposed Development

The proposed development will consist of the preservation and protection of the existing Protected Structure of Auburn House as 1 no. residential dwelling. The conversion of the existing stables of Auburn House to accommodate 4 no. dwellings, and the construction of 406 no. residential dwellings, apartments and duplexes providing for an overall total of 411 no. residential units. A creche (173m²) will be constructed as part of the development.

The breakdown of the proposed development is set out in the Schedule of Accommodation below:

| Description | | 1-Bed | 2-Bed | 3-Bed | 4-Bed | 5-Bed or more | Total | |
|---|---|---|---|---|---|---|---|---|
| Houses *(including converted stables)* | | 1 | 2 | 46 | 39 | 14 | 102 Houses | |
| Apartments | Block 1 | 27 | 22 | 2 | - | - | 51 | 266 Apartments |
| | Block 2 | 29 | 27 | 1 | - | - | 57 | |
| | Block 3 | 27 | 22 | 2 | - | - | 51 | |
| | Block 4 | 9 | 17 | 1 | - | - | 27 | |
| | Block 5 | 6 | 22 | - | - | - | 28 | |
| | Block 6 | 5 | 14 | 2 | - | - | 21 | |
| | Block 7 | - | 6 | - | - | - | 6 | |
| | Block 8 | 6 | 17 | 2 | - | - | 25 | |
| Duplexes | Block 1 | 1 | 3 | 2 | - | - | 6 | 43 Duplexes |
| | Block 2A | 6 | 2 | - | - | - | 8 | |
| | Block 2B | 8 | 3 | - | - | - | 11 | |
| | Block 2C | 7 | 2 | - | - | - | 9 | |
| | Block 2D | 5 | 4 | - | - | - | 9 | |
| **Total** | | **137** | **163** | **58** | **39** | **13** | **411** | |

***Table 1*** **|** *Schedule of Accommodation*

A community building (178m²) is also proposed, to be located at the "walled garden" location of the site.

The development includes all associated site works, boundary treatments, drainage and service connections.

## 1.3 Background to the Report

This Flood Risk Assessment report follows the guidelines set out in the *DEHLG/OPW Guidelines on the Planning Process and Flood Risk Management* published in November 2009. 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.

### 1.3.1 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.

### 1.3.2 Assessing Consequence

There is not a defined method used to quantify a value for the consequences of a flooding event. Therefore, in order 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 in order to determine a value for consequences. Consequences will also be categorized as low, moderate, and high.

### 1.3.3 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. Tidal

### 2.1 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.

### 2.2 Pathway

The site is approximately 1.3km south of the nearest coastline at the Malahide Estuary. The Dublin Coastal Protection Project indicated that the 2002 high tide event reached 2.95m OD Malin. The lowest proposed finished floor level at the development is to be constructed at 9.60m OD Malin, well above the historic high tide event.

The Fingal East Meath Flood Risk Assessment and Management Study (FEM FRAMS) maps available on the OPW's National Flood Information Portal have been consulted as part of this assessment. These maps include tidal flood mapping, which outlines existing and potential flood hazard and risk areas which are being incorporated into a Flood Risk Management Plan. An extract of Tidal Flood Extent Map No. E09MAL_EXCCD_F0_35 is shown in the Figure below:

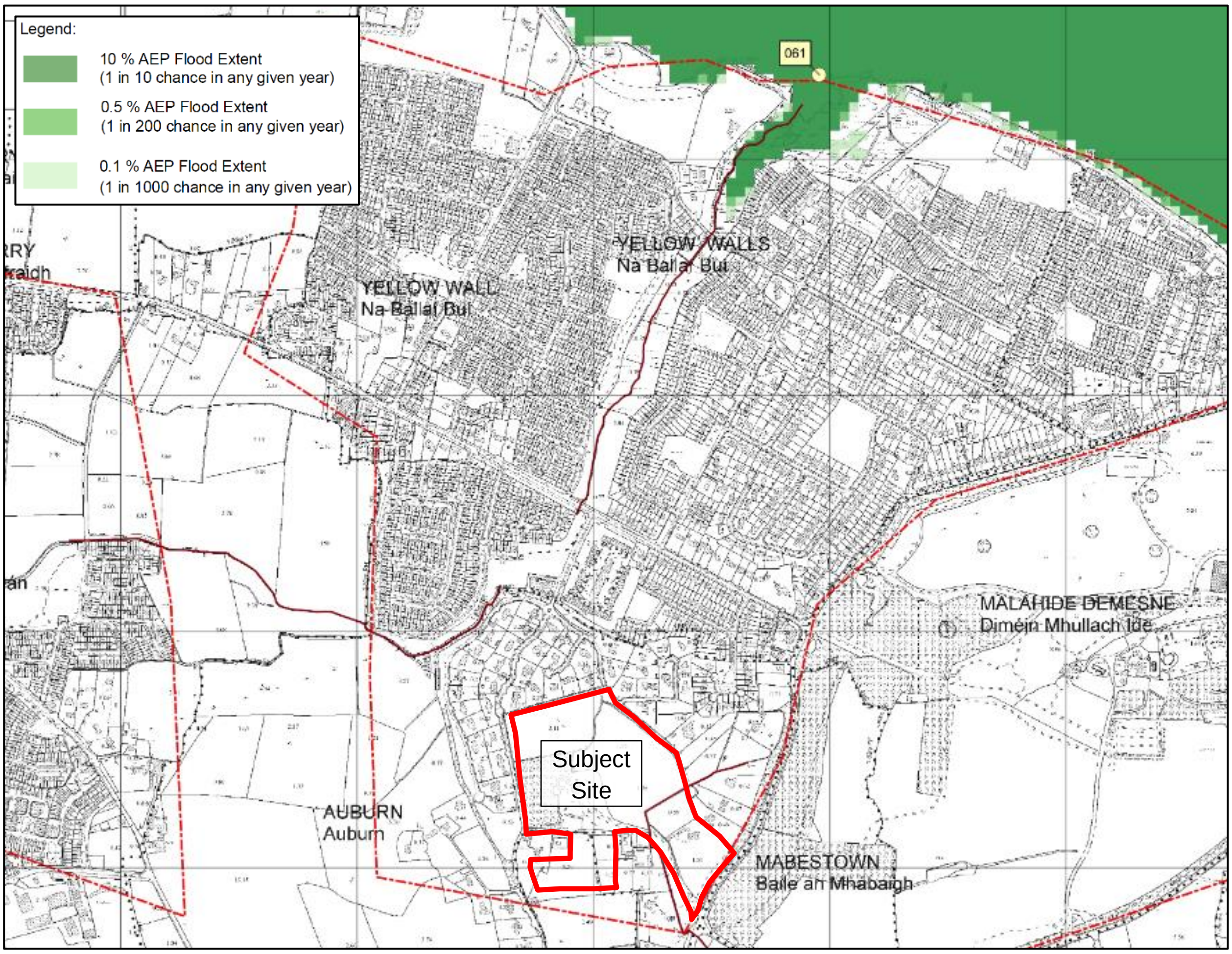


***Figure 2 |*** *Extract from the FEM FRAMS Tidal Flood Extents Map*

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 subject development is not at risk of flooding for the 1-in-1,000 year event.

Given that the site is located 1.3 kilometres inland from the Irish Sea, that there is at least a 6.65m level difference between the proposed buildings and the high tide and given that the site is outside of the 1-in-1,000 year 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.

# 3. Fluvial

## 3.1 Source

Fluvial flooding occurs when a river / water course'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.

## 3.2 Pathway

The subject site is located within the Sluice River catchment. The Hazelbrook Stream, a tributary of the Sluice River, traverses the subject site.

A review of the available historic records does not indicate that there have been any known instances of flooding at the site or in the surrounding area. However, the Fingal East Meath Flood Risk Assessment and Management Study (FEM FRAMS) maps, available on the OPW's National Flood Information Portal and extracted below, indicate that a large portion of the subject site falls within the 0.1% AEP (1-in-1,000 year) flood plain.

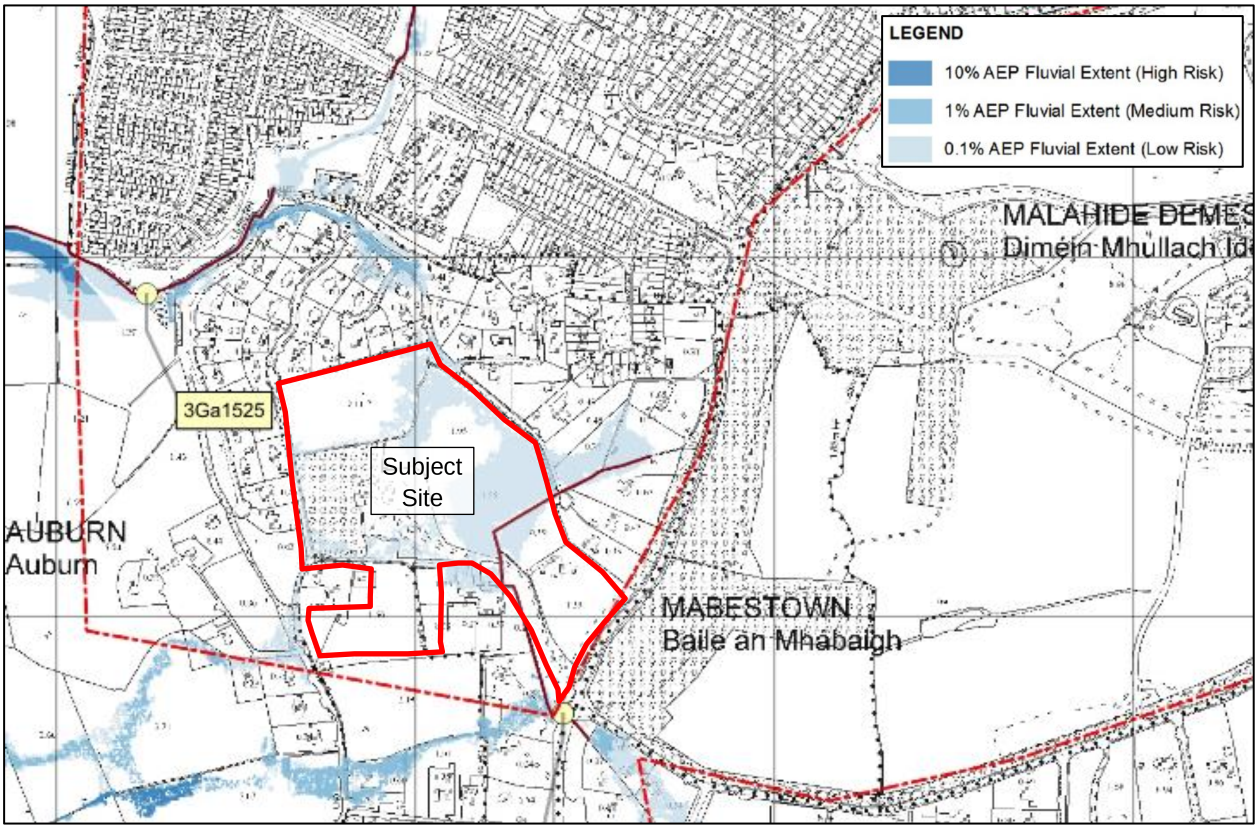


***Figure 3*** | *Extract from the FEM FRAMS Fluvial Flood Extents Map*

JBA Consulting were appointed by the developer, Kinwest Ltd., to provide a Flood Risk Assessment for the proposed development. JBA Consulting engaged with the OPW regarding the model setup and assumptions of the CFRAM/Streamstown flood model, and engaged with Fingal County Council regarding the existing hydrological environment and culvert location/dimensions. Based on these consultations and review of detailed topographic surveys, JBA developed a site-specific flood model for the site and Hazelbrook Stream to confirm the flood risk.

The main difference between the CFRAM/Streamstown Update and JBA flood models is the inclusion of the existing onsite watercourses within the JBA model.

The model produced by JBA is based on a detailed assessment of the local watercourse network, which was not included as part of the CFRAM/Streamstown flood modelling. Due to the inclusion of the onsite stream network, the model produced by JBA displays a significantly reduced 0.1% AEP flood zone within the site. The local stream retains the 0.1% AEP event in-bank through the site and back into the Hazelbrook Stream.

The figure below is extracted from the JBA Consulting report and shows no flooding within Flood Zone A or B for the 0.1% AEP (1-in-1,000 year) flood plain.

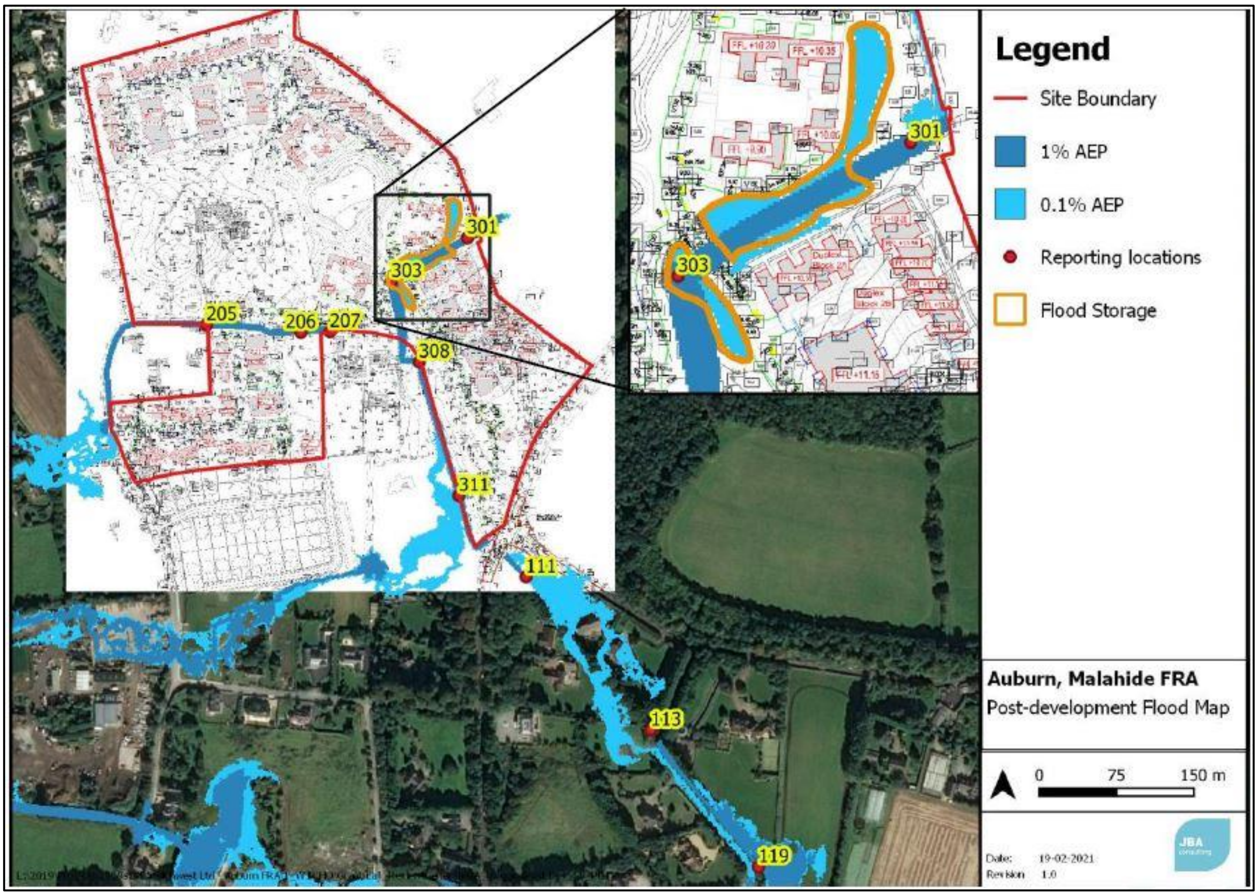


***Figure 4 |*** *Post Development Flood Extents (Extracted from Flood Risk Assessment by JBA Consulting)*

In summary, the detailed site-specific flood model shows that all proposed residential development is located in Flood Zone C, therefore the proposed dwellings are not at risk of inundation from any of the modelled flood events, including the climate change & residual risk scenarios, in accordance with the OPW guidelines for a site-specific flood model. Furthermore, the assessment by JBA Consulting concludes that there is no increased risk of inundation downstream of the site from the proposed development. The proposed finished floor levels provide a minimum freeboard of 0.7m above the highest flood level through the site, which is the 0.1% HEFS Climate Change event.

The report by JBA Consulting, which accompanies this submission under separate cover, includes assessments against a range of flood events, including a number of blockage (residual risk) events, and accounting for climate change. The results confirm that the proposed residential dwellings will not be impacted by any of the flood events, and a sufficient freeboard has been provided.

## 3.3 Likelihood

Given that the majority of the site is outside of the 1-in-1,000 year flood plain, and that no properties are proposed within the small area within the 1-in-1,000 year flood plain, the likelihood of fluvial flooding is low.

## 3.4 Consequence

The consequence of fluvial flooding would be some minor inundation to open spaces. Therefore, the consequences of fluvial flooding occurring at the proposed development is considered low.

## 3.5 Risk

There is an extremely low risk of fluvial flooding as the likelihood is low and the consequence is low.

## 3.6 Flood Risk Management

As noted above, the proposed finished floor levels of all proposed residential units provide a minimum freeboard of 0.7m above the nearest flood level through the site, which is the 0.1% HEFS Climate Change event.

Should fluvial flooding occur, surface water can flow overland towards the existing Hazelbrook Stream via open spaces and also towards the dry detention basin, as shown in the flood routing figure below, and in full on Drawing No.19-020-P210.

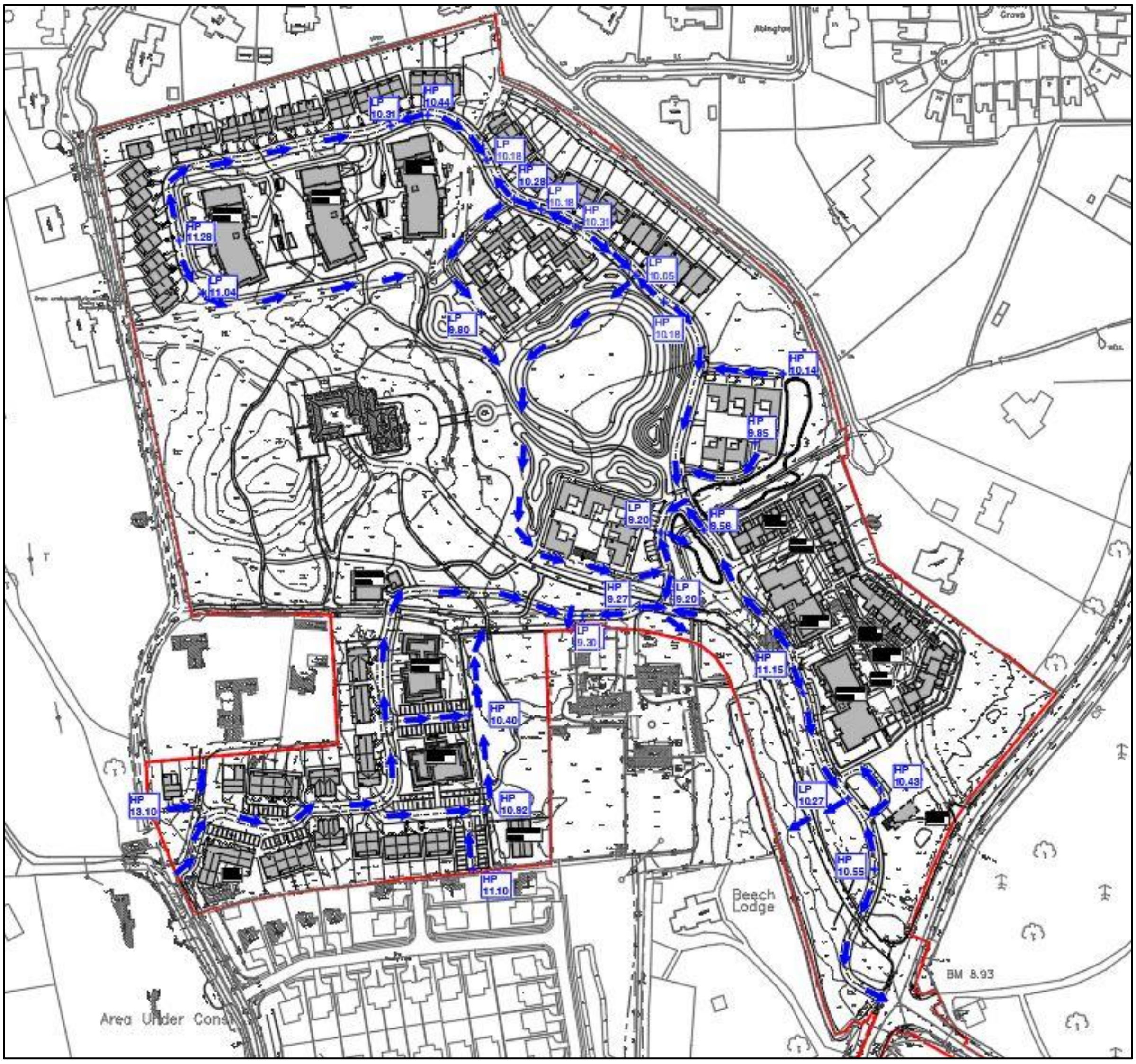


***Figure 5*** **|** *Overland Flood Route*

## 3.7 Residual Risk

The residual risk of fluvial flooding is considered extremely low.

# 4. Pluvial

## 4.1 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.

## 4.2 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 4** | Pathways and Receptors*

## 4.3 Likelihood

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

### 4.3.1 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.

### 4.3.2 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 event occurred approximately 1km north of the site in 2005, with no recorded flooding in the immediate vicinity of the site.

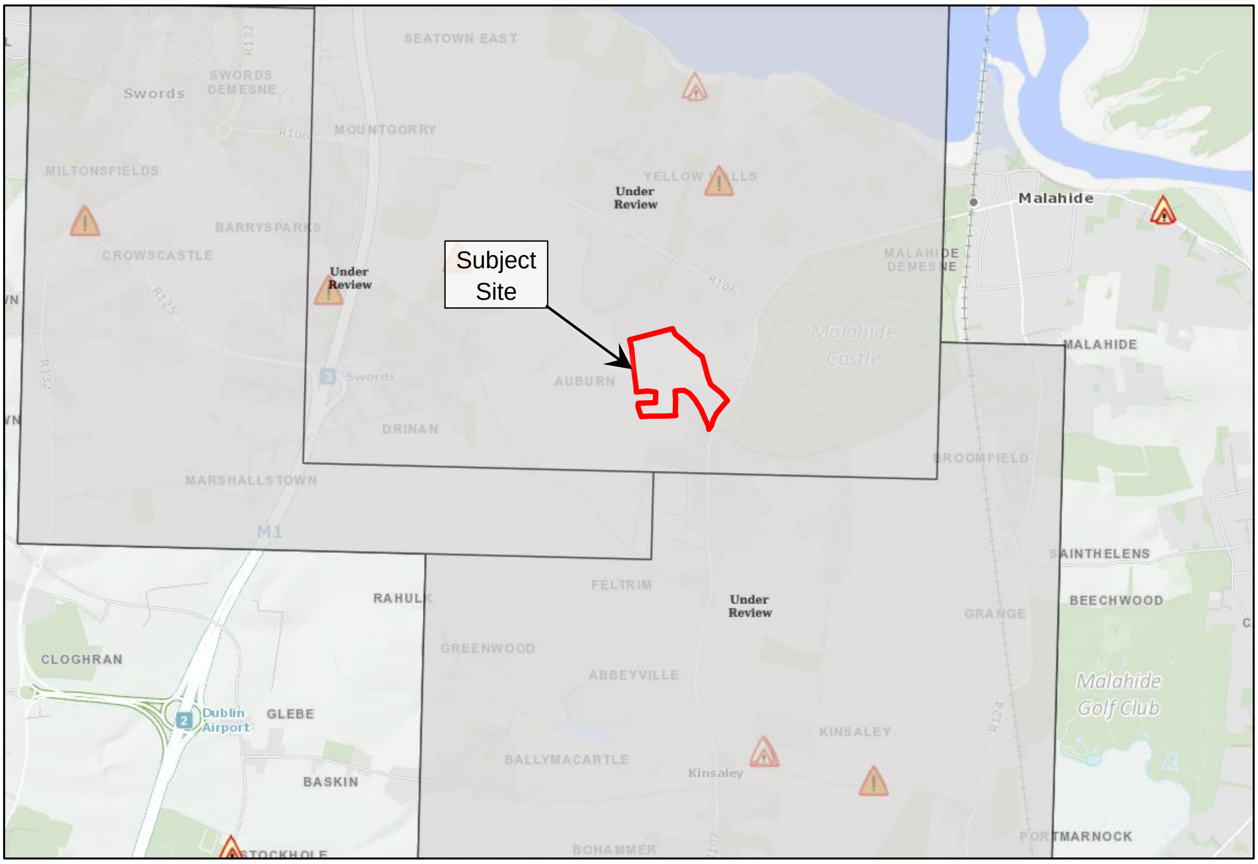


***Figure 6*** | *Local Flood Event History Extracted from OPW's National Flood Hazard Maps*

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

### 4.3.3 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.

### 4.3.4 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.

### 4.3.5 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.

## 4.4 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.

## 4.5 Risk

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

### 4.5.1 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.

### 4.5.2 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.

### 4.5.3 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.

### 4.5.4 Overland flooding from surrounding areas:

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

### 4.5.5 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.

## 4.6 Flood Risk Management

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

### 4.6.1 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 green sedum roofing on apartment blocks will ensure that these areas act as soft scape and will significantly slow down and reduce the amount of surface water runoff from the site. Permeable paving in private driveways and parking courts and filter drains around the perimeter of the apartment blocks 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 for each catchment will limit runoff to the equivalent greenfield rate. Excess storm water from the main catchment is to be attenuated in the dry detention basin 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. Several smaller catchments for the apartments will be attenuated privately, with sufficient volume also for the 1-in-100 year storm and climate change factor.

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

### 4.6.2 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 (refer to the Overland Flood Routing figure in Section 3.6 above) towards the Hazelbrook Stream and towards the dry detention basin. The risk to the surrounding buildings is mitigated by setting finished floor levels at least 200mm above the adjacent road channel line.

### 4.6.3 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 4.6.1 above, minimising the risk of pluvial flooding from the subject site. Sufficient attenuation storage is provided for the 1-in-100 year storm, accounting for a 20% increase due to climate change.

### 4.6.4 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 buildings, as described in Section 4.6.2 above.

### 4.6.5 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 4.6.1 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.

## 4.7 Residual Risk

As a result of the design measures detailed above in Section 4.6, there is a low residual risk of flooding from each of the surface water risks.

# 5. Groundwater

## 5.1 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.

## 5.2 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.

## 5.3 Receptor

The receptors for ground water flooding would be underground services, roads and the ground floor of buildings.

## 5.4 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 high to extreme groundwater vulnerability.

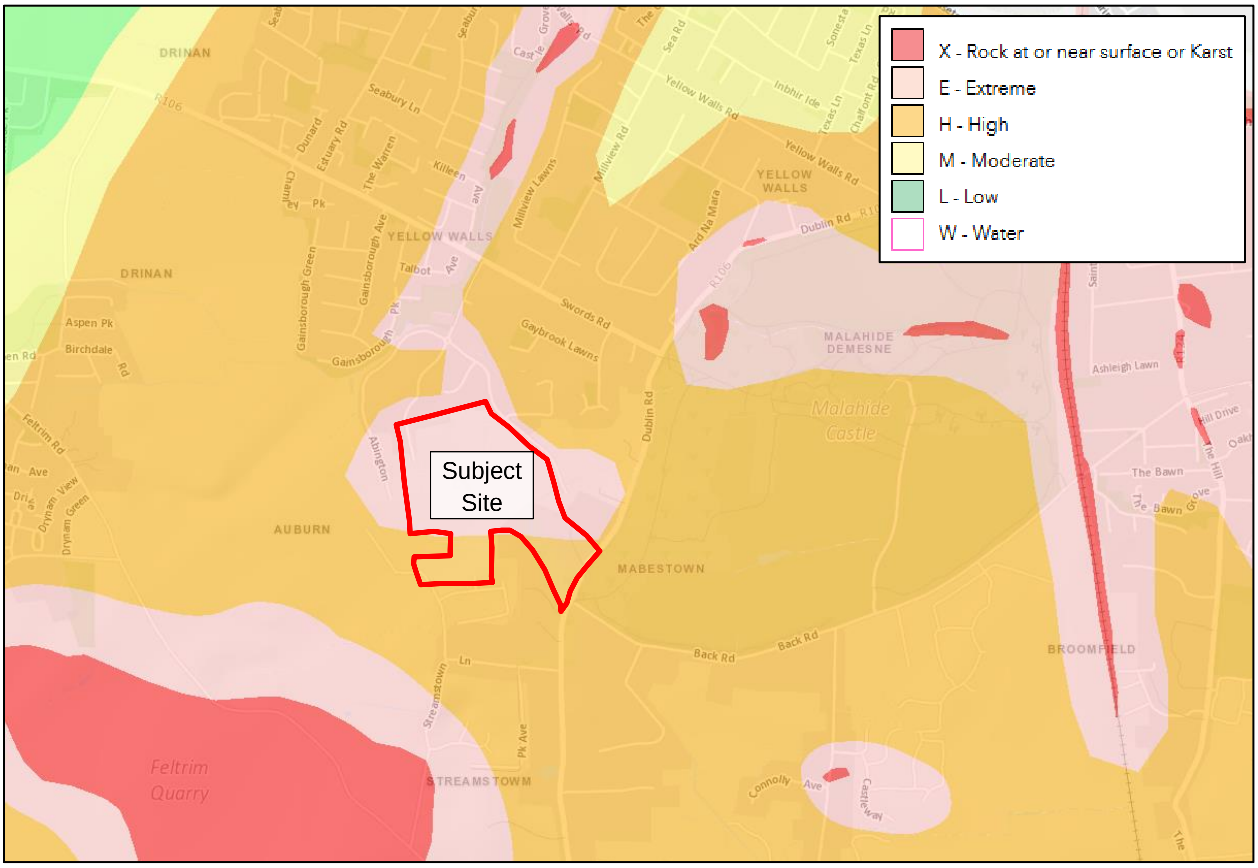


***Figure 7*** **|** *Extract of Groundwater Vulnerability Map*

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

## 5.5 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.

## 5.6 Risk

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

## 5.7 Flood Risk Management

Finished floor levels have been set above the road levels, as described in Section 3.6, to ensure that any seepage of ground water onto the development does not flood into the buildings. In the event of ground water flooding on site, this water can escape from the site via the overland flood routing, also described in Section 3.6.

The buildings' design will incorporate suitable damp-proof membranes to protect against damp and water ingress from below ground level.

## 5.8 Residual Risk

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

# 6. Human/Mechanical Errors

## 6.1 Source

The subject site will be drained by an internal private storm water drainage system, which discharges to the existing natural surface water network, the Hazelbrook Stream, which is a tributary of the Sluice River, which in turn outfalls to the Baldoyle Estuary.

The internal surface water network is a source of possible flooding were it to become blocked.

## 6.2 Pathway

If the proposed private drainage system blocks this could lead to possible flooding within the private and public areas.

## 6.3 Receptor

The receptors for flooding due to human/mechanical error would be the ground floor levels of buildings, the roads and the open landscaped areas around the site.

## 6.4 Likelihood

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

## 6.5 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.

## 6.6 Risk

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

## 6.7 Flood Risk Management

As described in Section 3.6, finished floor levels have been designed to be above the adjacent road network, which will reduce the risk of flooding if the surface water network were to block. In the event of the surface water system surcharging, the surface water can still escape from the site by overland flood routing, as also described in Section 3.6, 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.

## 6.8 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.

## 7. Conclusions and Recommendations

The subject lands have been analysed for risks from tidal flooding from the Irish Sea and Hazelbrook stream, fluvial flooding from Hazelbrook stream, pluvial flooding, ground water and failures of mechanical systems. *Table 5*, below, presents the various residual flood risks involved.

| **Source** | **Pathway** | **Receptor** | **Likelihood** | **Consequence** | **Risk** | **Mitigation Measure** | **Residual Risk** |
|---|---|---|---|---|---|---|---|
| Tidal | *Irish Sea (Malahide Estuary)* | *Proposed development* | *Extremely low* | *None* | *Extremely low* | *None* | Extremely low |
| Fluvial | *Hazelbrook Stream (tributary of the Sluice River)* | *Proposed development* | *Low* | *Low* | *Extremely Low* | *Setting of floor levels & freeboard, overland flood routing* | Extremely Low |
| Pluvial | *Private & Public Drainage Network* | *Proposed development, downstream properties and roads* | *Ranges from high to low* | *Moderate* | *Ranges from high to low* | *Appropriate drainage, SuDS and attenuation design, setting of floor levels, overland flood routing* | Low |
| Ground Water | *Ground* | *Underground services, ground level of buildings, roads* | *High* | *Moderate* | *High* | *Appropriate setting of floor levels, flood routing, damp proof membranes* | Low |
| Human/ Mechanical Error | *Drainage network* | *Proposed development* | *High* | *Moderate* | *High* | *Setting of floor levels, overland flood routing, regular inspection of SW network* | Low |

***Table 5*** | *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.

# UK and Ireland Office Locations