

# Appendix 7. Water

## 7.1 Flood Risk Assessment

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**Shankill Property Investments Limited**

# Sea Gardens Phase 2

## Flood Risk Assessment

Reference: 293308-ARUP-ZZ-XX-RP-C-0001

FINAL March 12, 2025

This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 293308-00

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# 1. Introduction

## 1.1 Project Background

Shankill Property Investments Limited is seeking permission from Wicklow County Council (WCC) for the development of a proposed mixed-use development, including residential, retail/retail services, and commercial uses on the former Bray Golf Course lands in Bray, County Wicklow. The proposed development is part of the Harbour Point Masterplan, now Sea Gardens. Phase 1a of the masterplan is nearing completion, and planning permission for Phase 1b has recently been granted. The proposed development relates to the next phase of the masterplan, which is called Sea Gardens Phase 2.

This Flood Risk Assessment (FRA) has been undertaken and prepared in support of the Sea Gardens Phase 2 planning application. The FRA is in accordance with the Guidelines for Planning Authorities on 'The Planning System and Flood Risk Management' published in November 2009, jointly by the Office of Public Works (OPW) and the then Department of Environment, Heritage and Local Government (DEHLG).

## 1.2 Scope of Study

The scope of the study includes the following:

- A review of all relevant available information and data, as detailed in the section below;
- A review of the risk of tidal, fluvial, groundwater and pluvial flooding at the site;
- Hydrological analysis and hydraulic modelling of the River Dargle to quantify risk of flooding to the site and impact of proposals to adjacent sites;
- Preparation of a site-specific FRA Report.

## 1.3 Summary of data used

The following data was collated and reviewed:

- River Dargle Flood Defence Drawings, O'Connor Sutton Cronin, April 2007;
- River Dargle (Bray) Flood Defence Scheme Environmental Impact Assessment, July 2007;
- River Dargle at Bray Flood Defence Scheme Physical Model Study, HR Wallingford, February 2009;
- Flood Review for the Bray Town Centre Development Final Report, JBA consulting, November 2009;
- Former Bray Golf Club Lands Independent Report on Flood Risk, Fairhurst, June 2022;
- Coastal Quarter SHD 2 Flood Risk Assessment, Atkins, September 2022;
- Data collected from the Flood Studies Update (FSU) Programme Web Portal;
- Data collected from the hydrometric website of the Office of Public Works (OPW) ([waterlevel.ie](http://waterlevel.ie));
- Review of the Irish Coastal Wave and Water Level Modelling Study maps and reports (ICWWS) ([Publications - Floodinfo.ie](http://Publications-Floodinfo.ie));
- Topographical data of the site;
- Site walkover survey;
- Architectural drawings of the proposed development;
- Aerial photography and mapping from Google Maps.

## 1.4 Site Description

The proposed site is located between Dublin Rd, Chapel Lane and Ravenswell Road, on the north side of Bray, adjacent to the north bank of the River Dargle. The site is currently greenfield and sits on the former Bray Golf Course lands. The southern boundary of the site is bordered by Ravenswell Road and the River Dargle.

The northern part of the site is bordered by three schools: North Wicklow Educate Together Secondary School, Ravenswell Primary School, and Colaiste Raithin. The DART line is located east of the red line boundary. On the southwest, the site is bordered by three residential areas known as Bray Commons, Dwyer Park and Little Bray. Figure 1-1 shows an aerial view of the site, with the site boundary shown in red.



**Figure 1-1 Site location north of the River Dargle (Background aerial image: © Google Earth)**

The site slopes from the northwest to the River Dargle in the southeast. The levels range from 7.2m AOD on the northern boundary to 1.47m AOD on the southeast boundary. The contours of the site are shown in Figure 1-2 at 0.5m spacing.

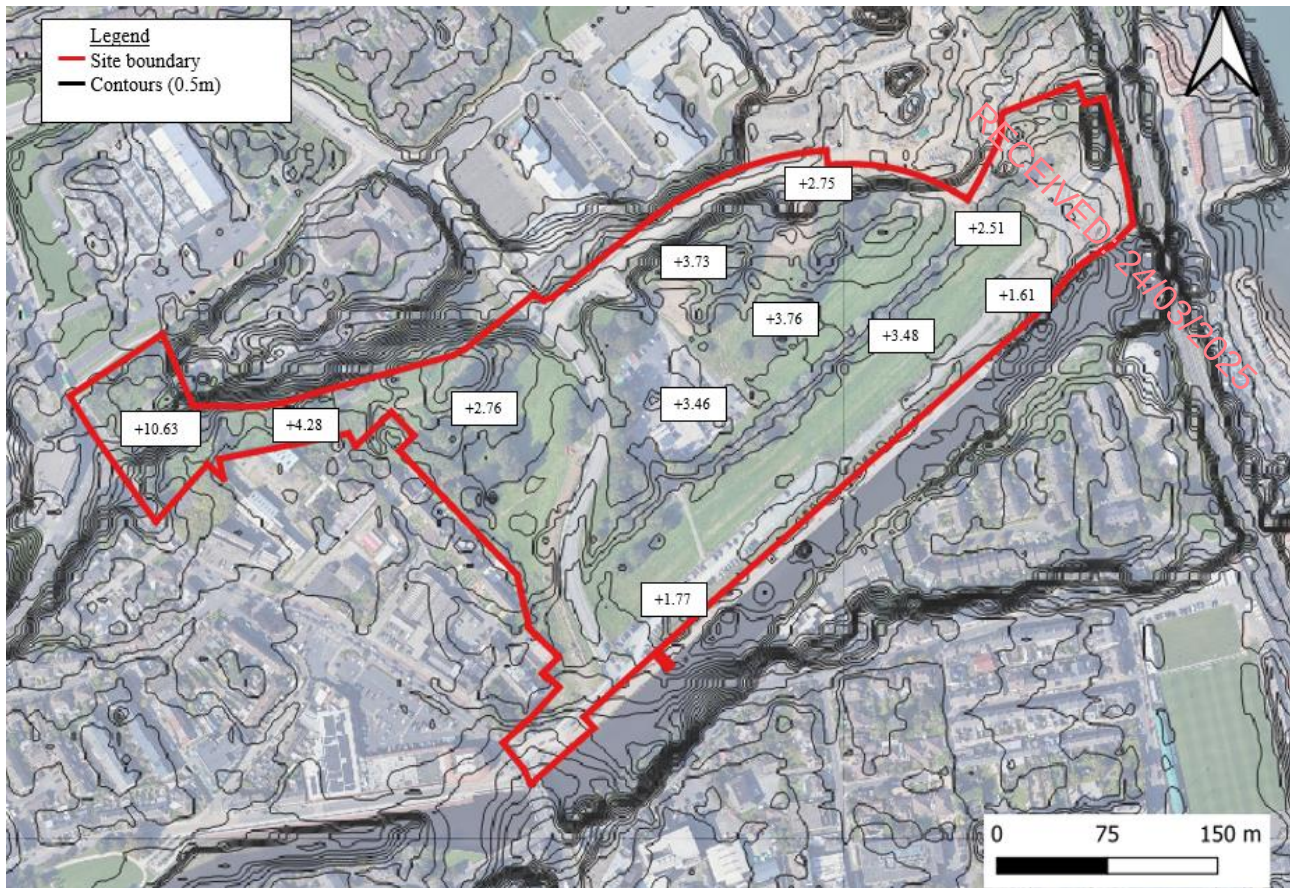


Figure 1-2 Site location with elevation contours (0.5m)

## 1.5 Proposed Development

Shankill Property Investments Limited (the applicant) is seeking permission from Wicklow County Council (WCC) for a proposed development on a site of approximately 11 hectares located on the former Bray Golf Course lands in Bray, County Wicklow. This proposed development pertains to Sea Gardens Phase 2, which is part of the Sea Gardens Masterplan (previously known as the Harbour Point Masterplan). The Masterplan has been developed by the applicant in collaboration with a multidisciplinary team.

In summary, the application for Sea Gardens Phase 2 proposes a mixed-use development comprising residential (c. 41,013 sq.m), retail/retail services (c. 8,155 sq.m), and commercial (c. 10,961 sq.m) spaces. The residential component will comprise 341 residential units (94 houses, 106 duplex units, and 141 apartments located in Blocks E and H). In addition, a hotel is proposed in Block I, a public house in Block E, a childcare facility and a medical centre in Block H, and retail/retail services units distributed in Blocks E, G, H and I. The proposed development will also provide private, communal, and public open spaces, along with car and bicycle parking for residents and visitors. An internal road network for vehicles, cyclists, and pedestrians will connect to the existing transport networks. All associated development infrastructure will also be provided, including public lighting, hard and soft landscaping, utilities, drainage, and clearance, demolition and removal of existing structures on site.

The proposed heights are as follows: houses will be 2 storeys, duplex units will be 2-3 storeys, Block E will be 3-15 storeys, Block G will be 1-2 storeys, Block H will be 3-4 storeys and Block I will be 3-7 storeys.

Sea Gardens Phase 2 will complement the permitted Sea Gardens Phase 1A (construction of which is nearing completion) and Phase 1B, as well as the future Phase 3, which will be the subject of a separate application. Phase 3, located adjacent to the River Dargle, is expected to accommodate approximately 362 residential units above a podium, including approximately 14,000 sq.m of retail and other uses. The building heights in Phase 3 will range from 6-9 storeys. This area has been included in the current application for Sea Gardens Phase 2 to allow for temporary use during construction for storing materials and site facilities.

The new park at the south of the development is also referred in this report as **linear park** and it's a key element in the maintaining the flood mechanism through the site.

The site wide masterplan drawings are included in Appendix A and shown in Figure 1-3.

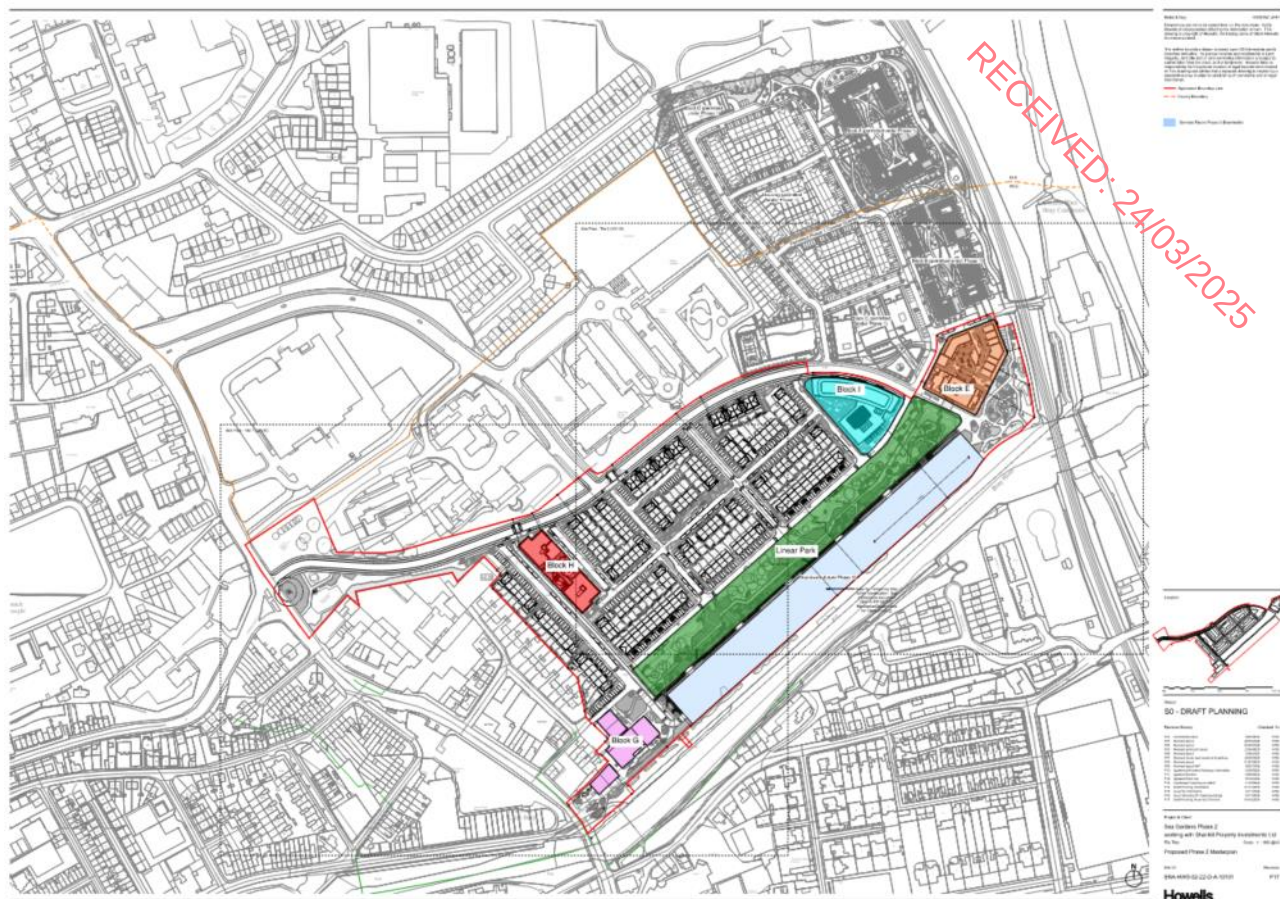


Figure 1-3 Site wide masterplan (Glenn Howells)

## 1.6 SSFRA carried out for Coastal Quarter Phase 1B

We are instructed that in High Court proceedings (*McManus v An Bord Pleanála*, High Court Record No. 2024/1256 JR) (the “**proceedings**”) challenging a grant of permission for a previous phase of the masterplan development (ABP-314686-22) (“**Coastal Quarter Phase 1B**”) one of the grounds of challenge relates to the site specific flood risk assessment carried out in respect of the proposed development in that instance. For the avoidance of doubt, the methodology adopted and conclusions reached in this report are the result of expert assessment of the flood risk associated with the proposed development the subject of the present application for permission. Nothing in this report should be read as accepting the validity of any of the arguments put forward by the Applicant in the proceedings in relation to the site specific flood risk assessment carried out for Coastal Quarter Phase 1B. The methodology adopted and conclusions reached in this report are entirely without prejudice to any arguments made in opposition to the grounds pleaded by the Applicant in the proceedings and are without prejudice to the methodology adopted and conclusions reached in the site specific flood risk assessment carried out in respect of the Coastal Quarter Phase 1B.

## 2. Planning Context

### 2.1 Introduction

The following planning policy documents are relevant to the assessment of this proposed development of the Sea Gardens Phase 2:

- The national planning guidelines published by the OPW and the DEHLG in November 2009 entitled ‘The Planning System and Flood Risk Management: Guidelines for Planning Authorities’;

- Wicklow County Development Plan 2022-2028;
- Bray Municipal District Local Plan 2018-2024.

## 2.2 The Planning System and Flood Risk Management

In November 2009, the DEHLG and the OPW jointly published a Guidance document for Planning Authorities entitled 'The Planning System and Flood Risk Management' hereafter referred to as 'the Guidelines'.

The Guidelines are issued under Section 28 of the Planning and Development Act 2000; and Planning Authorities and An Bord Pleanála are therefore required to implement these Guidelines in carrying out their functions under the Planning Acts.

The aim of the Guidelines is to ensure that flood risk is not proposed or increased in a given area through inappropriate development.

The Guidelines require the planning system to avoid development in areas at risk of flooding, unless they can be justified on wider sustainability grounds, where the risk can be reduced or managed to an acceptable level.

They require the adoption of a Sequential Approach to Flood Risk Management of Avoidance, Reduction, Justification and Mitigation and the incorporation of Flood Risk Assessment into the process of making decisions on planning applications and planning appeals. Fundamental to the guidelines is the introduction of flood risk zoning and the classifications of different types of development having regard to their vulnerability. The management of flood risk is now a key element of any development proposal in an area of potential flood risk and should therefore be addressed as early as possible in the site master planning stage.

### 2.2.1 Definition of Flood Zones

Flood zones are geographical areas within which the likelihood of flooding is within a particular range. Flood defences are not taken into account when zoning areas to flood zones.

There are three types of flood zones defined in the Guidelines as follows:

**Table 2-1 Flood Zone Categories**

| Zone         | Description                                                                                                                                                                                                     |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Flood Zone A | Probability of flooding from rivers and the sea is highest (greater than 1% of 1 in 100 for river flooding or 0.5% for 1 in 200 for coastal flooding)                                                           |
| Flood Zone B | Probability of flooding from rivers and the sea is moderate (between 0.1% or 1 in 1000 year and 1% or 1 in 100 for river flooding and between 0.1% or 1 in 1000 year and 0.5% or 1 in 200 for coastal flooding) |
| Flood Zone C | Probability of flooding from rivers and the sea is low (less than 0.1% or 1 in 1000 for both river and coastal flooding). Flood Zone C covers all areas of the plan which are not in zones A or B.              |

The site is within Flood Zones A & B, however it is defended by the River Dargle Flood Defence Scheme up to the 1 in 200 year flood event (0.5% Annual Exceedance Probability - AEP) and the 1 in 100 year (1%AEP) fluvial event. Designation of the flood zones is discussed in Section 5.1 Flood Protection Level and is defined in Figure 5-1.

### 2.2.2 Definition of Vulnerability Classes

The following table summarises the Vulnerability Classes defined in the Guidelines and provides a sample of the most common type of development applicable to each. The proposed uses for the Sea Gardens Phase 2 include highly vulnerable development (hotel, residential buildings, creche), less vulnerable development (commercial spaces) and water compatible uses (amenity open space).

**Table 2-2 Vulnerability Classes**

| Vulnerability Class                  | Land Uses and Types of Development                                                                                                                                                                                               |
|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Highly Vulnerable Development</b> | Includes Garda, ambulance and fire stations, hospitals, schools, residential dwellings, residential institutions, essential infrastructure, such as primary transport and utilities distribution and SEVESO and IPPC sites, etc. |
| <b>Less Vulnerable Development</b>   | Includes retail, leisure, warehousing, commercial, industrial, and non-residential institutions, etc.                                                                                                                            |
| <b>Water Compatible Development</b>  | Includes Flood Control Infrastructure, docks, marinas, wharves, navigation facilities, water-based recreation facilities, amenity open spaces and outdoor sport and recreation facilities.                                       |

### 2.2.3 Types of Vulnerability Class appropriate to each zone

The following table illustrates the different types of Vulnerability class appropriate to each Zone and indicates where a Justification Test will be required.

**Table 2-3 Flood Zone Justification Test**

|                   | Flood Zone A       | Flood Zone B       | Flood Zone C |
|-------------------|--------------------|--------------------|--------------|
| Highly Vulnerable | Justification Test | Justification Test | Appropriate  |
| Less Vulnerable   | Justification Test | Appropriate        | Appropriate  |
| Water Compatible  | Appropriate        | Appropriate        | Appropriate  |

The Guidelines recognise there is a need to reconcile the desire to avoid development in flood risk areas while also ensuring sequential and compact urban development. This section of the guidelines is particularly relevant to the Sea Gardens Phase 2. It states:

*“Notwithstanding the need for future development to avoid areas at risk of flooding, it is recognised that the existing urban structure of the country contains many well-established cities and urban centres, which will continue to be at risk of flooding. At the same time such centres may also have been targeted for growth in the National Spatial Strategy, regional planning guidelines and the various city and county development plans taking account of historical patterns of development and their national and strategic value.*

*In addition, development plans have identified various strategically located urban centres and particularly city and town centre areas whose continued growth and development is being encouraged in order to bring about compact and sustainable urban development and more balanced regional development.*

*Furthermore, development plan guidelines, issued by the Minister for the Environment, Heritage and Local Government under Section 28 of the Planning and Development Act 2000, have underlined the importance of compact and sequential development of urban areas with a focus on town and city centre locations for major retailing and higher residential densities.”*

## 2.3 Wicklow County Development Plan 2022 – 2028

The Wicklow County Development Plan 2022 – 2028 was adopted in September 2022 and came into effect in October 2022. This document guides development and land use within Wicklow County around Strategic County Outcomes (SCO). The SCOs most relevant to flood risk and justification are SCO1 and SCO7 reproduced in Table 2-4.

**Table 2-4 Strategic County Outcomes relevant to flood risk and justification**

| Strategic County Outcome                                                    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>SCO1 Sustainable Settlement Patterns &amp; Compact Growth</b>            | The delivery of compact growth in all towns and villages by capitalising on the potential for infill and brownfield development, moving away from a reliance on greenfield development and creating places that encourage active lifestyles is essential for the successful delivery of the development plan strategy.                                                                                                                             |
| <b>SCO7 Climate Resilience &amp; the Transition to a Low Carbon Economy</b> | Support the transition to low carbon clean energy by facilitating renewable energy use and generation at appropriate locations and supporting the development of offshore renewable energy enabling infrastructure especially at ports and harbours. Facilitate the sustainable management of waste including the circular economy. Restrict development in areas that are at risk of flooding and protect the natural landscape and biodiversity. |

Chapter 14 of the Wicklow County Development Plan 2022-2028 introduces 16 additional objectives in relation to flood risk management which are reproduced in Table 2-5. The key objective most relevant to this site specific FRA is CPO 14.09.

**Table 2-5 Wicklow County Development Plan 2022-2028 Flood Risk Management Objectives**

| Objective        | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CPO 14.01        | To support the implementation of recommendations in the OPW Flood Risk Management Plans (FRMPs), including planned investment measures for managing and reducing flood risk.                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| CPO 14.02        | To support and facilitate flood management activities, projects or programmes as may arise, including but not limited to those relating to the management of upstream catchments and the use of ‘natural water retention’ measures, and ensure each flood risk management activity is examined to determine actions required to embed and provide for effective climate change adaptation as set out in the Climate Change Sectoral Adaptation Plan for Flood Risk Management applicable at the time.                                                                                                        |
| CPO 14.03        | To recognise the concept of coastal evolution and fluvial flooding as part of our dynamic physical environment, and adopt an adaptive approach to working with these natural processes. The focus of a flood management strategy should not solely be driven by conservation of existing lands; it should recognise that marshes, mud flats and other associated eco-systems evolve and degenerate, and appropriate consideration should be given to the realignment of defences and use of managed retreat and sacrificial flood protection lands to maintain such habitats as part of an overall strategy. |
| CPO 14.04        | To ensure the County’s natural coastal defences (beaches, sand dunes, salt marshes and estuary lands) are protected and to ensure that their flood defence/management function is not put at risk by inappropriate works or development.                                                                                                                                                                                                                                                                                                                                                                     |
| CPO 14.05        | To continue to work with the OPW and other agencies to deliver Flood Defence Schemes in the County as identified in current and future FRMPs, and in particular: <ul style="list-style-type: none"> <li>• Avoca River (Arklow) Flood Defence Scheme;</li> <li>• Avoca River (Avoca) Flood Defence Scheme;</li> <li>• Low cost works in accordance with the OPW’s Minor Works Scheme;</li> <li>• Coastal Protection Projects, where funding allows;</li> </ul> and ensure that development proposals support, and do not impede or prevent, progression of such schemes.                                      |
| CPO 14.06        | To implement the ‘Guidelines on the Planning System and Flood Risk Management’.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| CPO 14.07        | To prepare new or update existing flood risk assessments and flood zone maps for all zoned lands within the County as part of the review process for Local Area Plans, zoning variations and Small Town Plans, where considered necessary.                                                                                                                                                                                                                                                                                                                                                                   |
| CPO 14.08        | The zoning of land that has been identified as being at a high or moderate probability of flooding (flood zones A or B) shall be in accordance with the requirements of the Flood Risk Management Guidelines and in particular the ‘Justification Test for Development Plans’.                                                                                                                                                                                                                                                                                                                               |
| <b>CPO 14.09</b> | Applications for new developments or significant alterations/extension to existing developments in an area at risk of flooding shall comply with the following: <ul style="list-style-type: none"> <li>• Follow the ‘sequential approach’ as set out in the Flood Risk Management Guidelines;</li> </ul>                                                                                                                                                                                                                                                                                                     |

| Objective | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
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|           | <ul style="list-style-type: none"> <li>An appropriately detailed flood risk / drainage impact assessment will be required with all planning applications, to ensure that the development itself is not at risk of flooding and the development does not increase the flood risk in the relevant catchment (both up and down stream of the application site), taking into account all sources of flooding;</li> <li>Restrict the types of development permitted in Flood Zone A and Flood Zone B to that which are 'appropriate' to each flood zone, as set out in Tables 3.1 and 3.2 of the Flood Risk Management Guidelines unless the 'plan making justification test' has been applied and passed;</li> <li>Where a site has been subject to and satisfied the 'Plan Making Justification Test' development will only be permitted where a proposal complies with the 'Justification Test for Development Management', as set out in Box 5.1 of the Guidelines.</li> <li>Flood Risk Assessments shall be in accordance with the requirements set out in the Guidelines and the SFRA.</li> </ul> <p>Where flood zone mapping does not indicate a risk of flooding but the Planning Authority is of the opinion that flood risk may arise or new information has come to light that may alter the flood designation of the land, an appropriate flood risk assessment will be required to be submitted by an applicant for planning permission and the sequential approach shall be applied as the 'Plan Making Justification Test' will not be satisfied.</p> |
| CPO 14.10 | To prohibit development in river flood plains or other areas known to provide natural attenuation for floodwaters except where the development can clearly be justified with the Flood Risk Management Guidelines 'Justification Test'.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| CPO 14.11 | To limit or break up large areas of hard surfacing in new developments and to require all surface car parks to integrate permeability measures such as permeable paving.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| CPO 14.12 | Excessive hard surfacing shall not be permitted for new, or extensions to, residential or commercial developments and all applications will be required to show that sustainable drainage techniques have been employed in the design of the development.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| CPO 14.13 | Ensure the implementation of Sustainable Urban Drainage Systems (SuDS) in accordance with the Wicklow County Council SuDS Policy to ensure surface water runoff is managed for maximum benefit. In particular to require proposed developments to meet the design criteria of each of the four pillars of SuDS design; Water Quality, Water Quantity, Amenity and Biodiversity.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| CPO 14.14 | Underground tanks and storage systems shall be permitted as a last resort only where it can be demonstrated the other more sustainable SuDS infrastructure measures are not feasible. In any case underground tanks and storage systems shall not be permitted under public open space, unless there is no other feasible alternative.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| CPO 14.15 | To promote the use of green infrastructure, such as swales and wetlands, where feasible as landscape features in new development to provide storm / surface runoff storage and reduce pollutants, as well as habitat, recreation and aesthetic functions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| CPO 14.16 | For developments adjacent to all watercourses or where it is necessary to maintain the ecological or environmental quality of the watercourse, any structures (including hard landscaping) must be set back from the edge of the watercourse in accordance with the guidelines in 'Planning for Watercourses in the Urban Environment' by Inland Fisheries Ireland.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

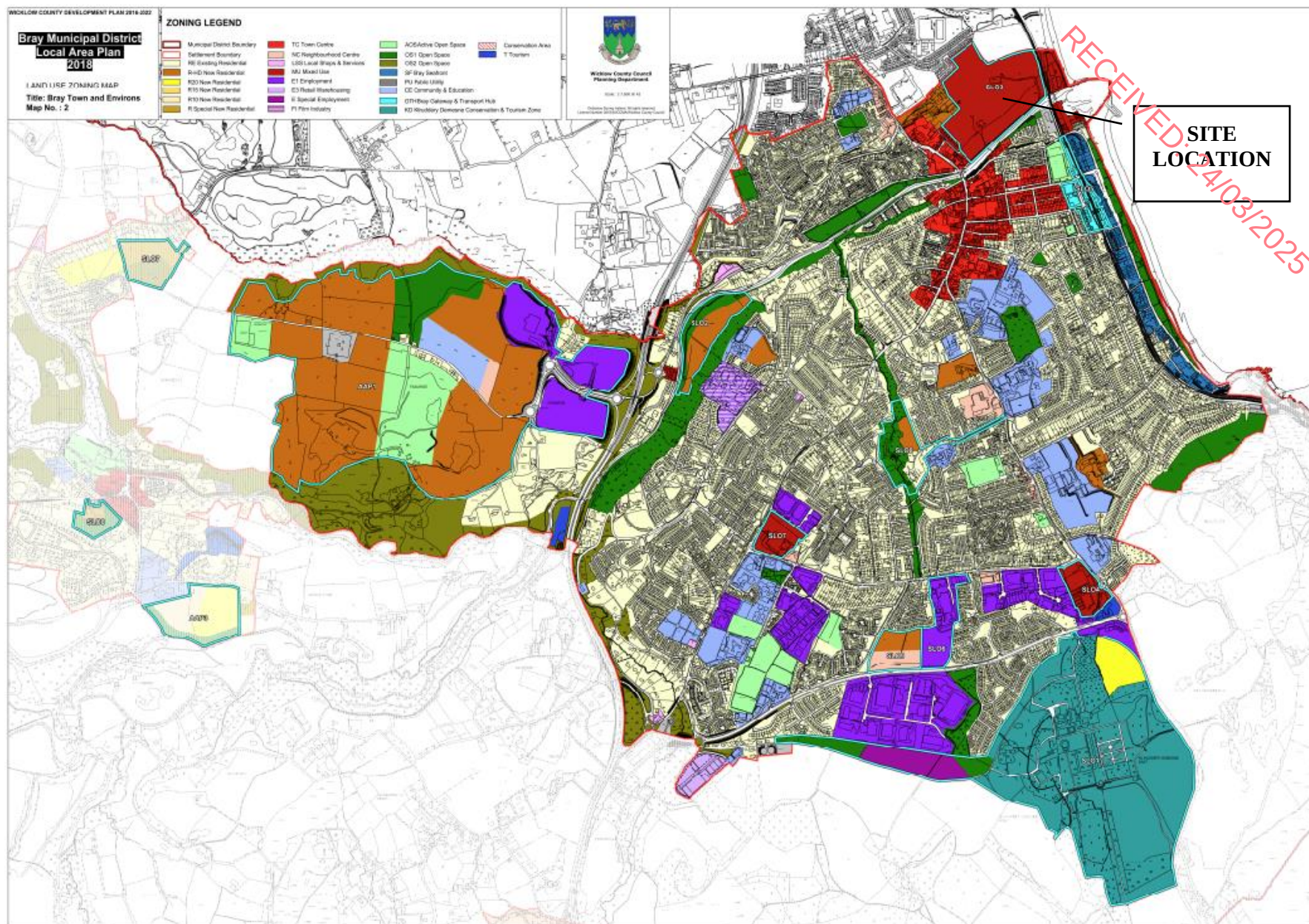
The SFRA which forms part of the Wicklow County Development Plan does not contain information on Bray. A detailed SFRA was developed as part of the Bray Municipality District Local Area Plan (LAP) 2018-2024 in accordance with the Guidelines utilising the most up to date information from the CFRAMS and other data sources such as the River Dargle Flood Defence Scheme. The Bray Municipality District LAP SFRA is therefore referred to for the purposes of this site specific FRA.

## 2.4 Bray Municipal District Local Area Plan 2018-2024

The Bray Municipal District Local Area Plan 2018-2024 was adopted by the Bray Town Council and details the specific land use plans for Bray Municipal District, including the proposed development site. This plan can be read in conjunction with the objectives and outcomes set out in the Wicklow County Development Plan 2022 – 2028. Figure 2-1 shows the site location within the context of the Bray Municipal District zoning map. The Sea Gardens Phase 2 site is designated for mixed use development under the zoning plan, in line with the development masterplan presented by Glenn Howells Architects.

The River Dargle Flood Defence Works is a €46 million project completed in 2017 along the southern border of the subject site. The aim of this work was to mitigate historic and future risks of fluvial flooding along the River Dargle through the widening and deepening of the river channel, and the construction of river walls and embankments over a 3 km stretch. The flood defence scheme was designed to withstand a 1 in 100 year (1%AEP) fluvial flood event (as well as ‘Hurricane Charlie’) and a 1 in 200 year (0.5%AEP) tidal flood event with climate change and freeboard allowances.

The completion of the flood defence works is in line with the Bray Local Area Plan and Wicklow County Development Plan which seek to utilise the Sea Gardens Phase 2 to further consolidate and develop the Bray town centre. A Justification Test for development plans was undertaken for Bray Town Centre, including the site. As stated in the Bray LAP, despite the subject site lying within Flood Zones A and B (see Figure 5-1), the subject site development is justified due to its essential function to facilitate regeneration and/or expansion of the centre of the urban settlement, its designation as previously developed and/or underutilised lands, its location within or adjoining the core of Bray town, and a lack of suitable alternative lands of lower flood risk for the particular use. Thus, the subject site passes the Justification Test for future development. This Development Management Justification Test is included in Section 6.4. The Flood Zones defined in Figure 5-1 generally correspond in a spatial sense with the indicative (i.e. non-modelling-based) maps proposed in the Bray LAP, but Arup have developed the extents shown using detailed hydraulic modelling and site-specific data not available at the time of the preparation of the LAP. Thus, the modelled flood extents that are used within this site-specific FRA are deemed more accurate than those of the Bray LAP.



**Figure 2-1 Bray Municipal District Local Zoning Plan and site location**

### 3. Flood Mechanisms and Historic Flooding at the Site

#### 3.1 Potential Flood Mechanism

The following potential sources of flood risk were assessed:

- Tidal/coastal flooding – Tidal flooding may occur during a surge event from the Irish Sea through Bray Harbour.
- Fluvial flooding (river or stream) – The risk of fluvial flooding at the site is due to the site proximity to the River Dargle. The site is located approximately 20 m from the river edge.
- Pluvial flooding/urban drainage – Pluvial flooding may occur when the capacity of the local surface water drainage network is exceeded during periods of intense rainfall.
- Groundwater flooding can occur during lengthy periods of heavy rainfall, typically during late winter/early spring when the groundwater table is already high. If the groundwater level rises above ground level, it can pond at local low points and cause periods of flooding.

#### 3.2 Historic Flood Data

Multiple extensive historical floods have occurred in Bray in 1905, 1931, 1965 and 1986. The 1986 flood is known colloquially as “Hurricane Charlie” and the recorded peak flow during the event was estimated at 300m<sup>3</sup>/s at Bray Harbour (Environmental Impact Assessment, Bray Flood Defence Scheme). Hurricane Charlie was an unprecedented event in nature and exceeded all previously recorded floods with the potential exception of the 1905 flood event. The River Dargle Flood Defence Scheme was completed in October 2017 in response to this event and consists of a network of flood walls, embankments, a by-pass channel, an upstream storage reservoir, and channel reconstruction to increase channel capacity and efficiency. The Inspectors Report for the River Dargle Flood Defence Scheme provides further information on previous flooding events, particularly the Hurricane Charlie event. It is understood there has been no recent flooding since the completion of the flood defence scheme.

#### 3.3 River Dargle Flood Defence Scheme

The River Dargle Flood Defence Scheme was designed to provide protection against the 1%AEP fluvial flood and the 0.5%AEP tidal flood and construction was completed in 2017. The original design of the flood defences was completed around 2007, when the Flood Studies Report (FSR) was the standard method of flood flow prediction. During this design assessment, it was determined that the Hurricane Charlie peak flow exceeded the calculated FSR peak flow for the 1%AEP event. As a precautionary approach, the Hurricane Charlie event was brought forward as the design event and the River Dargle Flood Defence Scheme was designed to the Hurricane Charlie event peak with an additional allowance for future adaptation to accommodate rising water levels due to climate change. The defences included approximately 2km of structural walls and 2km of embankments as well as a culvert which was constructed alongside the Fran O’Toole Bridge on Main Street to allow for increased flow capacity beneath the bridge during high flows.

According to information from the An Bord Pleanála Inspectors Report for the Scheme (Ref: 39YA0003/39XA0001), the scheme has been designed to include climate change allowances and freeboard in the tidally dominated reaches of 0.76m. In the fluvial dominated reaches, the scheme is not designed for climate change, but the walls are constructed to allow climate change adaptation (enhancement) in the future. A 0.5m freeboard is allowed in the fluvially dominated reaches.

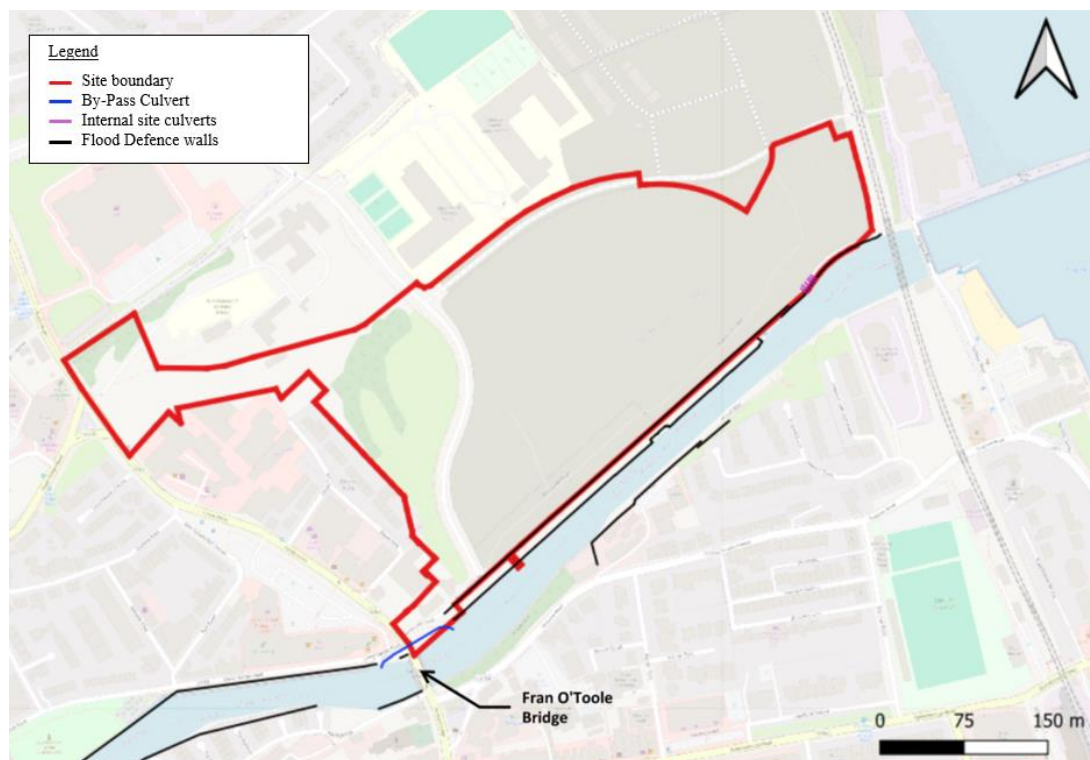
As the flood scheme construction continued, an additional six culverts with c. 1.35m diameter were built under Ravenswell Road, just upstream of the rail bridge as shown in Figure 3-1. All surface flow from the former golf club lands, located on the northside of the road, that does not infiltrate into the ground naturally flows towards Ravenswell Road and is discharged back to the river by the six culverts.

The intention of these culverts was that, in a flood event that exceeded the River Dargle Flood Relief Scheme Standard of Protection, flood water would have a way to travel through Little Bray, the golf club lands and eventually re-enter the river through these culverts.



**Figure 3-1 Culverts at Ravenswell Road (view from the right bank of the River Dargle)**

The site is therefore defended from flooding by the River Dargle by a series of floodwalls of varying heights on the northern and southern sides of the river, which bring the defence level between 8.78m AOD at La Vallee (2.3km upstream Bray Harbour) to 4.29m AOD at Bray Harbour. Along the site boundary, the defences range from 4.88m AOD at Dwyer Park to 4.3m AOD near the rail bridge. These levels include the 0.5m and 0.76m of freeboard and climate change included for river-dominated and tidally dominated sections, respectively. Cross sections of the River Dargle Flood Defence Scheme near the site are included in Appendix C. An overview of the location of flood defence walls, the by-pass culvert, and the Ravenswell Road culverts is shown in Figure 3-2.



**Figure 3-2 River Dargle flood defence scheme components in the vicinity of the site.**

### 3.4 Tidal Flood Risk

Two major flood studies have been carried out in recent years which provide predicted coastal flood extents and levels for Bray:

- Irish Coastal Protection Strategy Study (ICPSS);
- Irish Coastal Wave and Water Level Modelling Study (ICWWS) Phase 1, 2018.

#### 3.4.1 Irish Coastal Protection Strategy Study (ICPSS)

ICPSS data can be accessed through the Office of Public Works (OPW) website. The ICPSS was carried out from 2003-2004. The study produced maps of predicted tidal flood extents and levels along the coast.

The 0.5%AEP tidal flood extents for Bray Harbour are shown in Figure 3-3. The site is located within the extents of the 0.5%AEP event.

Flood levels were extracted for the 0.5% and 0.1%AEP (representing a 1 in 200 year and 1 in 1000-year event respectively). These data are reported in Table 3-1 and were extracted from ICPSS flood map SE/RA/EXT/2 at Node point 6, located approximately 650 m east of the site location.

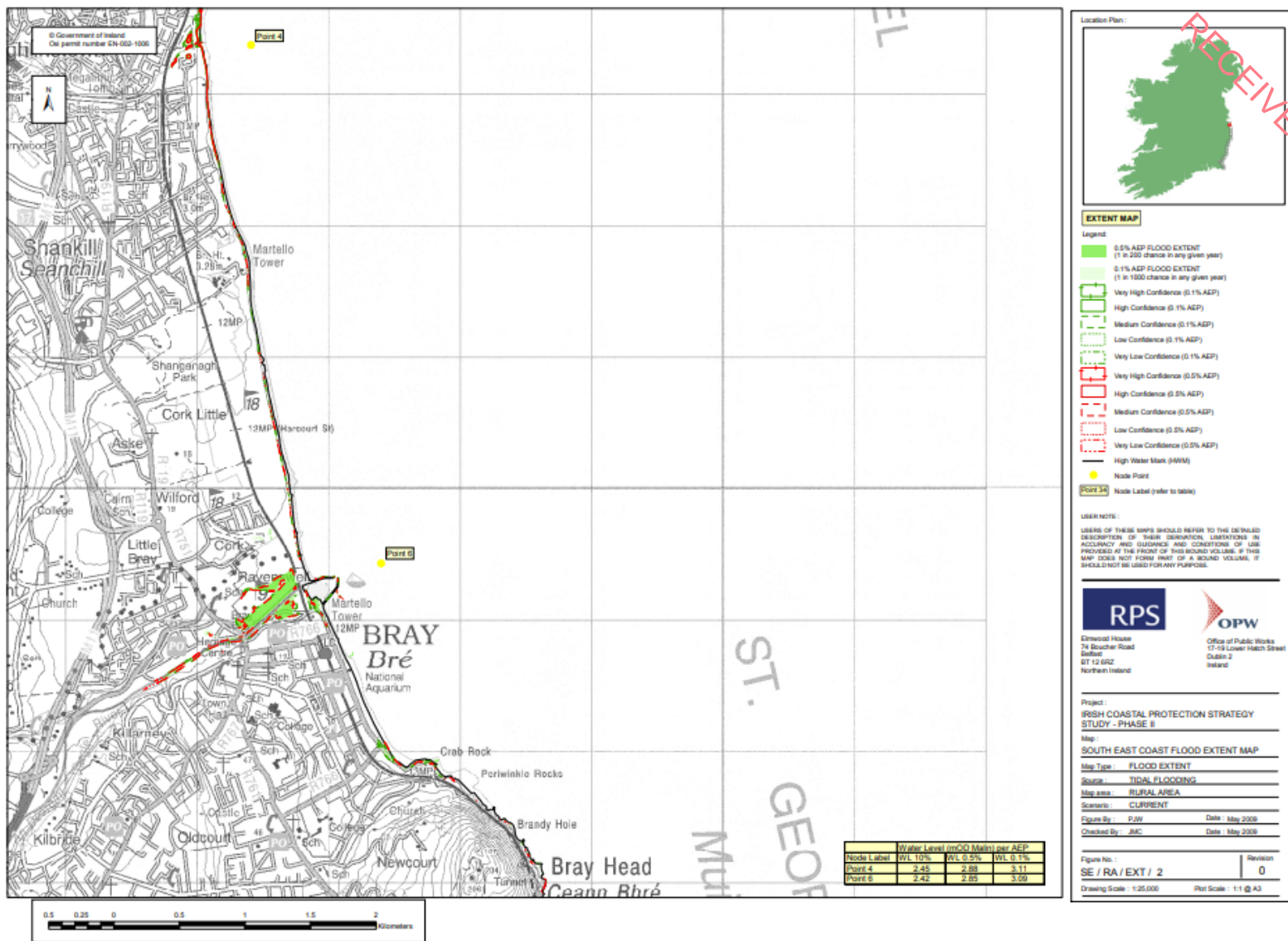


Figure 3-3 ICPSS 0.5% AEP floodplain extents (SE/RA/EXT/)

**Table 3-1 ICPSS Tidal Flood Return Levels**

| Return Period            | Flood Level (m AOD) |
|--------------------------|---------------------|
| 0.5%AEP (1 in 200 year)  | 2.85                |
| 0.1%AEP (1 in 1000 year) | 3.09                |

### 3.4.2 Irish Coastal Wave and Water Level Modelling Study (ICWWS) Phase 1, 2018

The Irish Coastal Wave and Water Level Modelling Study (ICWWS) Phase 1 was undertaken in 2018 as an update to the ICPSS, associated with astronomical tide, storm surge and seiche/local wind set-up allowance, for the coast of Ireland. The ICWWS outputs supersede the previous ICPSS outputs.

The closest node to Bray Harbour is SE6, located approximately 650 m east of the site location.

Return levels are reported for the 0.5%AEP and 0.1%AEP events in Table 3-2. These levels are higher than the ICPSS predictions and will be taken forward as coastal hydrological inputs.

**Table 3-2 Tidal Flood Levels for SE6 (ICWWS)**

| Return Period            | Flood Level (m OD) |
|--------------------------|--------------------|
| 0.5%AEP (1 in 200 year)  | 3.17               |
| 0.1%AEP (1 in 1000 year) | 3.39               |

The above levels have been mapped as part of the National Coastal Flood Hazard Mapping, which is a high level study that ignores the presence of defences. When the River Dargle flood defences are ignored, the site is at high risk of tidal flooding during the 0.5%AEP. However, since the construction of the River Dargle Flood Defence Scheme, the site is protected from the 0.5%AEP. As mentioned above, the flood defence walls along the southern part of the site are at a minimum level of 4.29m AOD, and as such provide protection for the 0.1%AEP event with 0.9m freeboard on top of the ICWWS levels. The site is therefore defended from such an event.

## 3.5 Fluvial Flood Risk

Fluvial flooding occurs when rivers and streams break their banks, and water flows out onto the adjacent low-lying areas. The site is adjacent to the River Dargle, which has historically caused fluvial flooding to the site.

There are no OPW CFRAMS fluvial maps for Bray. The National Indicative Fluvial Maps show the site to be at high risk of fluvial flooding. These maps ignore the presence of flood defences and are very high level.

In the absence of reliable and detailed flood mapping of the current extents, Arup conducted hydrological analysis and hydraulic modelling of the River Dargle and surrounding site location to assess both the fluvial and tidal risk of flooding to the area. Section 4 provides a further detailed account of this modelling exercise.

## 3.6 River Dargle Public Transportation Bridge

A proposed bridge has been designed and is awaiting construction near the mouth of the river at Bray Harbour. It consists of a single span bridge and a number of supporting structures to tie into existing pedestrian and cycleway infrastructure. The soffit level of the bridge has been designed well above the 1%AEP design flood level as determined by the River Dargle Flood Defence Scheme which states design flood levels ranging from 3.61m AOD to 3.65m AOD in the vicinity of the bridge. The proposed soffit is set to 4.925 m AOD at its lowest level; therefore, the bridge is not considered to have an impact on flooding.

## 3.7 Combined Tidal and Fluvial Flood Risk

In accordance with the Greater Dublin Drainage Study, river reaches should be designed for the 1-in-100-year flood and coastal areas for the 1-in-200-year flood. Inter-tidal areas should meet both criteria.

The Sea Gardens Phase 2 site sits within this intertidal area and therefore is an area at risk from tidal/fluvial flooding. Thus, a joint probability analysis was required and is detailed in Section 4.1.3.

### 3.8 Pluvial Flooding

Pluvial flooding occurs when extreme rainfall overwhelms drainage systems or soil infiltration capacity, causing excess rainwater to pond above ground at low points in the topography. The risk of pluvial flooding has been assessed by the flood maps produced as part of the Preliminary Flood Risk Assessment (PFRA) by the Office of Public Works (OPW). The PFRA was not a detailed assessment of flood risk but rather a broad assessment, based on available and readily deliverable information to identify areas where there is genuine cause for concern about a risk and impact of flooding that may require further development. As such, the pluvial PFRA maps are **only indicative** and may indicate depressions in topography that water could pond in or significant overland flow paths.

As shown in Figure 3-4, the red outline shows the approximate location of the site. The orange shade demonstrates pluvial flood risk; there are no pluvial extents located within the site boundary. The blue and green outlines are fluvial and tidal extents, respectively, that have been superseded by the other modelling extents. They should not be considered in regard to fluvial or tidal risk.

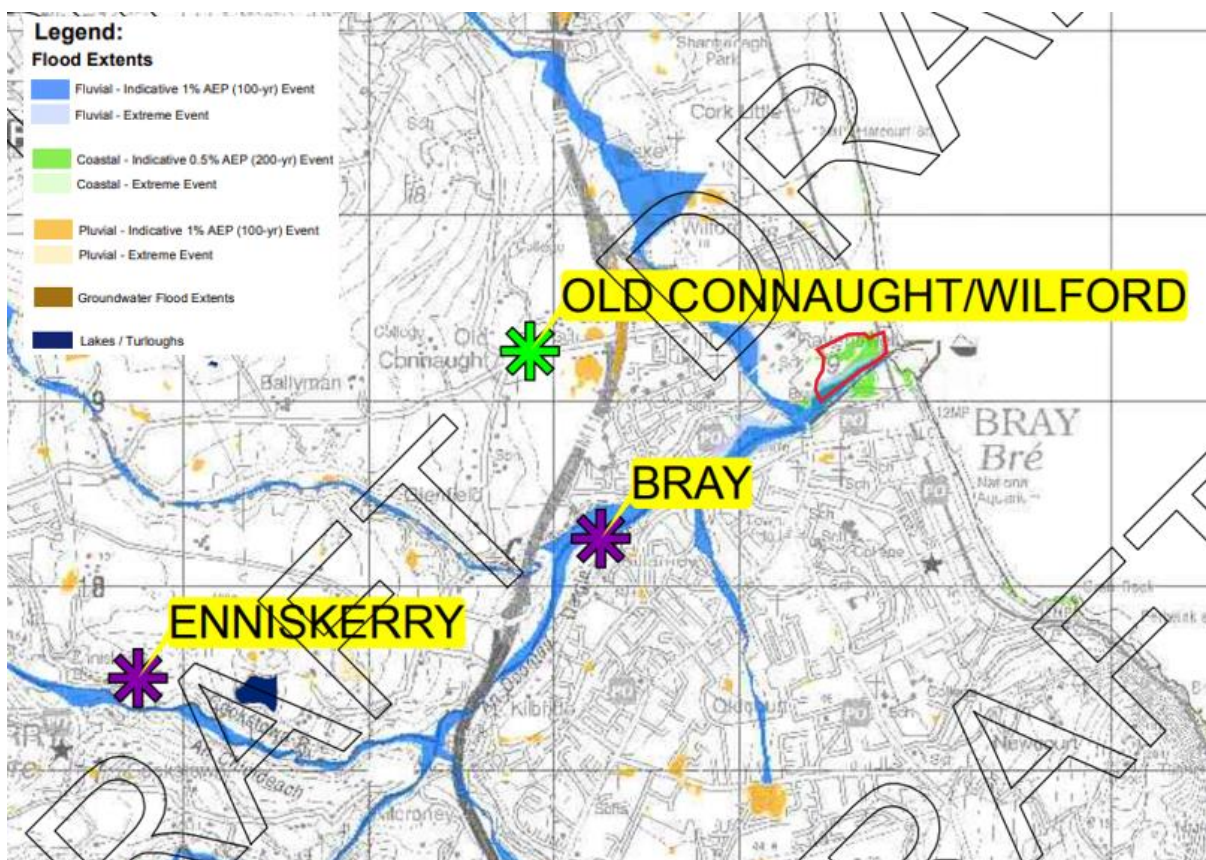


Figure 3-4 PFRA extract of site location showing pluvial flood risk (in orange)

The site topography indicates depressions at the southern part of the site, with the River Dargle flood defences along Ravenswell road providing an obstruction to any surface water flow from re-entering the river. The introduction of the 6 culverts under Ravenswell Road enables discharge of surface water to the river; however, water ponding might be observed for a short time within the low-lying areas of the site. No development is proposed in the low-lying area behind the flood walls. The risk of pluvial flooding to the development is therefore considered low.

### 3.9 Groundwater Flooding

Groundwater flooding can occur during lengthy periods of heavy rainfall, typically during late winter/early spring when the groundwater table is already high. If the groundwater level rises above surface level, it can pond at local points and cause flooding. Groundwater flooding tends to be very local and results from the interaction of site-specific factors such as local geology and tidal variations.

In Ireland, groundwater flooding is most commonly related to turloughs in the karstic limestone areas prevalent in particular in the west of Ireland.

According to the Geological Survey of Ireland (GSI) groundwater data viewer (<https://www.arcgis.com/apps/webappviewer>), there are no historic groundwater flood events recorded on the site and groundwater flooding is not expected.

To assess the risk of groundwater flooding to the development, the GSI groundwater flooding data maps and groundwater resources (aquifers) maps were reviewed (GSI, 2019).

Groundwater flooding maps do not show any extent of groundwater flooding within this development.

Groundwater resources (aquifers) maps show the potential of areas in Ireland to provide water supply and this information can be used as an indication of the risk of groundwater flooding. Groundwater flooding is generally associated with regionally important aquifers, but not locally important aquifers or poor aquifers.

In the locally important aquifers or poor aquifers, the groundwater levels are generally relatively shallow (often following topography) and bedrock has a limited capacity to accept more rainwater falling on the land. In this geology, once the bedrock aquifer is “full”, the excess rainfall flows across the ground surface as water runoff. This is not considered groundwater flooding, but purely surface water runoff.

In regionally important aquifers, the network of fractures and faults which can carry the groundwater is much bigger and can carry water at greater distance. The groundwater levels may not follow the topography and they show greater fluctuation. When water falls on the ground surface and enters into the bedrock, the bedrock has more open fractures and faults to accept the water. This causes the groundwater levels to rise across an area. Where there is a depression or a low lying area, the groundwater can emerge and cause flooding.

Since the proposed development is not underlain by any regionally important aquifer, only locally important aquifers, and given that the GSI groundwater flood maps do not indicate any groundwater flood extents at the site, it is considered that the risk of groundwater flooding is low.

### **3.10 Summary of Initial Flood Risk Assessment**

The above Initial Flood Risk Assessment indicates that the proposed site is potentially susceptible to fluvial and tidal flooding events. Due to insufficient quantitative information, it is necessary to undertake a more detailed and robust assessment of the potential for flooding in the vicinity of the proposed development site. A summary of the risk assessed thus far is below:

- The predicted 0.5%AEP tidal ICWWS level near the site is 3.17 m AOD. This flood level would cause risk of flooding to the site, if defences were not in place.
- The River Dargle Flood Defence Scheme, which borders the site at the south, was designed to independently withstand a 1%AEP fluvial event, Hurricane Charlie and a 0.5%AEP tidal event. The site is defended from both of the above events.
- The risk of pluvial flooding at the areas where development is proposed is low. Some ponding might occur to low lying lands behind the River Dargle defences.
- The risk of groundwater flooding is low.

## 4. Detailed Flood Risk Assessment and Model Construction

A hydraulic model has been developed in the context of the proposed development at the Sea Gardens Phase 2 site and surrounding area. The model has been designed using existing site conditions and surveys.

The hydraulic model is underpinned by hydrological estimates of fluvial flows and tidal levels as informed by the ICWWS study and joint probability considerations. The hydrological estimation and hydraulic modelling are discussed in detail in the following sections and Appendix D.

### 4.1 Hydrology

#### 4.1.1 Fluvial Flow Estimation

The 1% AEP design flow rate was determined using the OPW Flood Studies Update (FSU) methodology. This method is accepted as the most up to date and accurate method to estimate flows for catchments larger than 25km<sup>2</sup> and as such has been considered the most applicable method for the Dargle catchment. The 1%AEP flow was estimated to be 89.8 m<sup>3</sup>/s at the upstream boundary of the model. A detailed description of the calculations of this value can be found in Appendix D.

Several other reports have been completed on the River Dargle area which have informed design decisions around development of the area. Principally, the historical flood resulting from the 1986 storm on the 25<sup>th</sup> August to 26<sup>th</sup> August has been considered a significant hydrological event in the collective memory of residents of the area. The Environmental Impact Statement (EIS) prepared for the River Dargle Flood Defence Scheme states the following about the event:

*Over a 24 hour duration of the storm from 9:00am on the 25<sup>th</sup> of August to 9:00am on the 26<sup>th</sup> of August, recorded rainfall in the Dargle catchment ranged from values in excess of 80mm in low lying areas to at least 250mm in the highest areas. Recorded rainfall in the middle catchment, which comprises a significant proportion of the total catchment area, varied from 150mm to 200mm. At Bray Garda Station and at Glenasmole, which is just outside the Dargle catchment, rainfalls of 8mm and 165mm respectively were recorded during this 24-hour period. Rainfalls of this magnitude in Bray have an estimated return period approaching one hundred years and the recorded Glenasmole rainfall has an estimated return period in excess of 100 years. If it is considered, which is generally the case, that the 'Hurricane Charlie' flow of 285m<sup>3</sup>/s represented the total 100-year flow in the River Dargle catchment, then, direct applications of the FSR methodologies underestimate the design flow to varying degrees. Correlation does exist however, between the estimated 'Hurricane Charlie' flow and that determined using the catchment characteristic methodology when modified from observed data from the River Dodder. For the purposes of this EIS, a flow of 285m<sup>3</sup>/s was taken to represent the 1986 100-year flow to an outfall at the upstream end of the river reach under investigation.*

The River Dargle Flood Defence Scheme therefore used the historical value of 285m<sup>3</sup>/s as a precautionary approach in building the flood defences and the subsequent River Dargle Flood Defence Physical Model Study completed by HR Wallingford concluded the flood defences were capable of containing the flow of the River Dargle within the main river channel for the 100-year return period peak river flow (1%AEP) and MHWS tide. These design choices are in line with the design standard in 2007 for the scheme to provide protection for the 1%AEP event for fluvial flooding and the 0.5%AEP event for tidal/coastal flooding.

An FRA was completed by Atkins for the adjacent Coastal Quarter development (September 2022), for which IE Consulting undertook hydrological analysis and hydraulic modelling. IE Consulting used the FSU methodology as well to estimate the extreme flows, resulting in a 1%AEP flow of 78.9m<sup>3</sup>/s. IE Consulting decided to use the Hurricane Charlie event as the 1%AEP event, as the values calculated using the FSU methodology were significantly lower than what was used during the design of the River Dargle Flood Defence Scheme.

The FRA considered that the Defence Scheme was designed based on a historical event, and as such the flows were re-estimated to adjust the Hurricane Charlie event to the 1%AEP event using the Flood Studies Report (1975) national growth curve (the standard method of flood flow prediction in Ireland in 2007 when the flood defences were constructed).

Arup has used several hydrological methods to estimate the 1%AEP event, such as FSU, JH124 and FSR, with none of the methods resulting to as high flows as the Hurricane Charlie event. The FSU method is believed to be the most relevant and up to date hydrological method for the River Dargle catchment. The FSU estimate of 89.8m<sup>3</sup>/s is therefore adopted as the 1% AEP event. However, considering that Hurricane Charlie (HC) is in the living memory of the residents of Bray, it was decided that the assessment will include the HC event to calibrate/validate the model as well as ensure flood protection levels of the site are set at or above the event. The approach was presented and discussed with Wicklow County Council during a meeting on the 6<sup>th</sup> December 2023, who were in general agreement with the above approach.

Therefore, scenarios were run with both the 1%AEP event flow determined by FSU as the design flood event and the historical event, herein referred to as the Hurricane Charlie (HC) event. The upstream inflow to the model was adjusted accordingly to result in a peak flow of 300m<sup>3</sup>/s at Bray Harbour.

An exceedance flood event was included in the assessment. The exceedance event serves as an event during which, should a breach or overtopping of the flood defences occur, the natural flow paths through the low southern parts of the site would be maintained, ensuring natural drainage of the Little Bray and Dwyer Park areas. Additionally, this fluvial event allowed a demonstration of the activation of the culverts at the downstream end of the site by which site levels are landscaped to facilitate the removal of water in the unlikely event of a breach or overtopping. The exceedance event was set to a peak flow of 380m<sup>3</sup>/s.

A summary of fluvial hydrograph peaks used in the analysis is shown in Table 4-1. These flows represent the current climate scenario.

**Table 4-1 Peak Fluvial Flow Scenarios**

| Description                  | Hydrograph Peak at Upstream Boundary (m <sup>3</sup> /s)            |
|------------------------------|---------------------------------------------------------------------|
| 50% AEP (1 in 2-year event)  | 49.31                                                               |
| 1% AEP (1 in 100-year event) | 89.84                                                               |
| Hurricane Charlie (HC) event | 293.89 (adjusted to result in 300m <sup>3</sup> /s at Bray Harbour) |
| Exceedance event             | 380.00                                                              |

#### 4.1.2 Tidal Flood Levels

The tidal flood levels were determined utilising the ICWWS Phase 1 study. For the 0.5%AEP event, the study has estimated the extreme water level to be 3.17m AOD at point SE6 closest to Bray Harbour.

It is worth noting that these levels are less than the 0.5%AEP tidal levels adapted in the River Dargle Flood Defence Physical Model Study which were set to a design tide level of 3.50 m AOD. This lower value was then determined after analysis of historical tide data recorded at Dublin Port and additional allowances for rising sea level impacts. At the time of the Dargle Flood Defence study, neither the ICPSS or ICWWS had been published and the Dublin Port gauge represented the closest historical tidal gauge.

A summary of the peak tidal flood levels used is shown in Table 4-2. Peak values were obtained from the ICWWS Phase 1 study, and the Mean High Water Spring (MHWS) tide was obtained from the Irish Marine Institute Dublin Port gauge. Peak values were fit to an hourly tidal curve obtained from the Marine Institute NE Atlantic operational model at Bray Harbour to model tidal stage values during the model run.

**Table 4-2 Tidal Levels**

| Description                   | Tidal Level (m AOD) |
|-------------------------------|---------------------|
| Mean High Water Spring (MHWS) | 1.69                |
| 50%AEP (1 in 2-year tide)     | 2.55                |

| Description                   | Tidal Level (m AOD) |
|-------------------------------|---------------------|
| 0.5%AEP (1 in 200-year tide)  | 3.17                |
| 0.1%AEP (1 in 1000-year tide) | 3.39                |

#### 4.1.3 Joint probabilities

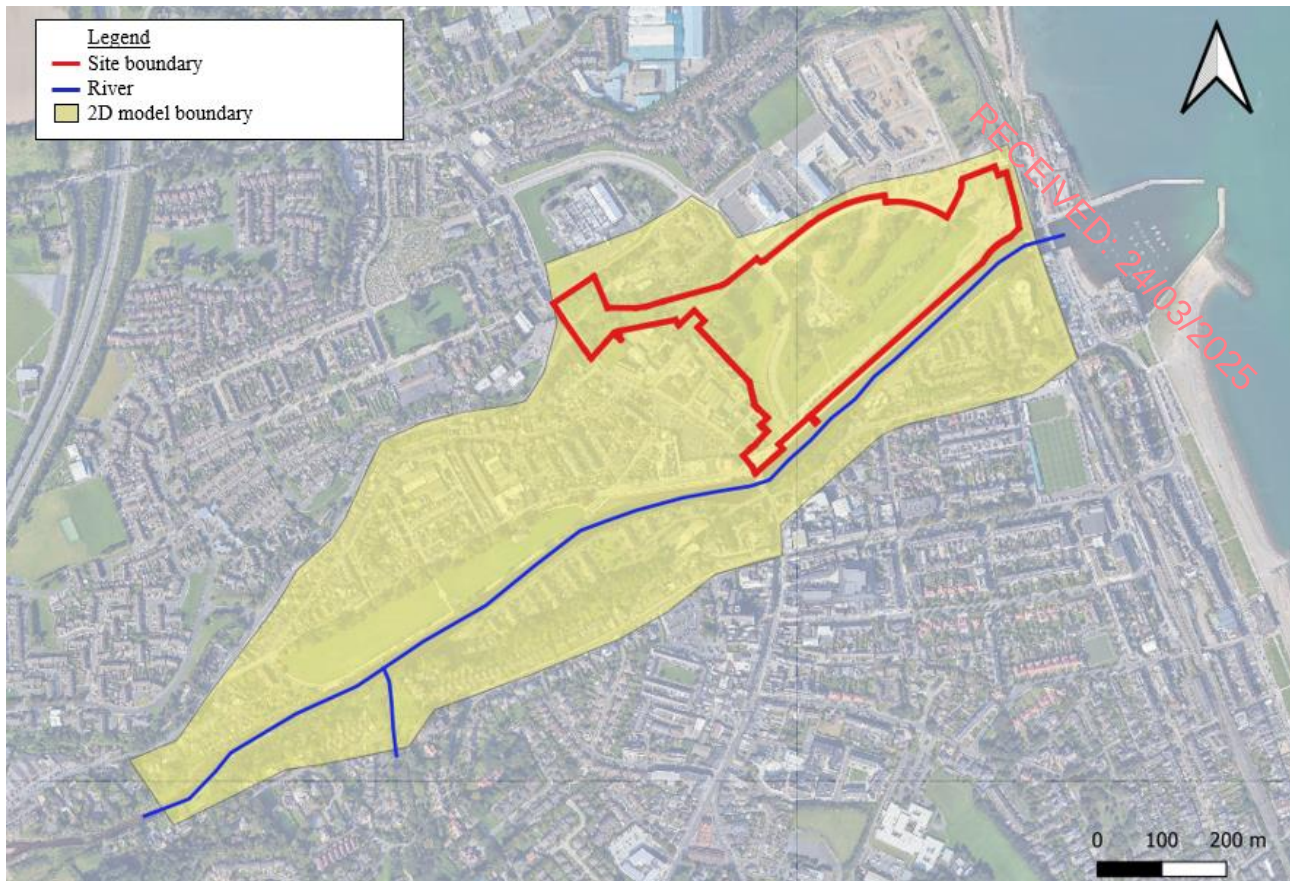
The following joint probability scenarios were selected to understand the flood extents for the fluvially dominant, tidally dominant, Hurricane Charlie, and exceedance flood events. The joint probabilities selected are in line with the recommendations given by the OPW Eastern CFRAMS report. Fluvially dominant events are run with the 50%AEP tidal event while the tidally dominant events are run with the 50%AEP fluvial event. This approach is considered suitable for this assessment. To define Flood Zone B, the 0.1%AEP tidal event was run with the 50%AEP fluvial event after it was determined the tidal event dominated the extents in proximity of the site. The Hurricane Charlie event was run with the Mean High Water Spring tidal curve (MHWS) as per the HR Wallingford Physical Model Study conducted during the development of the River Dargle Flood Defence Scheme. The Study notes that the Hurricane Charlie + MHWS joint probability event should not overtop the defences. The exceedance event was run with the MHWS tidal curve to test the impact of an event of higher magnitude than Hurricane Charlie.

**Table 4-3 Hydrological scenarios tested**

| Scenario          | Fluvial                                                                                      | Tidal                          |
|-------------------|----------------------------------------------------------------------------------------------|--------------------------------|
| Q100 + T2         | 1%AEP (1 in 100-year event)                                                                  | 50%AEP (1 in 2-year event)     |
| Q2 + T200         | 50%AEP (1 in 2-year return event)                                                            | 0.5%AEP (1 in 200-year event)  |
| Q2 + T1000        | 50%AEP (1 in 2-year return event)                                                            | 0.1%AEP (1 in 1000-year event) |
| HC + MHWS         | Historical Hurricane Charlie Event, where flow at Bray Harbour = 300 m <sup>3</sup> /s       | MHWS                           |
| Exceedance + MHWS | Exceedance value determined through iterative process to overtop walls and activate culverts | MHWS                           |

## 4.2 Hydraulic Model

The hydraulic model for the site and the River Dargle consists of a 2D model of the river and adjacent lands in HEC-RAS 6.3.1. The length of the river model is approximately 1715 m and extends from just downstream of the intersection of Hazelwood Road and Upper Dargle Road to immediately downstream of the Strand Road Bridge at Bray Harbour. The model includes the Swan River, a minor tributary joining the River Dargle 1.3km upstream from Bray Harbour along the Dargle's south bank. Figure 4-1 shows a depiction of the site boundary and the 2D model boundary.



**Figure 4-1 2D model boundary and site boundary**

The 2D model was developed using the below information:

River channel:

- Topographic survey by Murphy Surveys, 2020 for the Coastal Quarter development;
- 22 river cross sections, 6 bridge upstream/downstream face cross sections, and 1 culvert survey from Murphy Surveys, taken in 2020 (downstream section for Coastal Quarter development) and 2023 (upstream section).

Floodplain:

- LiDAR survey undertaken in 2023 and obtained from Murphy Surveys;
- OSI data obtained for Manning values, 2023.

Additional information on the hydraulic model inputs can be found in Appendix D.

#### 4.2.1 Undefended and defended models

The Planning System and Flood Risk Management – Guidelines for Planning Authorities, DEHLG, 2009, states in section 2.25:

*“The provision of flood protection measures in appropriate locations, such as in or adjacent to town centres, can significantly reduce flood risk. However, the presence of flood protection structures should be ignored in determining flood zones. This is because areas protected by flood defences still carry a residual risk of flooding from overtopping or breach of defences and the fact that there may be no guarantee that the defences will be maintained in perpetuity. The likelihood and extent of this residual risk needs to be considered, together with the potential impact on proposed uses, at both development plan and development management stages, as well as in emergency planning and applying the other requirements of these Guidelines in chapter 3. In particular, the finished floor levels within protected zones will need to take account of both urban design considerations and the residual risk remaining.”*

Based on the above, the **undefended model** was developed to exclude the River Dargle Flood Defences as constructed. This informs the flood zoning of the site as well as setting the flood protection levels at the site, and is discussed further in Section 4.3.

The baseline model for the purposes of comparing the impact of the development is considered to be a **defended model** that represents the current state of the river, with the River Dargle Flood Defences in place (including the flood defence walls and embankments, by-pass culvert along the Fran O'Toole bridge and 6 x 1.35m diameter culverts along Ravenswell Road).

#### 4.2.2 Proposed development model

The **proposed development model** is based on the **baseline defended model** and utilises the terrain modification functions within HEC-RAS to model the proposed changes to the site following construction of the new housing development. A site layout with ground levels was provided by Glenn Howells and BSLA architects as the basis for the terrain modifications. The layout is included in Appendix A. The design of the layout and changes in levels within the site has been an iterative process between architecture and river modelling to ensure reduced impact in terms of flooding. The levels of all residential buildings are proposed to be raised above the flood protection level of 3.5m AOD. The derivation of this level is explained further in Section 5.

As the site is defended from the tidal, fluvial and Hurricane Charlie events, only the exceedance event is tested on the **proposed development model**. The exceedance event run is used to assess the impact of the proposed development in altering the existing flow path from Little Bray and Dwyer Park through the lower part of the site to the 6 culverts and back in the river. As such, the defended proposed development model exceedance run is compared to the defended no proposals model exceedance run.

A summary of all the runs undertaken is shown in Table 4-4.

**Table 4-4 Summary of model runs and scenarios**

| Scenario          | Models | Undefended model | Baseline defended model | Proposed development model | Purpose                                                                                   |
|-------------------|--------|------------------|-------------------------|----------------------------|-------------------------------------------------------------------------------------------|
| Q100 + T2         |        | Yes              | Yes                     | No                         | Define Flood Zone A and set flood protection levels at site                               |
| Q2 + T200         |        | Yes              | Yes                     | No                         | Define Flood Zone A and set flood protection levels at site                               |
| Q2 + T1000        |        | Yes              | No                      | No                         | Define Flood Zone B, following confirmation of tidal dominance when defining Flood Zone A |
| HC + MHWS         |        | Yes              | Yes                     | No                         | Test model against HR Wallingford model                                                   |
| Exceedance + MHWS |        | No               | Yes                     | Yes                        | Assess impact to adjacent sites                                                           |

### 4.3 Consultations with Wicklow County Council (WCC)

Two meetings were held with Wicklow County Council flood risk engineers (3<sup>rd</sup> August 2023 and 6<sup>th</sup> December 2023) to discuss the flood risk management approach for the site and the modelling requirements. The meeting minutes and summary notes from the meetings can be found in Appendix B. The overall summary from the two meetings is included below.

- Arup completed hydrological estimation of the 1%AEP flood event and have found it to be lower than the Hurricane Charlie (HC) event. Several hydrological methods were used to estimate the 1%AEP flood event and compared; the FSU method was chosen as the most appropriate for the Dargle catchment and the purposes of the FRA. It was decided that the HC event will also be considered as part of the assessment as an event that occurred in living memory and flood protection levels for the site will be set at or above the event. This was presented to the WCC on the 6<sup>th</sup> December 2023 who accepted the approach.

- The Arup modelling of the HC event was compared to the HR Wallingford Physical model of the Flood Relief scheme. Key differences in model set up meant that a direct comparison of levels was not possible.

For example, the modelling extents of the Arup model does not include the Slang, an area further upstream of the site, where overtopping happened during HC. This was deemed unnecessary for the purposes of the study. Furthermore, the blockages at the Fran O'Toole bridge during the HC event are not included in the Arup model and finally, changes have occurred in the tidal flood levels used between the two models.

- WCC agreed that, while during the HC event the river overtopped at The Slang, causing flooding to Little Bray, the flow paths shown in the Arup model in Little Bray were modelled correctly around the SuperValu parking lot, down Castle Street and through Dwyer Park into the lowlands within the site boundary. This provided confidence to WCC in the Arup model.
- It was agreed that it is necessary to ensure floodwaters entering Little Bray can leave Little Bray through Dwyer Park and the lowland areas of the site and re-enter the river through the culverts under Ravenswell Road, constructed as part of the Flood Relief Scheme for this purpose. This is investigated further in this FRA through exceedance modelling.
- WCC also requested that any proposed roads which run south to north from the Ravenswell car park and replacing the access road to the Ravenswell Primary School will maintain lower levels established during the construction of the access road so as to prevent interference of flows from Dwyer Park.
- A drainage channel on the dry side of the Dargle River flood defences helps to drain water from the site during a rainfall event, as with the introduction of the defences the natural flow path to the river was intercepted. This should be preserved during construction.
- An external pedestrian escape to higher ground should be provided for the apartment blocks (part of the future Phase 3 of the development).

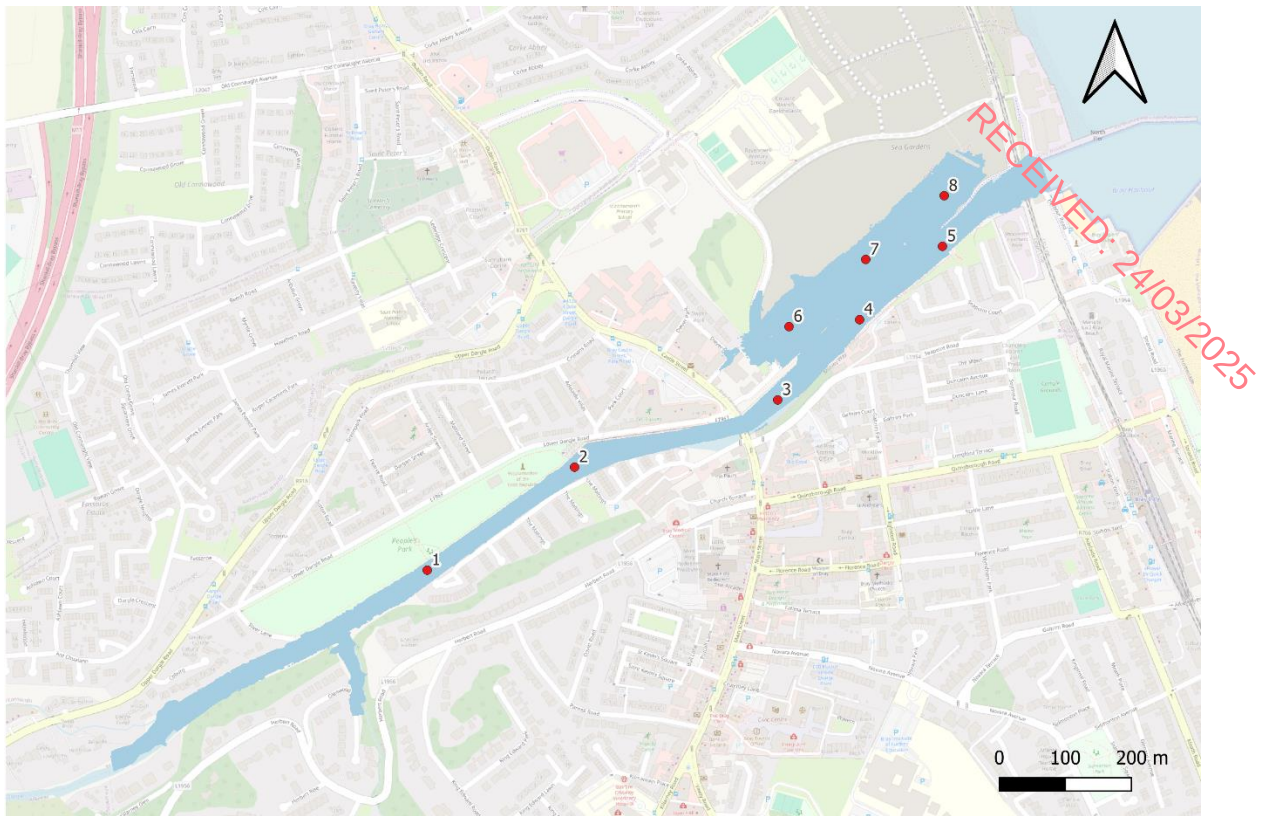
#### 4.4 Model Results – undefended and defended models

The flood extents are shown on the following plans for the undeveloped site. The flood extents are presented by scenario (flood event) to facilitate direct comparison between the undefended and defended scenarios. Tables below the flood extent maps show the water surface elevation at the specified points.

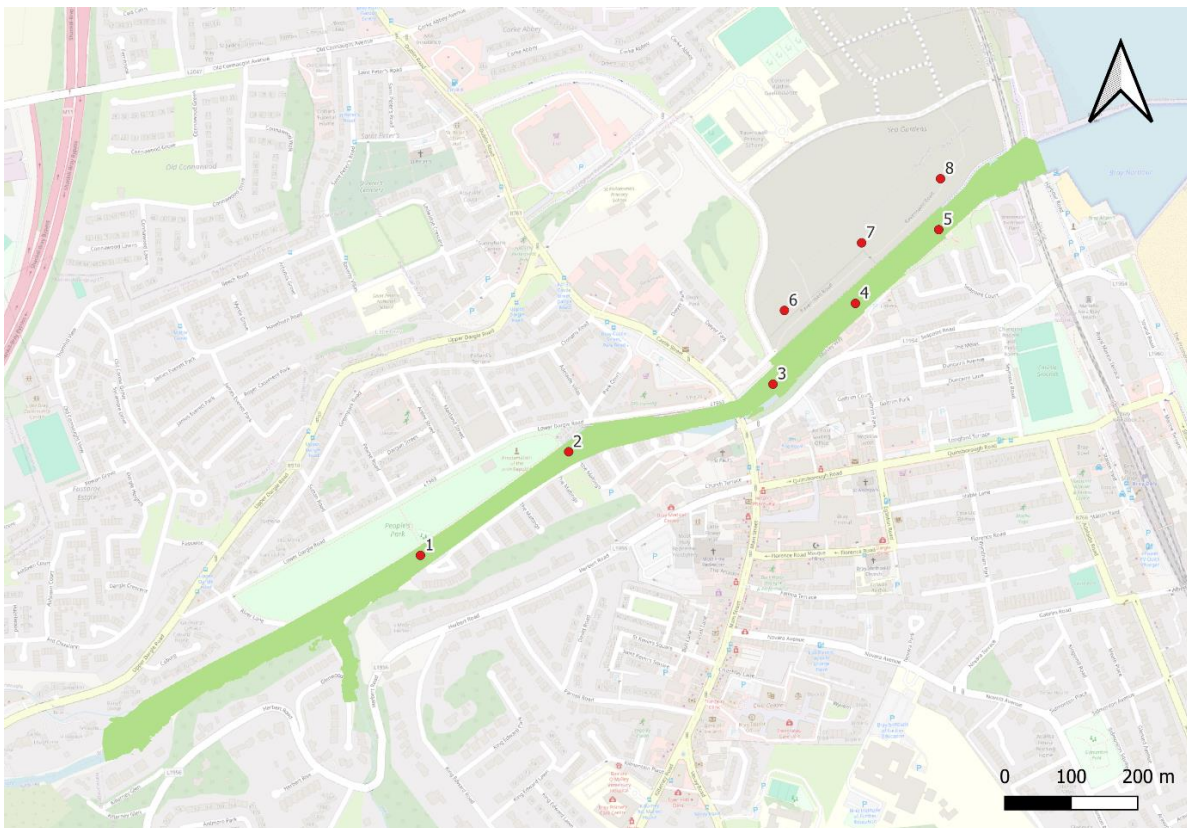
##### 4.4.1 1%AEP (1 in 100-year) Fluvial Event + 50%AEP (1 in 2 year) Tidal Event

Figure 4-2 below shows the undefended flood extents for the 1%AEP fluvial event coinciding with a 50%AEP tidal event, referred to as the Q100+T2 event. Corresponding flood levels in the flood plain region and channel are also shown below.

Figure 4-3 provides the results of the defended flood model with the River Dargle Flood Defences in place. It can be seen that the fluvially dominant flood is contained in channel for the defended condition. Table 4-5 shows the in-channel flood levels rise slightly compared to the undefended condition due to the increased volume of water now diverted from behind the defences to the river channel. The construction of the by-pass culvert beside the existing Fran O'Toole bridge as a part of the River Dargle Flood Defence Scheme results in a localised area of reduced water levels at Point 2, as a result of the introduction of the culvert and improvement in flow conveyance than in the undefended model.



**Figure 4-2 Undefended model Q100+T2**



**Figure 4-3 Baseline defended model Q100+T2**

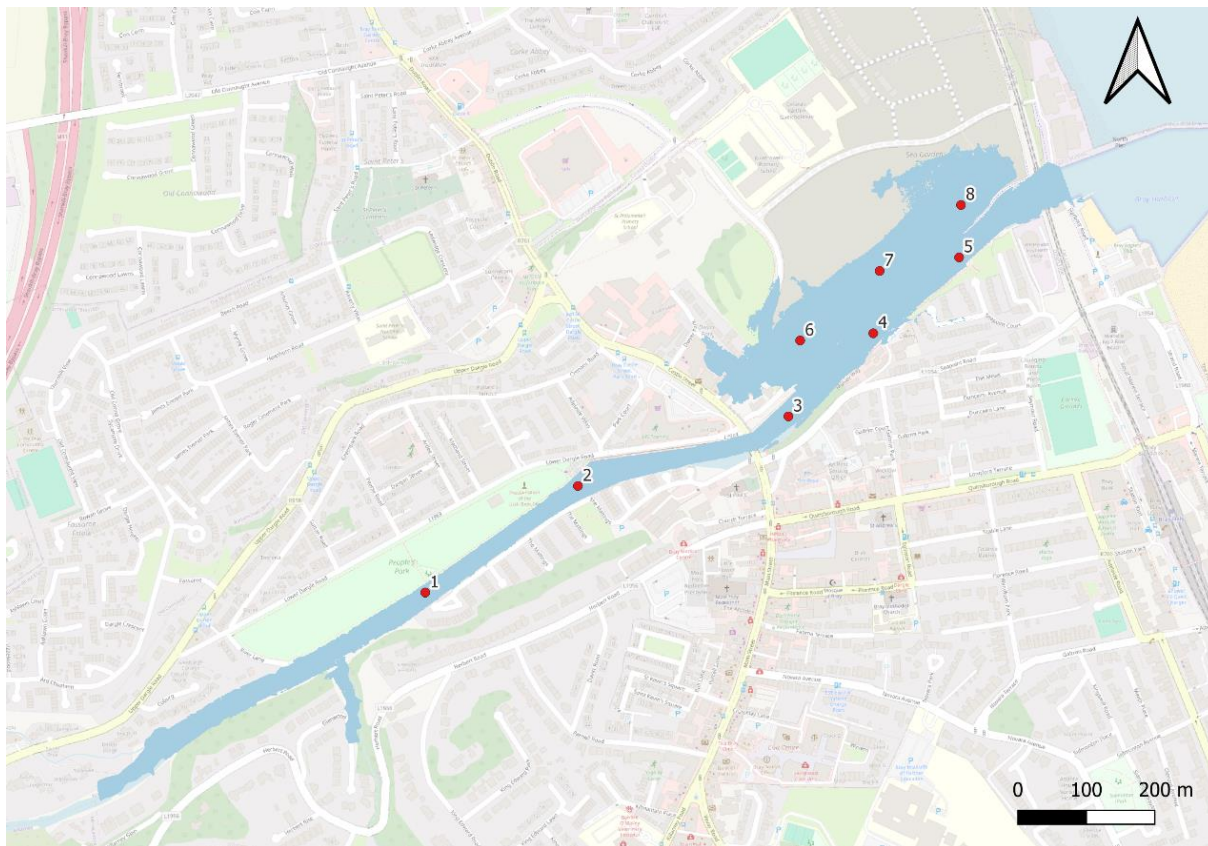
**Table 4-5 Elevation points for undefended and defended model Q100+T2**

| Point | Undefended Q100+T2 (m AOD) | Defended Q100+T2 (m AOD) | Increase in levels due to defences (m) |
|-------|----------------------------|--------------------------|----------------------------------------|
| 1     | 3.185                      | 3.213                    | 0.028                                  |
| 2     | 3.049                      | 2.997                    | -0.052 (decrease in levels)            |
| 3     | 2.698                      | 2.782                    | 0.084                                  |
| 4     | 2.654                      | 2.716                    | 0.062                                  |
| 5     | 2.596                      | 2.621                    | 0.025                                  |
| 6     | 2.632                      | ---                      | ---                                    |
| 7     | 2.623                      | ---                      | ---                                    |
| 8     | 2.617                      | ---                      | ---                                    |

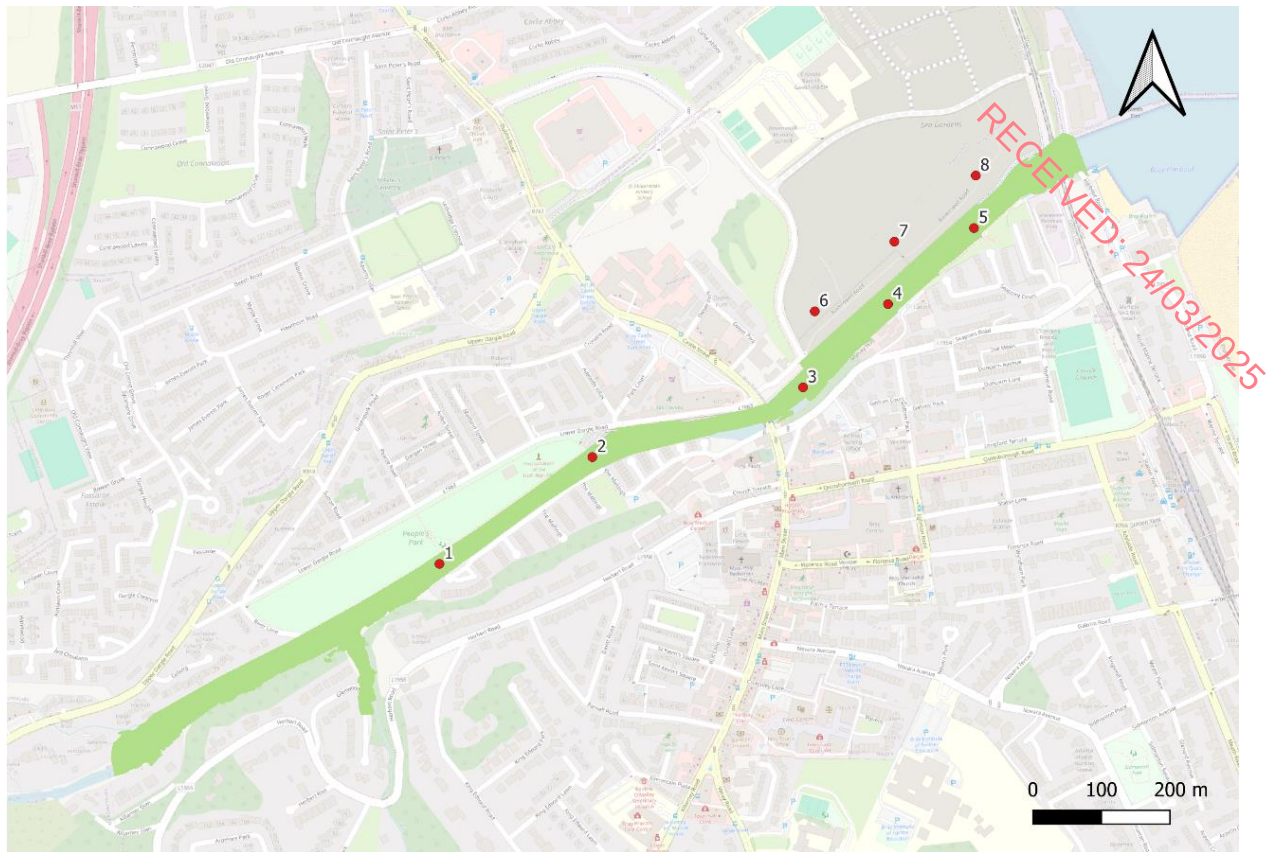
#### 4.4.2 0.5%AEP (1 in 200-year) Tidal Event + 50%AEP (1 in 2-year) Fluvial Event

The tidally dominant scenario is the 0.5% AEP tidal event coinciding with the 50% AEP fluvial event, referred to as the T200+Q2 event. Figure 4-4 below shows the flood extents for the undefended condition and the resulting flood levels.

By comparison, Figure 4-5 provides the results of the defended flood model with the River Dargle Flood Defences in place. The tidally dominant flood is contained in channel for the defended condition. Table 4-6 shows in-channel levels near the site are very similar between the undefended and defended conditions, as the levels are dictated by the tidal cycle rather than any attenuation and storage provided within the catchment. Again, there are decreases in water levels upstream of the Fran O'Toole bridge, attributed to increased flow capacity and improvement in conveyance to the channel via the introduction of the by-pass culvert.



**Figure 4-4 Undefended model T200+Q2**



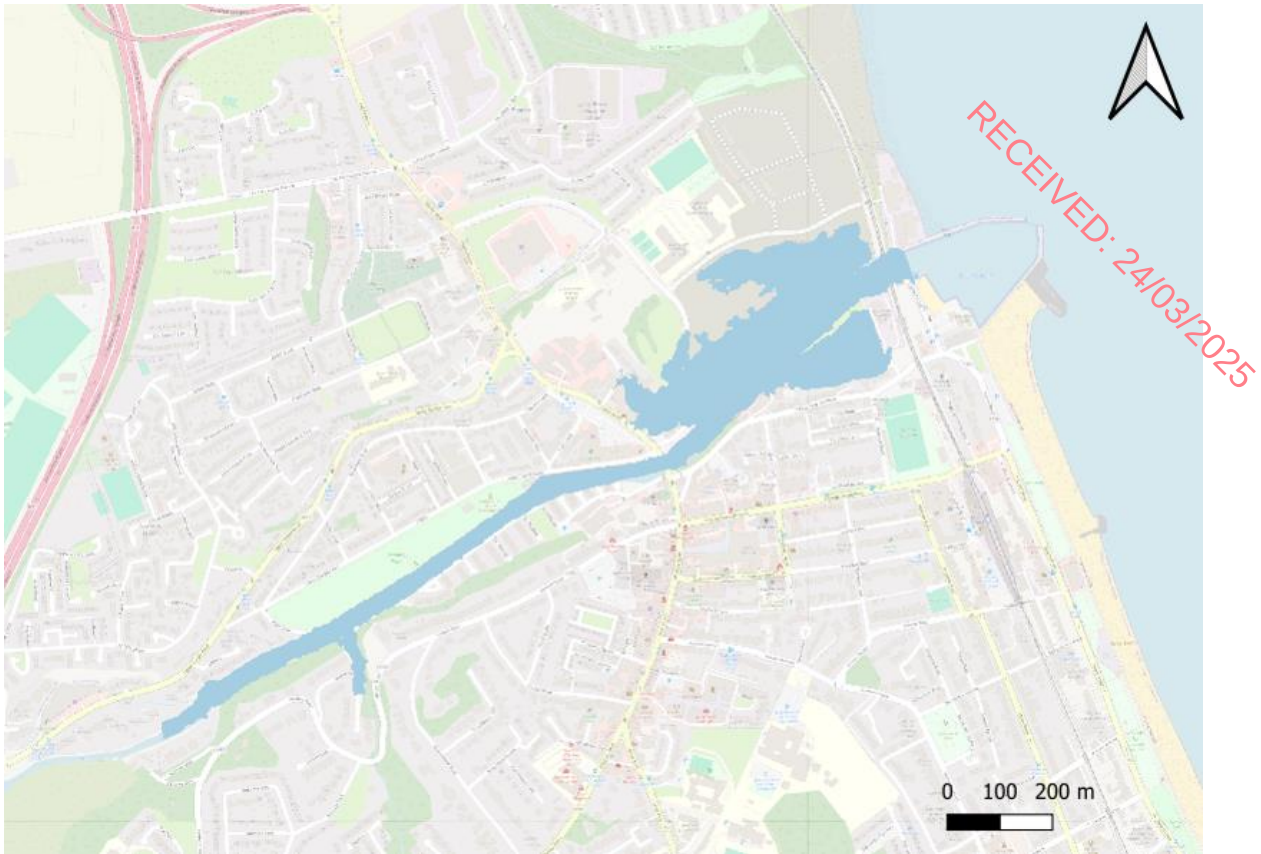
**Figure 4-5 Baseline defended model T200+Q2**

**Table 4-6 Elevation points for undefended and defended model T200+Q2**

| Point | Undefended T200+Q2 (m AOD) | Defended T200+Q2 (m AOD) | Increase in levels due to defences (m) |
|-------|----------------------------|--------------------------|----------------------------------------|
| 1     | 3.368                      | 3.317                    | -0.051 (decrease)                      |
| 2     | 3.322                      | 3.266                    | -0.056 (decrease)                      |
| 3     | 3.214                      | 3.215                    | 0.001                                  |
| 4     | 3.205                      | 3.202                    | -0.003 (decrease)                      |
| 5     | 3.184                      | 3.185                    | 0.001                                  |
| 6     | 3.204                      | ---                      | ---                                    |
| 7     | 3.189                      | ---                      | ---                                    |
| 8     | 3.186                      | ---                      | ---                                    |

#### 4.4.3 0.1%AEP (1 in 1000-year) Tidal Event + 50%AEP (1 in 2-year) Fluvial Event

The tidally dominant scenario to define Flood Zone B is the 0.1%AEP tidal event coinciding with the 50% AEP fluvial event, referred to as the T1000+Q2 event. Figure 4-6 below shows the flood extents for the undefended condition and Figure 4-7 shows the defended condition. Levels for this scenario are compared with the 0.5%AEP tidal events and are discussed further in Section 5.1 Flood Protection Level.



**Figure 4-6 Undefended Q2+T1000**



**Figure 4-7 Defended Q2+T1000**

#### 4.4.4 Hurricane Charlie Event + Mean High Water Spring

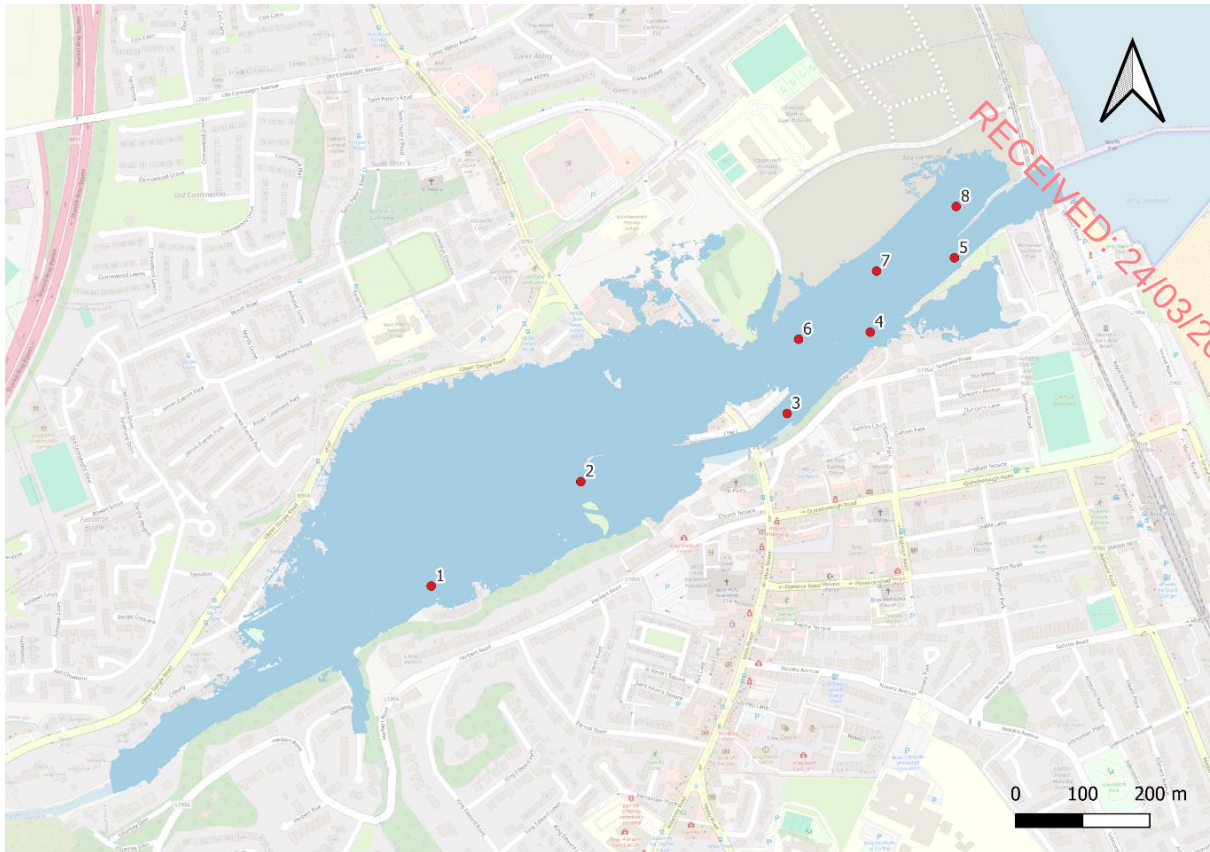
The Hurricane Charlie flows are in excess of the typical extreme values that would normally be considered as part of the analysis, however, as this event is in the living memory of the town's residents, it is prudent that this event is considered in the analysis. Figure 4-8 shows the flood extents for the undefended condition and the resulting flood levels.

By comparison, Figure 4-9 provides the results of the defended flood model with the River Dargle Flood Defences in place. The model is demonstrating that the flood defence scheme can contain Hurricane Charlie within bank, as per design specifications and as per the HR Wallingford model.

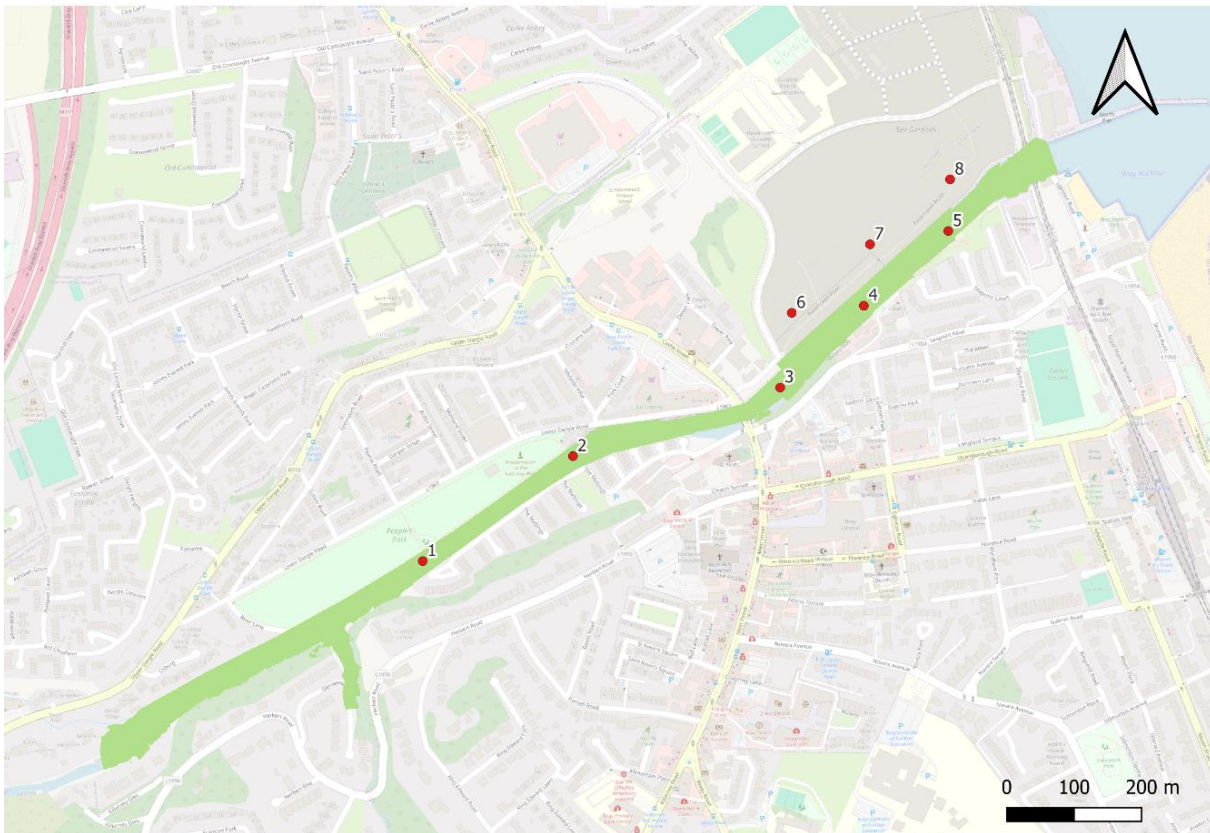
When comparing the Arup hydraulic model with the HR Wallingford physical model, some differences in flood levels were noted. These differences reflect differences in the model size and methodology used.

The HR Wallingford model included areas farther upstream (at La Vallee/ The Slang) where water may have exited the riverbanks and proceeded via overland routes on the left bank. The Arup hydraulic model boundaries did not extend as far upstream because the model's intended purpose was to focus on the FRA of the site location near Bray Harbour. Additionally, the Arup model has only considered riverbed levels post-defence scheme which differ significantly following the riverbed dredging completed as part of the Flood Defence Scheme. Therefore, while levels between models may differ, the overland flows as they occurred during the Hurricane Charlie event have been replicated satisfactorily. Following comparison of the Arup hydraulic model results for the HC event and HR Wallingford modelled results, an increase to the Manning's coefficient of the river bed from 0.03 to 0.04 was done, which resulted in a better correlation of water levels within the river between the two models. During consultations with WCC, the local engineers agreed that a 0.04 Manning value is more representative of the River Dargle's conditions.

The defended and undefended model extents and levels for Hurricane Charlie according to the Arup model are shown in the figures below and Table 4-7. As expected, the introduction of the River Dargle Flood Defences result in a general increases in river levels within the channel, as water stored within the site is now maintained within the river channel. As in the other scenarios, there is a consistent decrease in levels around point 2, where flow capacity and improvements in conveyance have been introduced to the river channel via the by-pass culvert under Fran O'Toole bridge. While points 1 to 4 are within the HC fluvially dominated extents and as such the impact of the defences is more prominent in terms of changes in levels, it can be seen that the change in levels due to the defences reduces significantly at Point 5. This reduction in level difference is attributed to the tidal influence of Bray Harbor and the proximity of point 5 to the tidal boundary of the model.



**Figure 4-8 Undefended Hurricane Charlie + MHWS**



**Figure 4-9 Baseline defended Hurricane Charlie + MHWS**

**Table 4-7 Elevation points for undefended and defended model HC+MHWS**

| Point | Undefended HC+MHWS (m AOD) | Defended HC+MHWS (m AOD) | Increase in levels due to defences (m) |
|-------|----------------------------|--------------------------|----------------------------------------|
| 1     | 4.952                      | 5.053                    | 0.101                                  |
| 2     | 4.668                      | 4.622                    | -0.046 (decrease)                      |
| 3     | 3.497                      | 3.783                    | 0.286                                  |
| 4     | 3.294                      | 3.514                    | 0.22                                   |
| 5     | 3.006                      | 3.018                    | 0.012                                  |
| 6     | 3.367                      | ---                      | ---                                    |
| 7     | 3.204                      | ---                      | ---                                    |
| 8     | 3.101                      | ---                      | ---                                    |

## 4.5 Model results – Proposed Development Model

As demonstrated above, the defended Q100+T2, Q2+T200, and HC+MHWS events are maintained within the River Dargle channel and do not overtop the defences. As such, the proposed development and any changes in levels within the site will have no impact in terms of flood risk during the above events.

Following consultations with WCC, it was deemed necessary to ensure that during an exceedance flood event (an event that would overtop defences or cause breaching), floodwaters entering Little Bray can leave Little Bray through Dwyer Park, through the site and across the lower parts of the site and re-enter the river through the culverts under Ravenswell Road, following similar flow paths as during Hurricane Charlie.

It is therefore necessary to run an exceedance event model simulation to demonstrate there is no impediment to flows due to the masterplan proposals and thus, no impacts on the surrounding community due to modifications of the site levels. Additionally, the existing flow paths should be maintained within the new design and should not create a damming effect on upstream communities or prevent floodwaters from reaching the existing culverts. A fluvial flow of 380m<sup>3</sup>/s has been selected, through iteration, as an event which can demonstrate these flow paths and the subsidence of floodwaters via the culverts.

Figure 4-10 shows a comparison in QGIS of the flood extents produced during the baseline defended exceedance event with no proposals and the exceedance event with proposals. The red represents an increase in flood extents due to proposals, while the blue represents a decrease in flood extents. The purple colouring shows no change in extents. Within the majority of the Little Bray area, there is no change in extents, with some decreases to flood extents shown in the vicinity of the site. No red extents are shown in the map below, indicating no increase in flood extents as a result of the proposals. The overall decreases in extents are a result of lowering of levels at the entrance to the site from Dwyer Park and improvements in flow conveyance.

Table 4-8 lists the differences in flood levels during this event, while Figure 4-11 demonstrates the change in levels in a graphical manner (blue shows decreases and red increases in levels due to proposals along a colour gradient). Levels increase slightly within the site area by c. 96mm at the location of the linear park (a water compatible use), as a result of regrading within the site to raise the residential buildings above the flood protection level of 3.5m AOD. As this increase is within the site boundary and is managed through the measures outlined in Section 5, the increased risk is considered acceptable. As explained earlier, improvements in conveyance at the entrance to the site from Dwyer Park result in flood level decreases at Dwyer Park of c. 226mm.

Water levels are increased slightly within the River Dargle channel along the masterplan site by 3-16mm. This increase in levels does not have a negative impact to any adjacent sites and risk receptors and as such, considering the modelled flood event is an extreme exceedance event, the increase is considered acceptable. It should be noted the levels within the Seapoint site are not increasing due to the proposals during the exceedance runs.

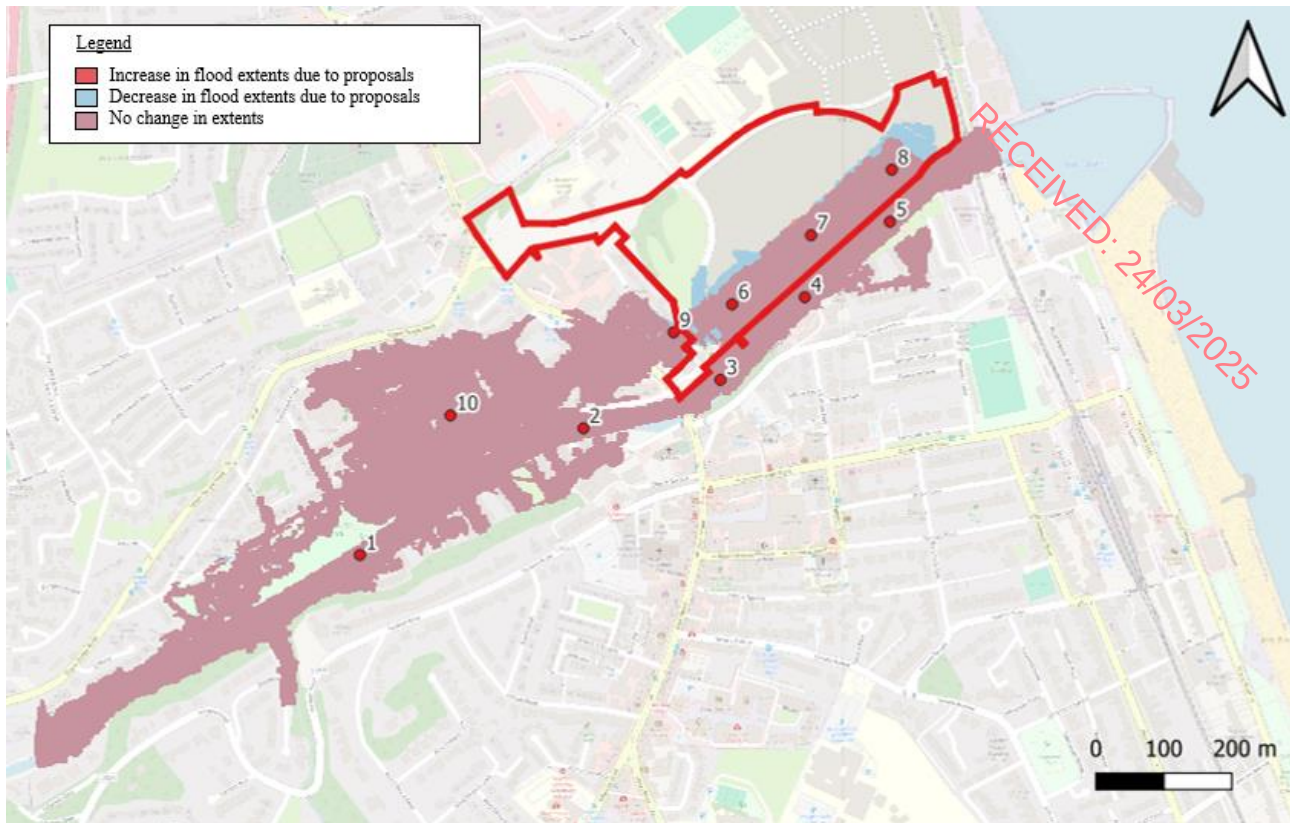
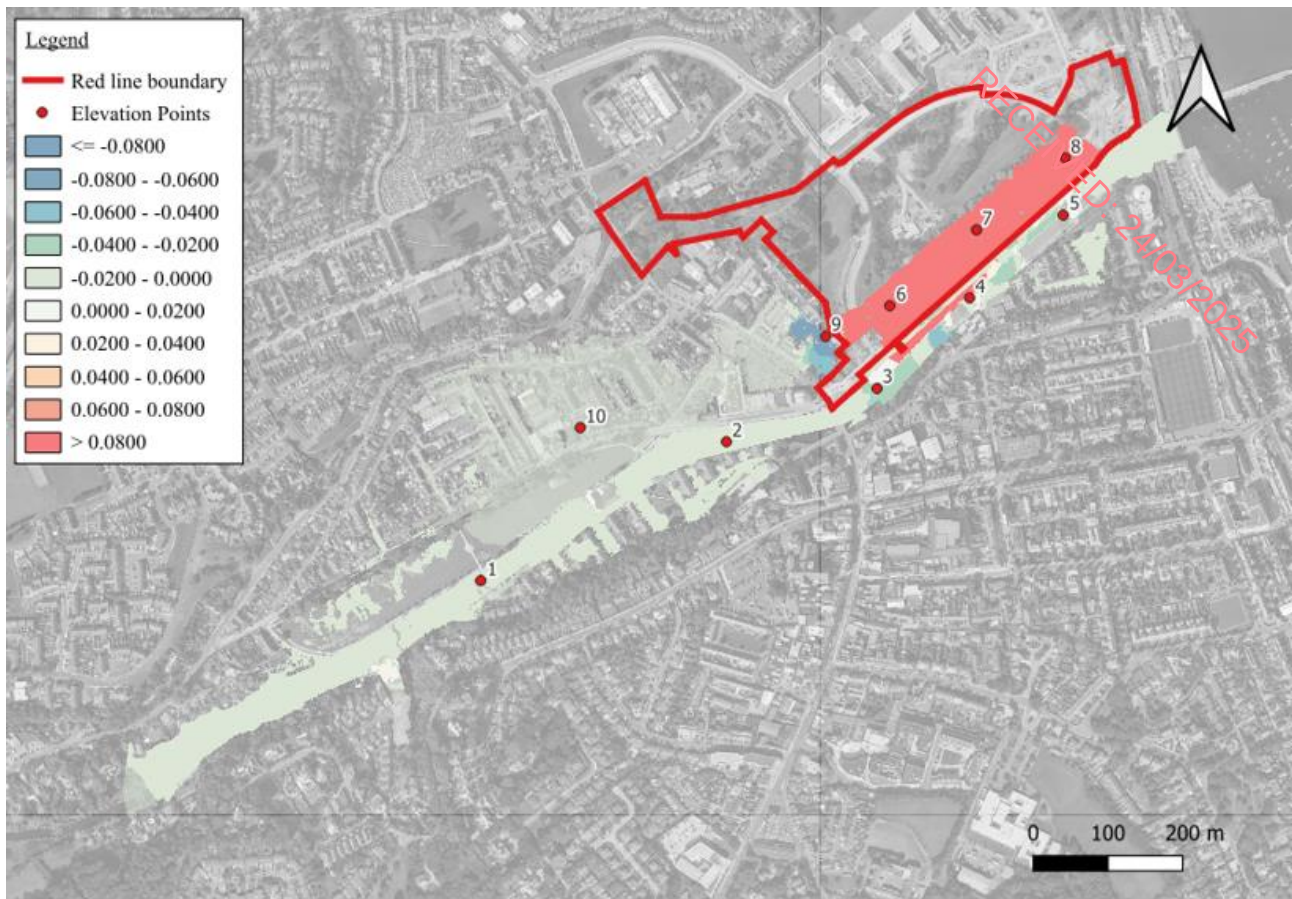


Figure 4-10 Flood extents of proposals vs. no proposals during an exceedance event.

Table 4-8 Flood levels for exceedance scenario with and without proposals

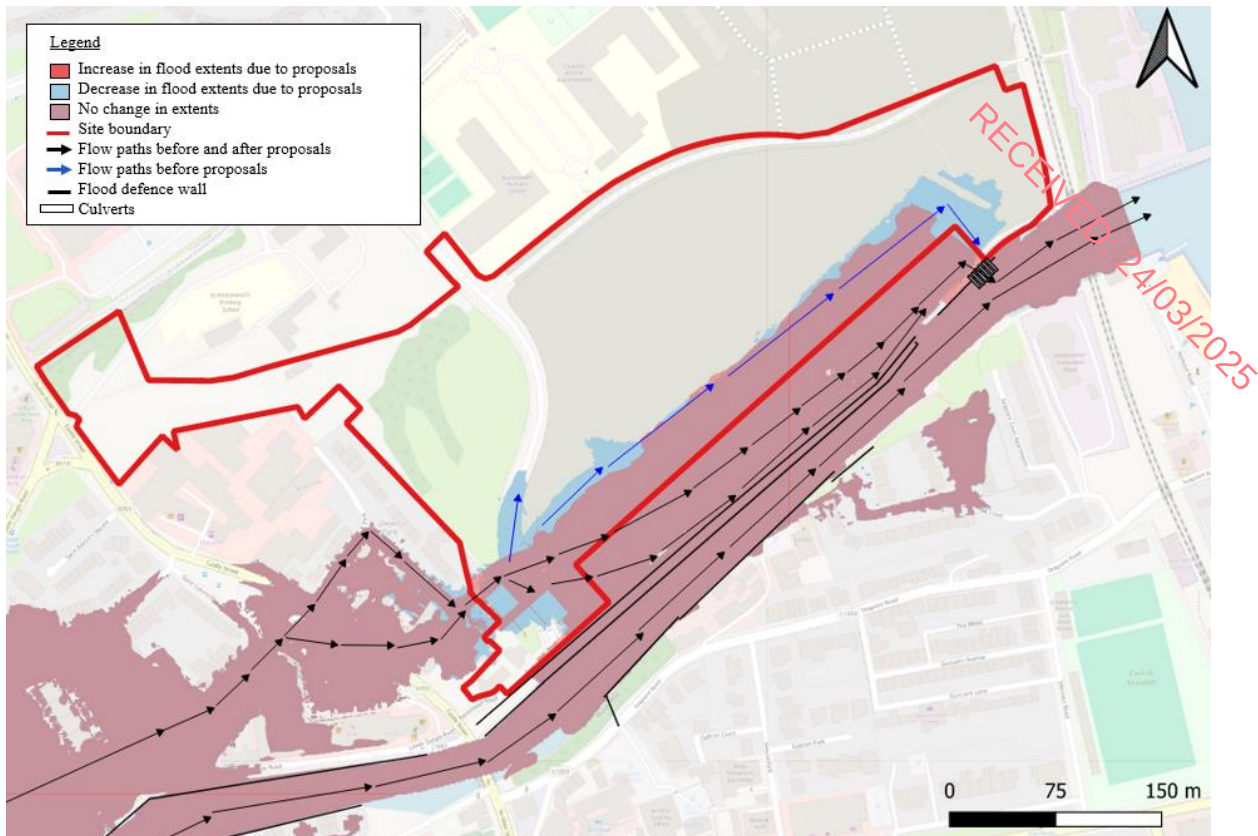
| Point | Exceedance Scenario No Proposals (m AOD) | Exceedance Scenario Proposals (m AOD) | Increase in levels due to proposals (m) |
|-------|------------------------------------------|---------------------------------------|-----------------------------------------|
| 1     | 5.717                                    | 5.716                                 | -0.002 (decrease)                       |
| 2     | 5.277                                    | 5.276                                 | -0.002 (decrease)                       |
| 3     | 4.280                                    | 4.260                                 | -0.023 (decrease)                       |
| 4     | 4.013                                    | 4.029                                 | 0.020 (increase within river)           |
| 5     | 3.478                                    | 3.481                                 | 0.002 (increase within river)           |
| 6     | 2.650                                    | 2.746                                 | 0.080 (increase within site)            |
| 7     | 2.650                                    | 2.746                                 | 0.080 (increase within site)            |
| 8     | 2.650                                    | 2.746                                 | 0.080 (increase within site)            |
| 9     | 3.013                                    | 2.787                                 | -0.226 (decrease)                       |
| 10    | 4.008                                    | 4.007                                 | -0.001 (decrease)                       |



**Figure 4-11 Proposals vs. no proposals for exceedance event (380m<sup>3</sup>/s) with Phase 2 development**

Overland flow routes have been maintained during the exceedance event as shown in Figure 4-12. There are no new flow paths created because of the proposals. Site levels and regrading to lower levels at the interface of the site with Dwyer Park ensure that flood water enters through Dwyer Park, continues into the linear park and heads southeast towards the existing culverts and drainage system at the southern portion of the site. All residential buildings are situated above the flood extents, north of the linear park.

Emergency access and egress plans will enable all persons within the housing blocks or retail units to evacuate to higher ground via access roads if needed.

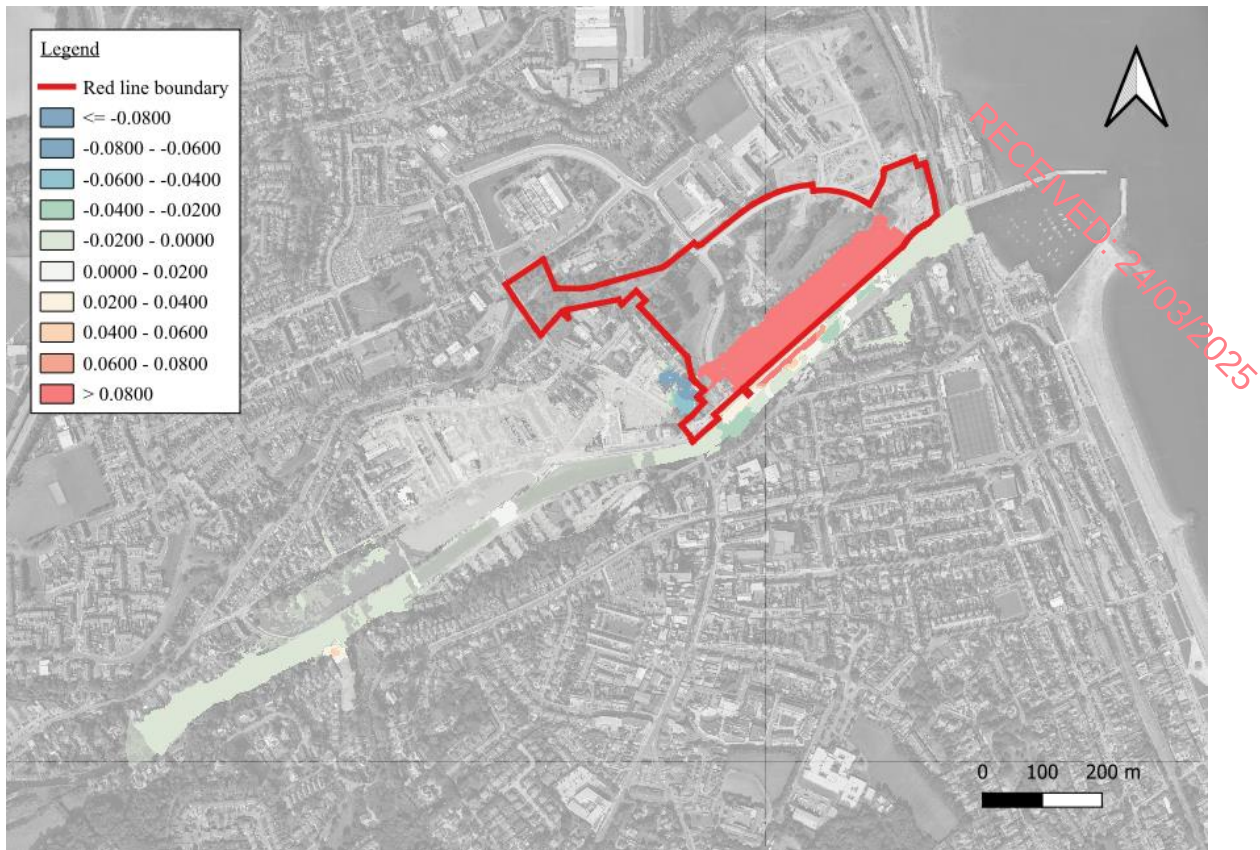


**Figure 4-12 Flow path during exceedance event**

#### 4.5.1 Construction Phasing Model

Construction phasing has been planned and tested through the exceedance modelling in accordance with the flood risk strategy to ensure phasing of works does not create additional flood risk to other sites. The phasing plans are included in Appendix A. It is proposed that the development will be undertaken in two phases beginning with the portion of the development east of the bisecting access road. Phase 2 includes the portion to the west of the access road. The proposals vs. no proposals map is shown in Figure 4-13 and depicts the water level changes following the completion of construction phase 1.

No significant changes occur to flood levels outside of the site area during the two construction phases.



**Figure 4-13 Proposals vs. no proposals for exceedance event (380m<sup>3</sup>/s) showing levels after the completion of construction phase I.**

#### 4.5.2 Future Phase 3 Development

Phase 3 of the Bray Sea Gardens Development will include the addition of the area south of the linear park to include 6 apartment blocks built on a podium. The ground floor beneath the podium is proposed to be lowered to 1.5m AOD and will serve as a carpark, raising the higher vulnerability residences off the ground and above the design flood protection level. Flood modelling has been undertaken to include Phase 3 development to ensure the cumulative impact of the potential future development with the Phase 2 development in place. Modelling was done for the exceedance scenario.

The modelling has demonstrated that the Phase 3 development will cause no increase in flood extents outside the redline boundary. All flow paths to the existing culverts are also maintained. Small increases in flood levels (20-40mm) occur locally north of Lower Dargle Road and at the confluence of the Swan River and the Dargle River, as shown in green in Figure 4-14. These are attributed to water entering a courtyard depression (no buildings impacted) and LiDAR discrepancies, respectively. The overall impact of Phase 3 is considered insignificant and would be subject to further detailed modelling undertaken as part of a future planning application for Phase 3, where mitigation measures could be provided if needed. A separate site-specific FRA will be prepared to describe in detail the modelling work.



Figure 4-14 Proposals vs. no proposals for exceedance event (380m<sup>3</sup>/s) with Phase 2 and Phase 3 developments

## 5. Management of Flood Risk

The site is protected by the River Dargle Flood Defence Scheme for the 1% AEP fluvial event, the 0.5% tidal event and Hurricane Charlie with an allowance for freeboard and climate change at the tidal reaches. At the fluvial reaches, the scheme was designed for enhancement and future adaptation. As such, the proposed development and any changes to the levels within the site will have no impact in term of flood risk to River Dargle during the above events.

When defences are not taken into account, portions of the site by the River Dargle are impacted by both the 1% AEP fluvial event, the 0.5% tidal event, and the 0.1% tidal event. The development site is therefore considered to be partially in Flood Zones A, B and C. This is discussed further in Section 5.1.

It is prudent to consider the risk of flooding from fluvial and tidal sources in the absence of these defences and to provide mitigation measures and strategies in the event of an exceedance or breach event. Following consultation with WCC, the modelling of the exceedance event was carried out to ensure this scenario was accounted for. The following measures are considered to protect the proposed development, its users and contents.

### 5.1 Flood Protection Level

The Strategic Flood Risk Assessment of the Wicklow County Development Plan 2022-2028 provides guidelines for setting minimum finished floor levels. It suggests that raising finished floor levels within a development is an effective way of avoiding damage to the interior of buildings in times of flooding. The guidelines recommend the finished floor level in accordance with the design scenario and whether the location is defended or undefended. In the case of the Bray Sea Gardens, the site is protected by flood defences and the finished floor level should be based on either the 1% AEP fluvial flood level or the 0.5% AEP tidal flood level, whichever is highest at the site location. A 300mm freeboard should be allowed.

The highest of the above levels along the River Dargle adjacent to the site is the 0.5%AEP tidal flood level. This level is 3.2m AOD. The flood protection level is therefore:

**Flood protection level: 0.5% AEP tidal + 300mm freeboard = 3.2 + 0.3 = 3.5m AOD.**

It should be noted that the above flood protection level of **3.5m AOD** is below or at the Hurricane Charlie maximum undefended flood level near the site.

The WCC SFRA requirements also state that climate change allowance does not need to be included in the development levels, provided the local flood defence scheme either includes climate change allowance directly or has been designed to be adaptive. The River Dargle Flood Defence Scheme has allowed for climate change within the design of the defences at the tidal reaches and adaptation/enhancement at the fluvial reaches; therefore, an additional climate change allowance has not been included in the setting of the flood protection level.

The site is therefore defended to the present flood protection level, with an allowance for climate change (i.e. inherent to the Dargle Flood Defence Scheme) and freeboard. In the scenario of an exceedance or breach event, the site will remain protected through the raising of finished floor levels and by the provision of demountable barriers when raising levels is not feasible.

The designation of Flood Zones A and B is shown in Figure 5-1, with the 0.5% AEP tidal flood level defining Flood Zone A and the 0.1% tidal flood level defining Flood Zone B, in proximity of the site boundary. An outline of the proposed development masterplan is shown in Figure 5-2. Please note that while the plan extents do overlap with Flood Zone B, this is permitted in line with the Justification Test (see Section 6.4). The tidally dominant events for both the 0.5% and 0.1% AEP scenarios produce the largest extents at the site location (and dominate over the 1% and 0.1% fluvial extents, respectively) as shown in Table 5-1. As reported in Table 4-2, the 0.5% and 0.1% AEP tidally generated flood levels are 3.17m AOD and 3.39m AOD. Note the slight difference between the levels shown and the tidal boundary condition levels relates to the 50% AEP fluvial scenario run in conjunction with the tidal boundary to account for a nominal fluvial discharge.

For reference, note that the minimum finished floor levels within the development are 3.5m AOD.

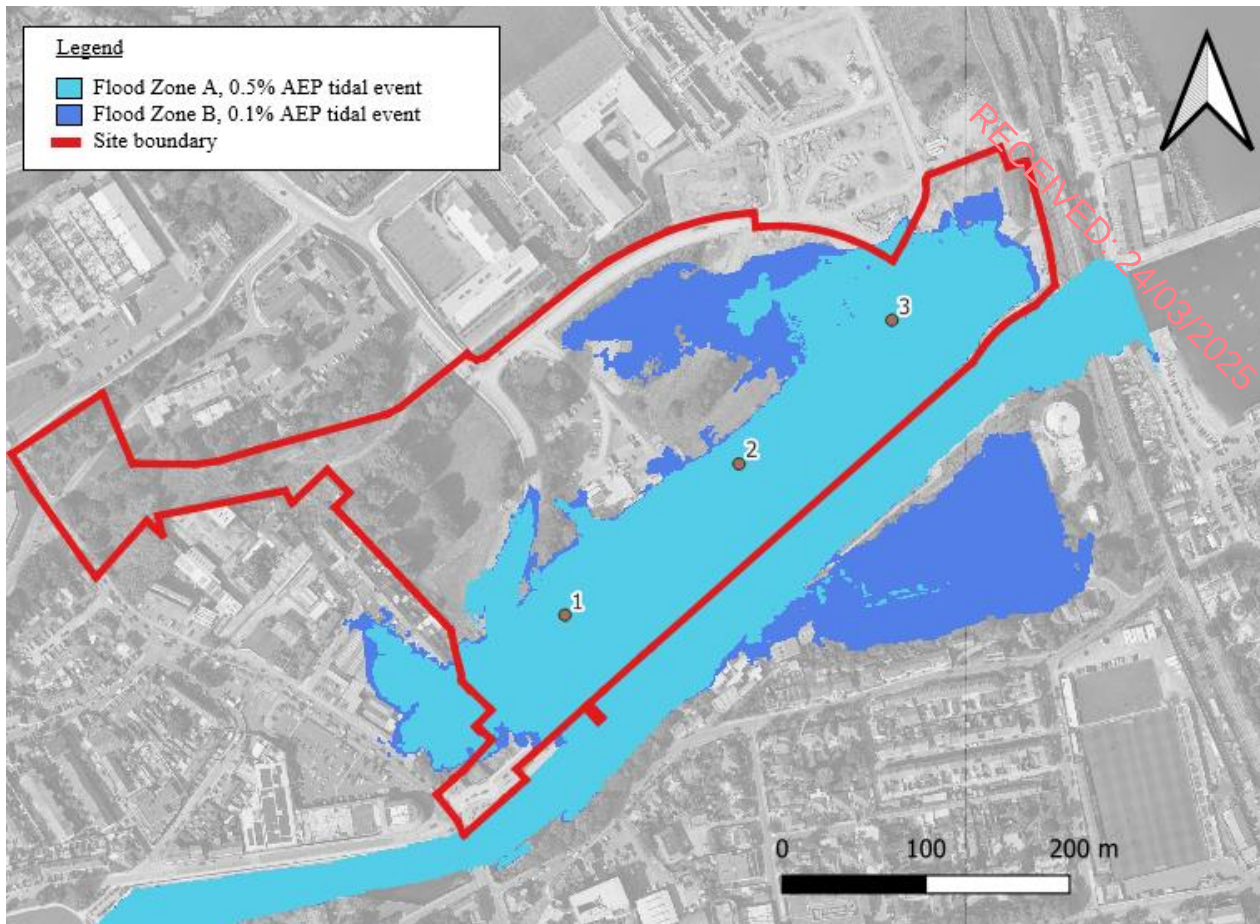


Figure 5-1 Definition of Flood Zones A and B using the tidally dominant events.

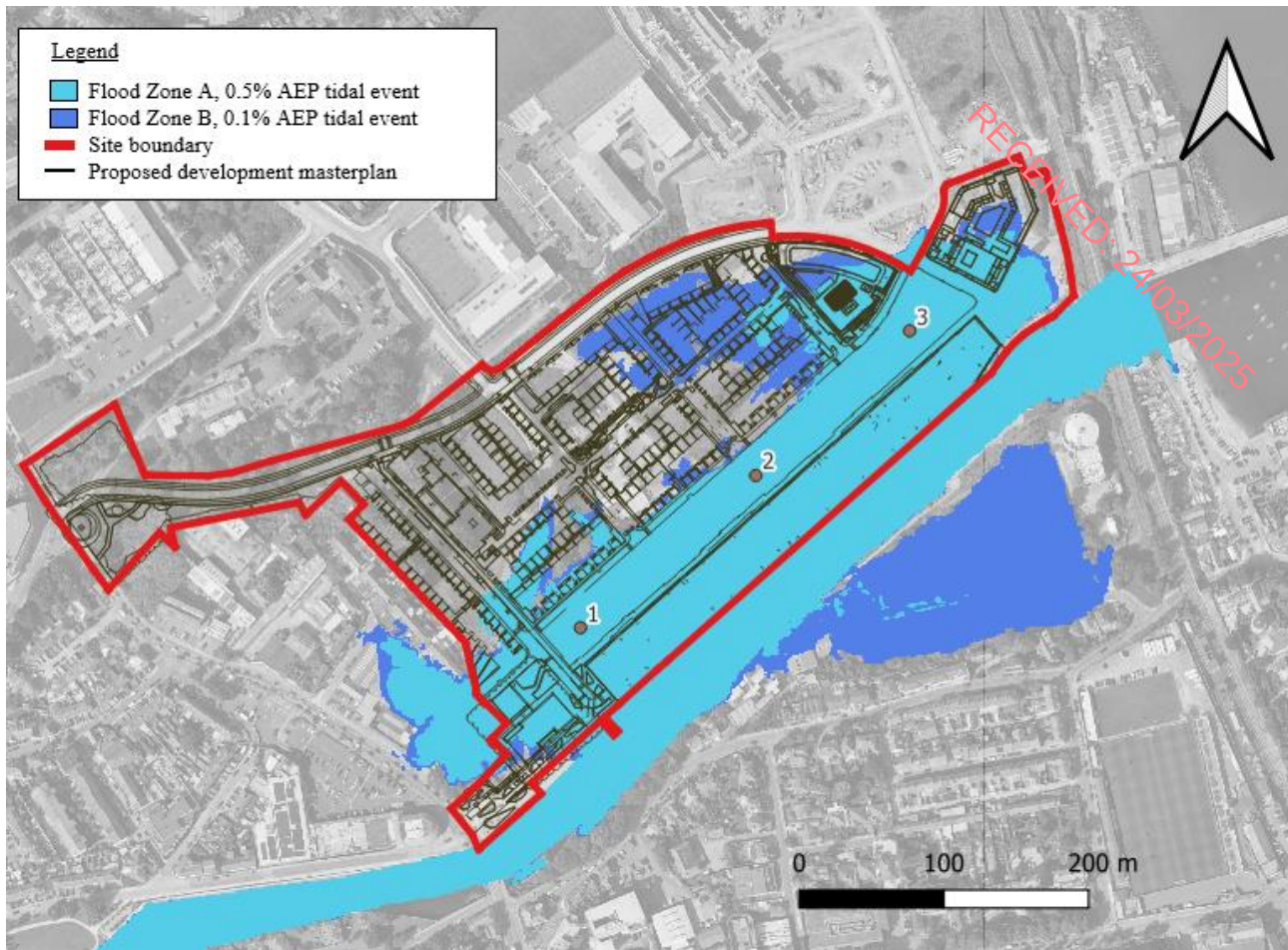


Figure 5-2 Flood Zones A and B with proposed development overlap.

Table 5-1 Elevation points for the Flood Zone A and B extents

| Point | Level for 0.5%AEP tidal event (mAOD) | Level for 0.1%AEP tidal event (mAOD) |
|-------|--------------------------------------|--------------------------------------|
| 1     | 3.201                                | 3.421                                |
| 2     | 3.189                                | 3.407                                |
| 3     | 3.186                                | 3.405                                |

## 5.2 Flood Management Strategy

All residential buildings have been proposed as much possible within areas at lower risk of flooding and away from the low-lying area at the southern part of the site. The low-lying areas at highest risk of flooding are dedicated to the linear park / amenity open space uses, with the Block G retail units also proposed in an area at high risk of flooding.

The residential buildings and key access roads are proposed to be raised above the flood protection level of 3.5m AOD, in order to prevent risk of flooding to property and residents as well as provide safe access and egress from and to the buildings.

In some instances, raising the ground levels to the flood protection level was not feasible. This is the case for some of the retail units of Block G, that are located nearest to the entrance from the Dwyer Park residential neighbourhood. The ground levels at this location have to be maintained low to ensure that flow paths are followed through the site during an exceedance event.

The flood protection measures for each area are described below and their location in the masterplan is indicated in Figure 5-3. A detailed drawing of Block G levels is shown in Figure 5-4.

### 5.2.1 Raising Development Levels

The following buildings will be raised to or above the present flood protection level of 3.5m AOD (see numbered location in Figure 5-3):

1. All duplexes, 'own-door' units, WCC homes lying to the north of the linear park, the Block I - Hotel and Block E. Details on the exact levels at each location can be found in the architectural planning drawings by Cantrell Crowley Architects for the Block I – Hotel and by Glen Howells Architect for the rest of the buildings and masterplan (marked in purple and number 1 in Figure 5-3).
2. Two of the retail unit spaces located within Block G, set at levels of 3.5m AOD and 4.0m AOD respectively (marked in orange and number 2 in Figure 5-4).

### 5.2.2 Flood Protection through Demountable Barriers

Demountable barriers and a water exclusion design strategy up to the flood protection level of 3.5m AOD will be provided for the following locations around the site (see numbered location in Figure 5-3):

3. Three of the retail unit spaces located within Block G, set at levels of 2.5m AOD, 3.0m AOD and 3.25m AOD (marked in pink and number 3 in Figure 5-4), respectively. The retail units are proposed at lower levels in order to tie into proposed architectural levels for surrounding roads and ensure the flood path from Dwyer Park is maintained. Demountable barriers are proposed for entrances, air vents and other openings to protect up to 3.5m AOD and are indicated in red in Figure 5-4.

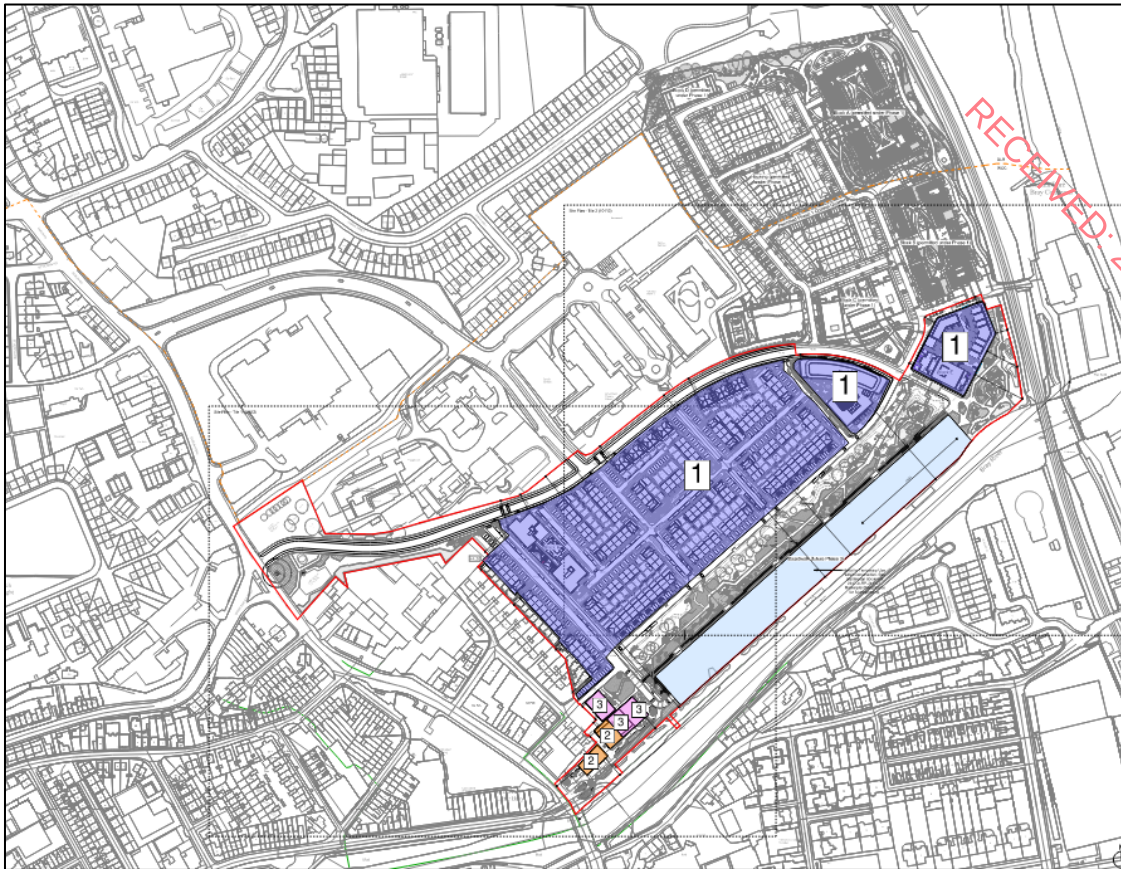


Figure 5-3 Masterplan indicating areas with raised development levels or other flood protection measures

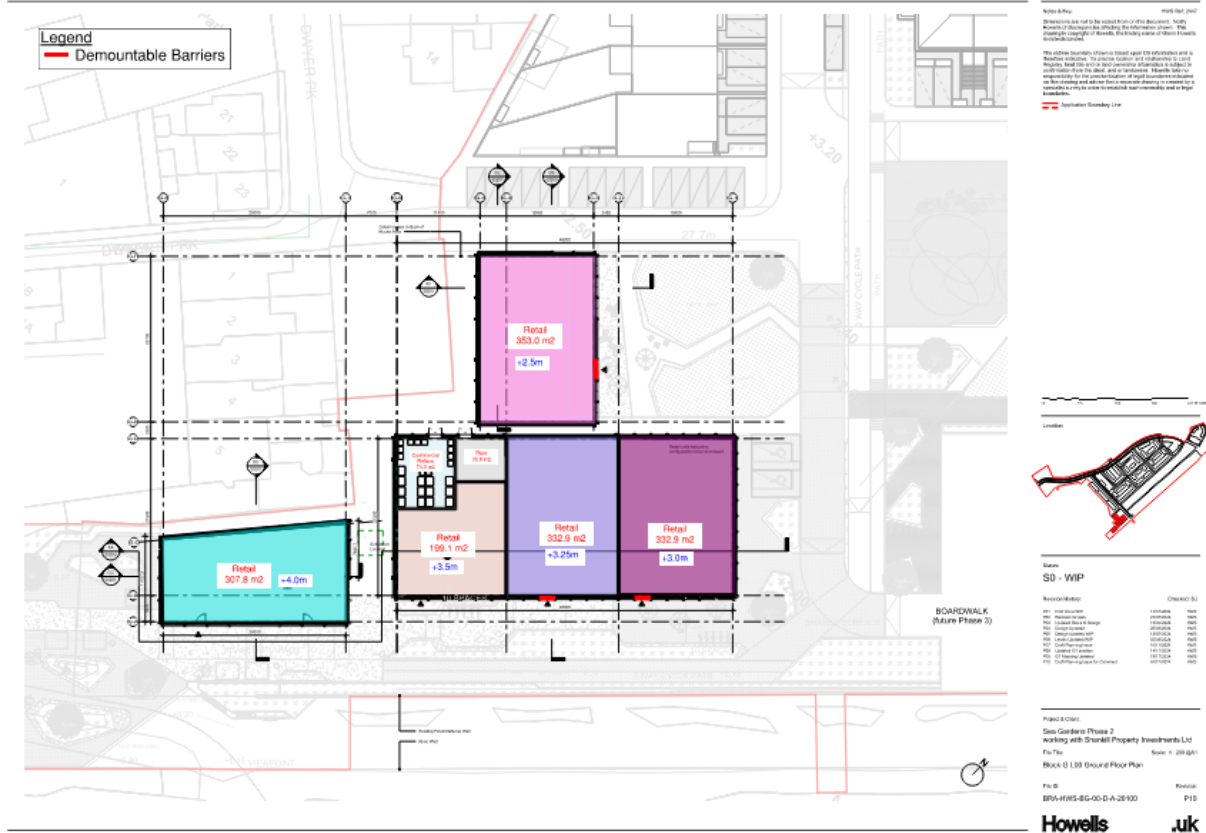


Figure 5-4 Detailed architectural drawing of Block G levels and location of demountable barriers shown in red

Demountable barriers cannot provide a complete elimination of the risk of water penetrating the building either under/around the barriers or through cracks in the walls, through the brickwork or blockwork, at damp-proof course of walls, the expansion joints between walls, air-bricks/vents, backflow through overloaded drainage/sewer systems or service entries. Care should be taken in the design and selection of materials beneath the flood protection level to ensure minimal water ingress. Non-return valves will be fitted if necessary and air-brick covers can be installed before a flood occurs, in a similar manner to the demountable barriers.

It is prudent to design for the event that some flood water may enter the buildings. Resilience measures can reduce the risk of flood damage through selection of building materials, construction techniques and internal finishes, and can speed up recovery and repairs. The following measures shall be followed:

- Lifts will be fitted with a sump to allow for pumping of flood water following a flood event, in the case of water penetrating the barriers. Electrical equipment of the lift will be placed at the ceiling. Following a flood warning, lifts will be set to a setting so they cannot land on the ground floor.
- Materials and construction of the buildings shall facilitate quick drying and cleaning where possible.
- Non-return valves to be installed within drainage systems to prevent backflow.
- Fittings (electrical and gas) as high as practical above floor (ideally above 3.5m AOD if possible).
- Design of above elements shall follow guidance from: “Improving the flood performance of new buildings, Flood Resilient construction”, May 2007, Consortium managed by CIRIA as well as the “BS 85500-2015 Flood resistant and resilient construction”.

### 5.2.3 Residual Risk and Future Proofing

There is a residual risk of flooding due to the possibility of the breaching of defences. An exceedance event was run to establish the risk posed to the proposed development. The following measures have been proposed to allow adaptation of the scheme in the unlikely event of a breach or exceedance of the defences:

- Areas subject to flooding in an exceedance event have been allocated to less vulnerable and water compatible uses such as the linear park and retail units.
- The masterplan has been designed to maintain existing flow paths during flood events including the flow path from the Dwyer Park gate on the west of the site to the culverts on the eastern part of the side.
- The linear park has been designed with levels to channel water towards the culverts on the eastern side and to reduce ponding after a flood.

## 5.3 Flood Emergency Response Plan

A Flood Emergency Response Plan has been prepared in conjunction with this Flood Risk Assessment report describing the plan in place in the event of a significant flooding or exceedance event. This plan is intended for the building users and tenants within the site that are set below the flood protection level of 3.5m AOD (Block G) as well as linear park users. The plan has been informed by the Bray Flood Emergency Plan and details triggers for activation including the receipt of a timely flood warning, a staged response and sets out the management and operational roles and responsibilities. The plan includes arrangements for access and egress for pedestrians, vehicles and emergency services. The plan also outlines the requirement for building management to ensure that spare components for demountable barriers are available onsite, organise annual training for personnel responsible to erect and demount the barriers, run test erection of the barriers annually, develop a maintenance plan for the barriers and specify the barrier storage location. Closure of the linear park will also be required.

The Flood Emergency Response Plan is included in the Planning Package as a separate report, reference number 293308-ARUP-ZZ-XX-RP-C-0002.

## 5.4 Emergency Access and Egress Routes

In the event of a flood warning being issued and the development management decision to evacuate the buildings below the flood protection level (Block G), the safest route to areas away from flooding is towards the north of the site. Persons within the Block G retail/office spaces should evacuate to the north following the new road heading north towards Harbour Road.

Residents within the duplex and 'own-door' units north of the park and above the flood protection level of 3.5m AOD would not be impacted upon by a 0.5% AEP tidal event, which is the dominant design flood level in this area. In case of an emergency, they are still able to leave the site by moving northwards towards Harbour Road.

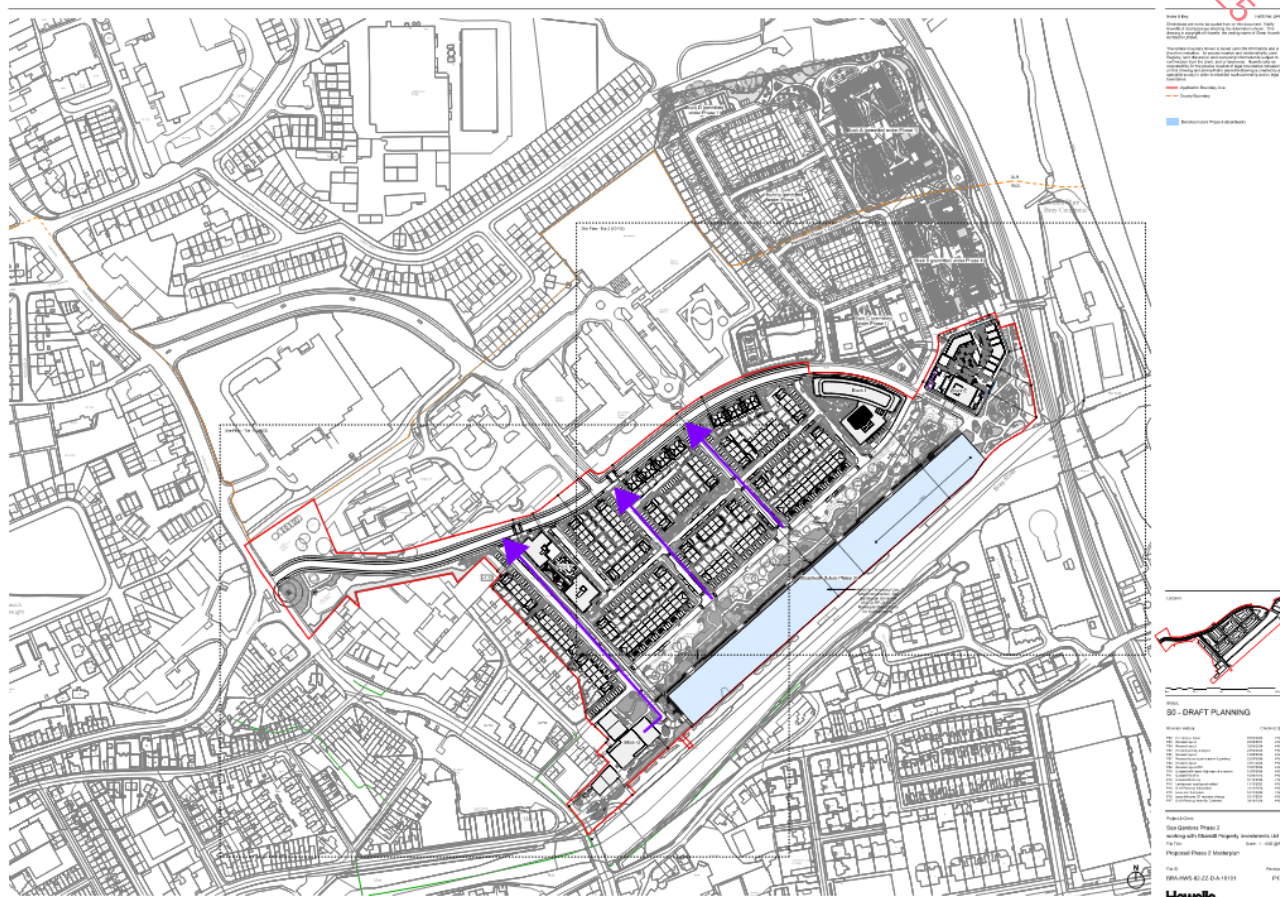


Figure 5-5 Safe access and egress route

## 5.5 Surface Water Drainage Strategy

AtkinsRéalis completed the Stormwater Impact Assessment Report detailing the surface water drainage strategy. The strategy includes attenuating flows onsite prior to a controlled discharge to a new surface water network within the site and SuDS. The new surface water sewer will discharge to the Dargle River via a pump at Qbar greenfield rates of runoff. Additionally, a portion of the Phase 2 development will connect to the Phase 1 surface water drainage network.

The SuDS techniques proposed within the development are the following:

- Swales are proposed to provide conveyance along roadways, footpaths and shared surfaces. Surface water will discharge to swales via drop kerbs/side inlet gullies or over edge flows.
- Permeable paving will be used in parking bays and lightly trafficked areas to provide attenuation, infiltration to ground, reduction of peak flow rates and improved water quality. Roof runoff will discharge directly to the subbase below the permeable paving area.

- Extensive green roof and intensive green courtyards will be installed on suitable apartment buildings in line with the WCC Development Plan, 2022-2028 Appendix 1 Section 1.2 Climate action. This will provide reduced peak flow rates, attenuation, evaporation and improved water quality.
- A concrete underground attenuation tank will be used within the linear public park area. The tank will have capacity for up to 1 in 100-year events. The tank is within the flow path of the exceedance events. The tank and access chambers/manholes will be sealed to ensure the attenuation volume is available during storm events even if flooding of the linear park would occur. This approach has been agreed in discussions with WCC. No infiltration will be provided to ground from the tank.
- Filter drains will be installed in rear gardens of the housing units to allow for flows from the roof runoff from the rear roof of the residential unit and will provide infiltration to the ground, reduced peak flows and improved water quality.
- A pump will be used to control stormwater flows within the proposed surface water network to reduce peak runoff rates.

## 6. Application of ‘Flood Risk Management Guidelines’

### 6.1 Flood Zones

Parts of the proposed development lie within Flood Zone A (i.e., within both the 1% AEP fluvial extents and 0.5% AEP tidal extents when the River Dargle Flood Defences are not considered).

### 6.2 Vulnerability Classification

The proposed development is primarily residential, with some retail units, and is therefore classified as ‘Highly Vulnerable Development’ and ‘Less Vulnerable Development’ respectively.

### 6.3 Sequential Approach and Requirement for Justification Test

Figure 6-1 below illustrates the Sequential Approach to be adopted under the ‘Planning System and Flood Risk Management’ guidelines. The site partially lies within Flood Zone A and is classified as ‘Highly and/or Less Vulnerable Development’; therefore, a Justification Test is required.

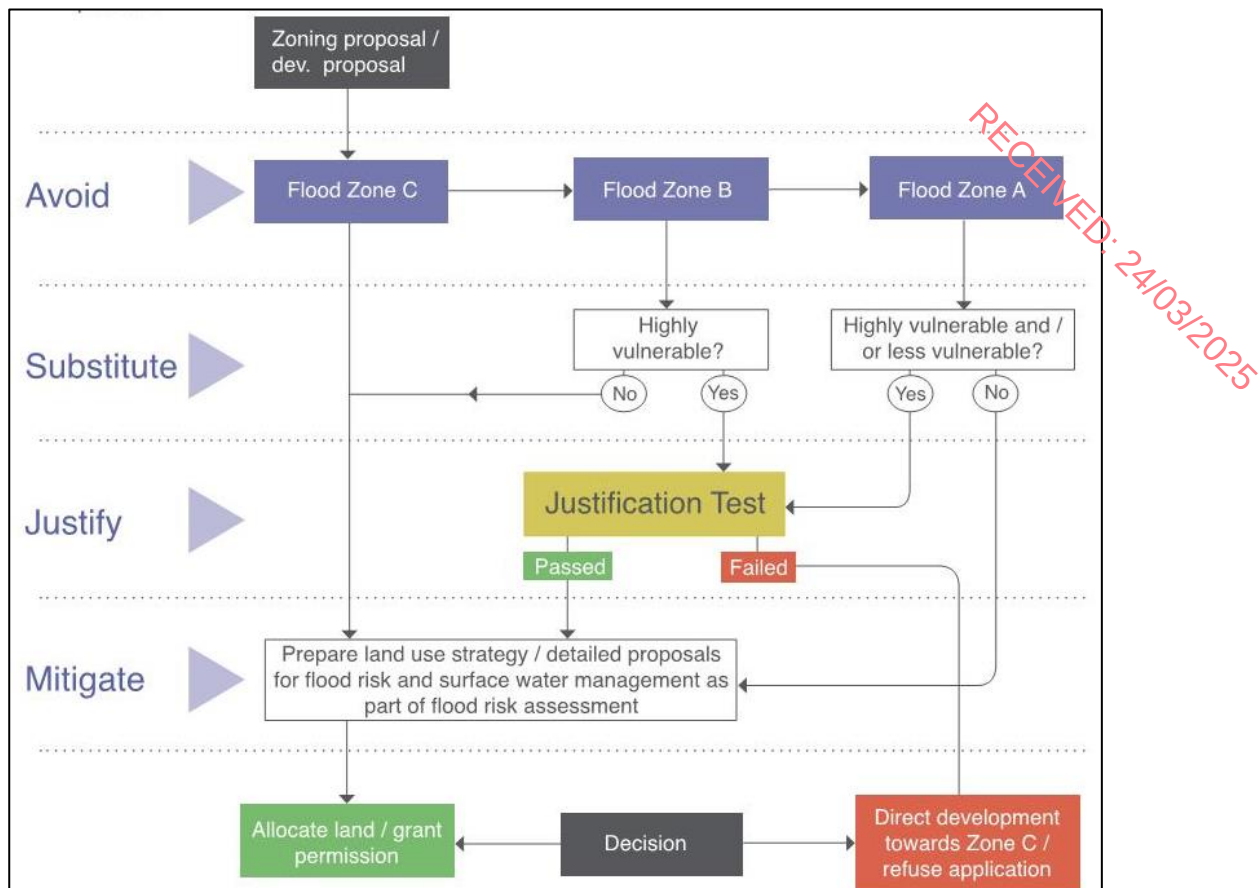


Figure 6-1 Sequential approach justification test

## 6.4 Application of the Justification Test

### 6.4.1 Overview

The Development Plan Justification Test has been undertaken as a part of the Strategic Flood Risk Assessment for the Bray Municipal District Local Area Plan 2018-2024. The Justification Test was passed and allows uses under 'Mixed Use' at the site area and surroundings, see Section 2.4.

### 6.4.2 Development Management Justification Test

The Development Management Justification Test is undertaken when developments vulnerable to flooding are proposed in areas at moderate or high risk of flooding (Flood Zones A and B). Prior to granting permission for the development, the planning authority must be satisfied that the development meets the criteria set out in the Development Management Justification Test described in Section 5 of The Planning Guidelines. These criteria are included in Table 6-1. It is demonstrated that the proposed development satisfies the criteria of the Development Management Justification Test.

**Table 6-1 Justification Test for Development Management**

| Justification Test Criteria                                                                                                                                                                                                                                                                                                                          | Response based on findings of FRA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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.                                                                                                                                    | <p>The Bray Municipal District Local Area Plan (LAP) 2018-2024 has zoned the former golf club lands for Mixed Use development including commercial, residential, education/cultural facilities and open space zones for expansion and regeneration of the urban centre.</p> <p>The development proposal include 341 residential units, childcare facilities, retail, hotel and medical centre which all align with the recommendations of the Development Plans.</p> <p>Therefore, it is considered that the proposed development satisfies the criteria of Part 1 of the development management Justification Test.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 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;                                                                                                                                                                                                                              | <p>In terms of assessing whether the development would increase flood risk elsewhere, flood defence measures have been constructed to protect the site up to the historical 'Hurricane Charlie' event, as well as the 1% AEP fluvial and 0.5% tidal events.</p> <p>As the site is not currently providing flood compensation storage and it is not within the functional floodplain, any development will have no negative impact to the fluvial or tidal flood risk elsewhere.</p> <p>Therefore, it is considered that the proposed development satisfies the criteria of Part 2(i) of the development management Justification Test.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| ii. The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible;                                                                                                                                                                                            | <p>The proposed site is already protected by flood defence measures which were designed to protect the area in accordance with the historical 'Hurricane Charlie' event.</p> <p>The proposed development has been designed to manage flood risk for the undefended 0.5% AEP tidal event and 1% aep fluvial event, setting highly vulnerable developments above the 3.50m AOD level. Mitigation measures include demountable barriers and a water exclusion strategy for retail units (less vulnerable) where land raising is not possible.</p> <p>The above flood mitigation measures ensure no negative flood impact within the site or surrounding environs.</p> <p>It is considered that the proposed development satisfies the criteria of Part 2(ii) of the development management Justification test.</p>                                                                                                                                                                                                                                                                      |
| 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 provision for emergency services access; | <p>The flood mitigation measures proposed herein have been assessed against an exceedance event to evaluate residual risks as well as impacts to other sites during such an unlikely event. No increases to flood extents were detected outside the red line boundary and the changes in flood levels do not impact other receptors and sites.</p> <p>The design of the linear park ensures that the flow paths through the site during an exceedance event are maintained, to allow flood waters to leave Little Bray and Dwyer Park through the linear park and re-enter the River Dargle via 6 circular culverts, located under the flood defence walls.</p> <p>The proposed development access roads are safe from flooding for this event and do not increase flood risk elsewhere. Safe dry access and egress is provided to and from the site via the access roads connecting at higher elevation to Dublin Road.</p> <p>It is considered that the proposed development therefore satisfies the criteria of Part 2(iii) of the development management Justification Test.</p> |

| Justification Test Criteria                                                                                                                                                                                                 | Response based on findings of FRA                                                                                                                                                                                                                                                                                                                  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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. | <p>The proposed development supports the development of a vibrant and active town centre and objective for increasing housing provision; therefore, it is in line with wider planning objectives.</p> <p>It is considered that the proposed development satisfies the criteria of Part 2(iv) of the development management Justification Test.</p> |

## 7. Discussion and Conclusion

The Sea Gardens Phase 2 development site is protected from fluvial and tidal flooding by the existing River Dargle Flood Defences. Risk of pluvial flooding to the development is low, with some local ponding potentially occurring at the low-lying areas of the site, behind the River Dargle Flood Defences. This is alleviated through an existing drainage ditch and culvert to the river. The risk of groundwater flood risk is low.

A hydrological analysis and hydraulic modelling were undertaken to analyse the risk of flooding to the site in the absence of defences and during an exceedance event. Three scenarios have been modelled: the fluvial 1% AEP event, tidal 0.5%AEP event and Hurricane Charlie extreme fluvial event. This were modelled for three conditions: undefended condition, defended baseline (no proposals) and defended with proposals.

The dominant flood event at the site location is the tidal 0.5%AEP event. The highest flood level nearest to the site was found to be 3.2m AOD. This level is used to set the flood protection level for the site, with a 300mm allowance for freeboard. As such, the flood protection level is set at 3.5m AOD.

In order to understand residual risks to the development and any impacts it might have to other sites, an overtopping exceedance scenario was run. The modelling demonstrates no rise in flood levels outside of the site and the maintenance of existing flow paths within the site to channel and remove water from Little Bray and Dwyer Park to the river.

The flood risk management strategy of the site comprises of:

- Locating residential (highly vulnerable) properties away from flood risk;
- Raising residential properties and key access routes above the flood protection level of 3.5m AOD. Some localised roads including those to the north and south of Block G have levels below 3.5m AOD to allow for maintenance of the exceedance flow path from Dwyer Park through the linear park as shown in Figure 4-12.
- Where raising of levels is not possible, demountable barriers and a water exclusion strategy is proposed for retail units (less vulnerable development).

The proposed development comprises of ‘highly and less vulnerable development’, and partially lies within Flood Zone A. Therefore, a Justification Test in accordance with the OPW Guidelines is required. Both the Development Plan and Development Management Justification Tests are passed.

This FRA demonstrates that the risks relating to flooding can be managed and mitigated to acceptable levels and therefore comply with DoEHLG / OPW planning guidance and the Wicklow County Council Development Plan 2022-2028 objective CPO 14.09.