

The background is a vibrant red color. It features several abstract geometric shapes: a large white circle with a blue border in the upper right; a smaller white circle with a blue border in the lower left; a large green semi-circle in the bottom right; and various other shapes in blue, green, and white scattered throughout the corners and edges.

Appendix N
Flood Risk
Assessment
Report

Jacobs Engineering Ireland Limited

Merrion House
Merrion Road
Dublin 4, D04 R2C5
Ireland
T +353 1 269 5666
F +353 1 269 5497
www.jacobs.com

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1. Introduction

1.1 Project Background

In June 2018 the National Transport Authority (NTA) published the Core Bus Corridors Project Report. The report was a discussion document outlining proposals for the delivery of a core bus corridor network across Dublin. It set out the vision for the provision of 230km of dedicated bus lanes and 200km of cycle lanes/tracks on sixteen key bus corridors.

The proposed development consists of 16 radial core bus corridors across Dublin, shown in **Figure 1.1** below. The network redesign is primarily implemented on the existing road network with some enhancements at key interchange locations.

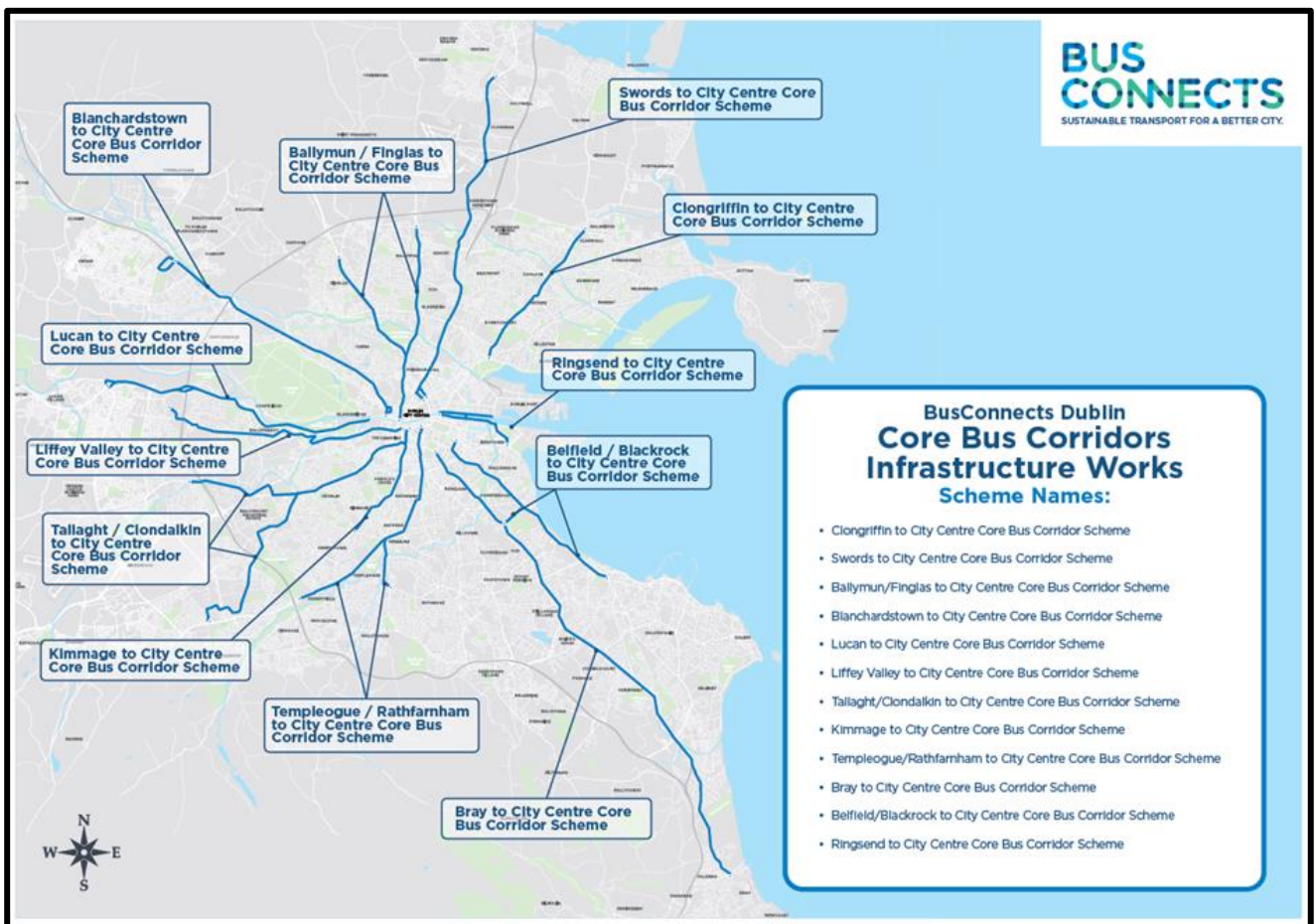


Figure 1.1 BusConnects Core Bus Network – Radial Corridors

Each bus corridor is subject to an independent flood risk assessment. This flood risk assessment relates specifically to the Bray to City Centre Core Bus Corridor scheme (the Proposed Scheme).

1.2 Works Description

The objective of this report is to assess the level of flood risk to the proposed development, using readily available information and information from site visits where necessary. The assessment will be equivalent to a Stage 1 and Stage 2 flood risk assessment as set out in ‘The Planning System and Flood Risk Management, Guidelines for Planning Authorities’ (Office of Public Works, 2009).

The report will set out the limitations of the study and any recommendations for further site-specific investigation as part of a Stage 3 flood risk assessment.

The Bray to City Centre Core Bus Corridor (CBC) scheme (herein after called the **Proposed Scheme**), refer to **Figure 1.2**, commences at the Leeson St Lower junction on St. Stephen's Green, and continues along Leeson St Lower and Upper including the existing one-way system on Sussex Road. It continues on Morehampton Road and Donnybrook Road through Donnybrook Village, and onto the Stillorgan Road, intersecting with the proposed Belfield/Blackrock to City Centre Core Bus Corridor at Nutley Lane and the UCD Interchange at University College Dublin (UCD). It continues south on Stillorgan/Bray Road as far as the Loughlinstown Roundabout. The route then proceeds along the R837 Dublin Road through Shankill and onto the R119, across the M11 access roundabout (Wilford Roundabout) and onto the R761 Dublin Road north of Bray. It carries on to Castle Street and terminates at the northern end of the Fran O'Toole Bridge (Dargle River Crossing) where it ties in with the Bray Bridge Improvement Scheme.

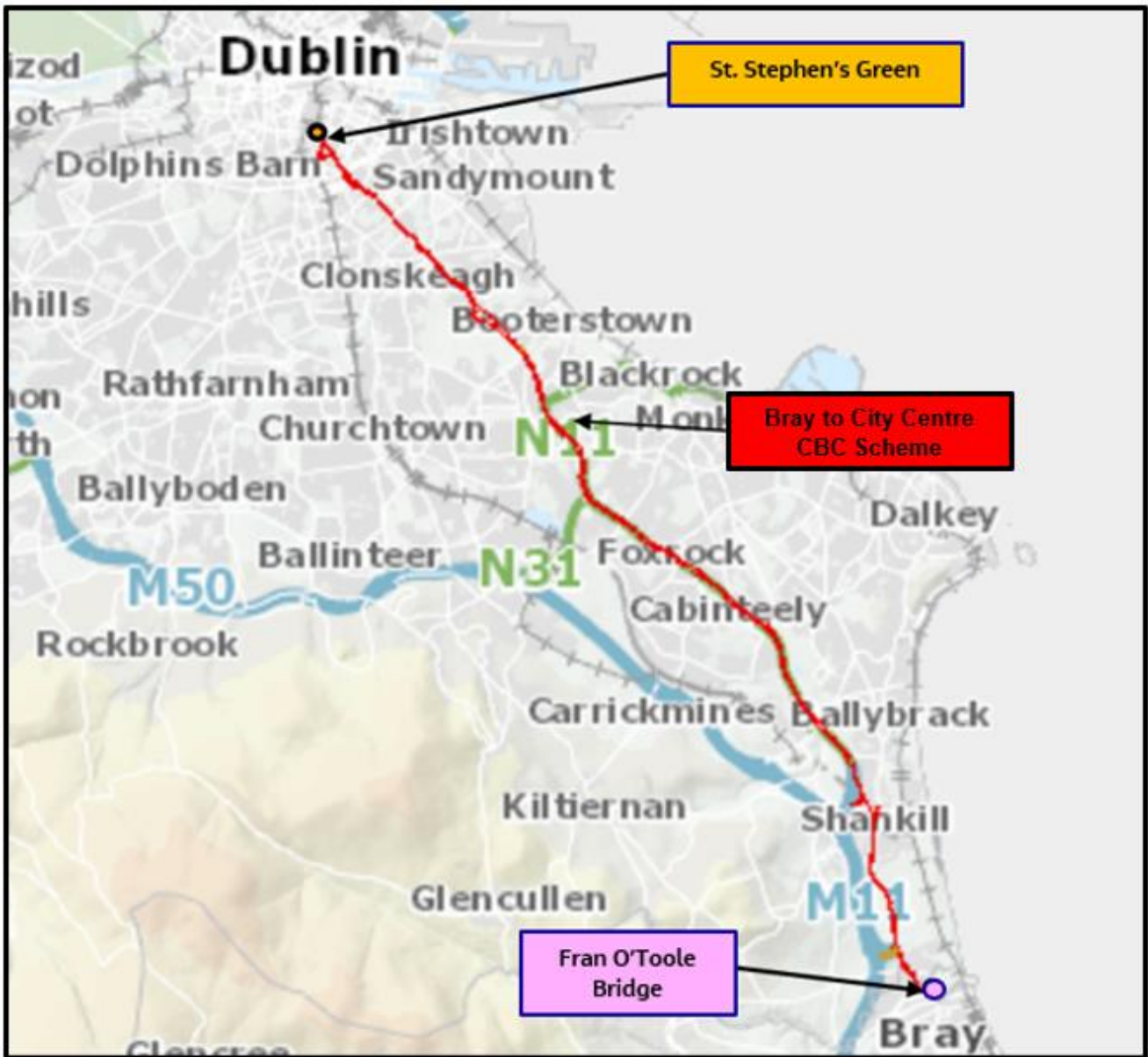


Figure 1.2 Location Map of Bray to City Centre CBC

The Bray to City Centre CBC is split into 4 sections which are described below, refer to **Figure 1.3**. The break points differ slightly from the sections in the Preferred Route Options Report and the Preliminary Design Report for the purpose of this Flood Risk Assessment.

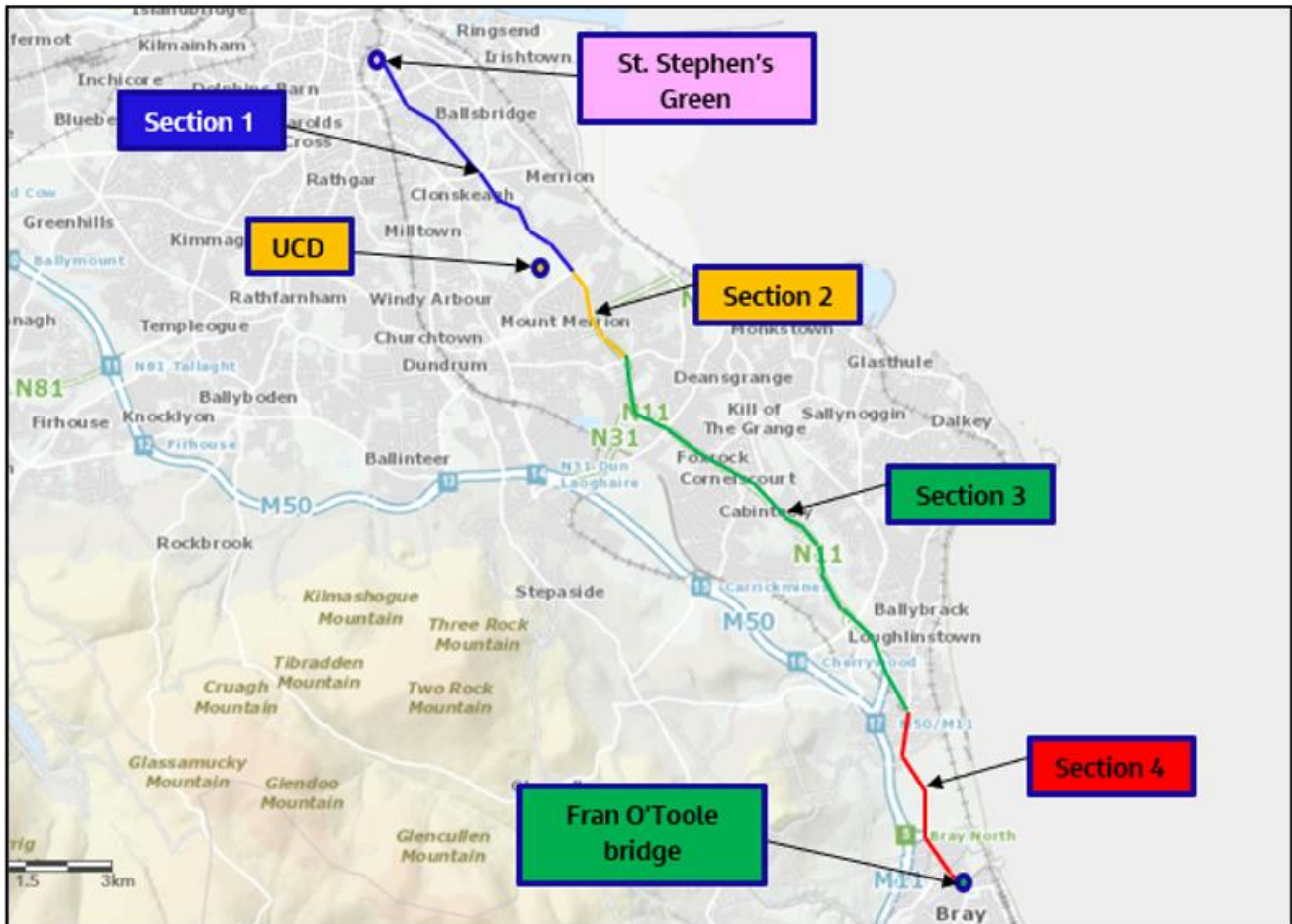


Figure 1.3 Bray to City Centre CBC scheme (sections)

1.2.1 Section 1 Leeson Street Lower to UCD

Section 1 of the route extends from Leeson St Lower (716068; 733182) to UCD (718767; 730262).

It is proposed to commence the CBC at the junction of Leeson Street Lower and St. Stephens Green. The corridor runs along Leeson Street Lower and Upper providing continuous bus priority and segregated cycle lanes in each direction including the one-way system on Sussex Road. It is proposed to achieve continuous bus priority and segregated cycle tracks in each direction along Morehampton Road and Donnybrook Road through Donnybrook Village and the Stillorgan Road to UCD (718767; 730262). Signal controlled priority will be used in a number of constrained locations to ensure bus priority.

This section of the route will require road, cycle track, and/or footpath widening between Brookvale Road and Eglinton Road, and between Anglesea Road and Airfield Park.

1.2.2 Section 2 UCD to Lower Kilmacud Road

Section 2 of the route extends from UCD (718767; 730262) to Lower Kilmacud Road (720314; 728081).

At the UCD Interchange (718767; 730262) it is proposed to retain existing bus lanes on the southbound on-ramp, northbound off-ramp and northbound on-ramp.

It is intended to provide a new bus lane on the following arms of the junction; southbound off-ramp and Stillorgan Road Overbridge. It is proposed to provide improved bus stop facilities on both southbound slip roads, and on the northbound on-ramp. It is intended to provide segregated cycle tracks on each of the junction arms and on the overbridge.

On the Stillorgan Road between Seafield Road and Foster's Avenue it is intended to provide a bus lane and two general traffic lanes in each direction. A short length of two-way segregated cycleway will be provided on both sides of the carriageway due to the proximity to UCD. These will be between Woodbine Road and Merrion Grove southbound, and between Fosters Avenue and Seafield Road northbound.

Between Merion Grove and Lower Kilmacud Road, it is proposed to provide a bus lane and two general traffic lanes plus a one-way segregated cycle track in each direction. It is proposed to extend the left turn slip and protected cycleway on the northbound approach to Foster's Avenue, and to close the left turn slip to and from Booterstown Avenue, and the left turn slip to Mount Merrion Avenue, Trees Road Lower, Priory Drive, and the Old Dublin Road.

A new toucan crossing is planned between Patrician Villas and St Laurence Park. It is also proposed to provide a new footway on the eastern side of the N11, and better connectivity to the toucan crossing, by modifying the existing pedestrian underpass structure and associated pedestrian access respectively. At the junction with Lower Kilmacud Road (720314; 728081) it is intended to realign the junction to provide improved pedestrian refuges, and to remove all left turn slips to and from the junction.

1.2.3 Section 3 Lower Kilmacud Road to Loughlinstown Roundabout

Section 3 of the route extends from Lower Kilmacud Road (720314; 728081) to Loughlinstown Roundabout (724874; 722882).

It is proposed to maintain one bus lane and two general traffic lanes in each direction. Improved segregated cycle tracks and pedestrian footways will be provided along this section of the route. The section between the R842 Bray Road and the new Druid's Glen junction at Kilbogget Park will not have any footpaths provided however, as alternative routes parallel to the N11 are available instead. It is intended to upgrade the existing pedestrian crossing adjacent to Merville Road / Glenalbyn Road to allow cyclists to use this crossing. A short section of northbound cycle track here will also be diverted on to St. Brigid's Church Road due to space and utilities constraints along the N11.

At all major junctions along this section is intended to reconfigure the junction layouts to provide enhanced cycle protection and turning movements, improved pedestrian crossing facilities, and to remove left run slips where possible. It is intended to provide a new pedestrian link from the Stillorgan Road to South Park Estate, and a new pedestrian entrance to Shanganagh Vale.

At the Wyattville Road Junction it is intended to remove the existing on-road southbound cycle track and provide a new off-road two-way cycle track.

At the Loughlinstown Roundabout (724874; 722882) it is proposed to signalise the existing roundabout and to provide a continuous bus lane outbound through the junction towards Shankill. The northbound bus lane from Shankill will stop short of the southside of the roundabout junction and resume to the north of the junction on the Bray Road.

1.2.4 Section 4 Loughlinstown Roundabout to Dargle River Crossing

Section 4 of the route extends from Loughlinstown Roundabout (724874; 722882) to Dargle River Crossing (726275; 718892).

South of Loughlinstown Roundabout it is proposed to provide one bus lane and one general traffic lane in each direction, though some signal-controlled priority is necessary to ensure continuous bus priority due to constraints,

where a continuous bus lane cannot be accommodated. A two-way segregated cycle track is planned between Stonebridge Road and St. Anne's Church (Corbawn Lane). The two-way cycle track will continue along Stonebridge Road as far as Stonebridge Lane. At the junction of Dublin Road and Stonebridge Road the existing junction is intended to be upgraded to provide bus priority and new pedestrian and cyclist crossing facilities.

Because of width restrictions approaching and through Shankill Village there is no dedicated cycle or bus provision between St. Anne's Church and Olcovar. Signal controlled priority will be used to provide bus priority. A northbound bus lane is provided as far as Olcovar, while the southbound bus lane starts just north of the new Shanganagh Castle junction. Signal controlled priority shall be used between here and Stonebridge Road where bus lanes are not achievable.

From south of Crinken Lane to Wilford Junction it is proposed to provide a bus lane, cycle track and a general traffic lane in each direction. Land take may be required on both sides of the road. Signal controlled priority shall be used in the northbound direction between Wilford Junction and Saint Brendan's College due to space constraints.

The existing M11 Wilford Roundabout is proposed to be reconfigured as a T-junction, which will result in a large area of currently paved carriageway being returned to grass verge. From the M11 junction to the Dargle River Crossing it is proposed to continue with a bus lane, general traffic lane and a segregate cycle track in each direction.

The junction with Corke Abbey Avenue is intended to be upgraded to improve bus priority, cycle movements, and pedestrian facilities. It is proposed to remove the existing uncontrolled pedestrian crossings and refuge islands between Chapel Lane and Upper Dargle Road. It is intended to upgrade the junction with the Upper Dargle Road to provide bus priority, improved cycle movements, and pedestrian facilities. Land take may be required on both sides of the road.

1.3 Report Structure

The flood risk assessment is structured as follows:

- Chapter 2 sets out the Planning Guidelines considered.
- Chapter 3 sets out the Flood Risk Assessment Methodology.
- Chapter 4 outlines the findings of the Stage 1 flood risk assessment.
- Chapter 5 presents the findings of the Stage 2 flood risk assessment.
- Chapter 6 details the potential flood risk implications arising from the work and the proposed mitigation measures.
- Chapter 7 assesses the proposed works in accordance with the Justification Test.
- Chapter 8 presents the conclusions and recommendations.

2. Planning Guidelines

2.1 The Planning System and Flood Risk management Guidelines for Planning Authorities

The Planning System and Flood Risk Management Guidelines for Planning Authorities *'introduce comprehensive mechanisms for the incorporation of flood risk identification, assessment and management into the planning process.'*

The Guidelines set out methodology to be used for the flood risk assessment for the proposed development is based on the FRM Guidelines which require the planning system at national, regional and local levels to:

- Avoid development in areas at risk from flooding, particularly floodplains, unless there are proven wider sustainability grounds that justify development. Where this is the case development must be appropriate and flood risks must be effectively managed to reduce the level of risk.
- Adopt a Sequential Approach to flood risk management when assessing the locations for new development based on avoidance, reduction, and mitigation of flood risk.
- Incorporate flood risk assessment into planning application decisions and appeals.

2.2 Dublin City Development Plan – Strategic Flood Risk Assessment (2016-2022)

The Strategic Flood Risk Assessment (SFRA) provides *'an area wide assessment of all types of significant flood risk to inform strategic land use planning decisions.'*

The assessment presents the key flood management policies and objectives that must be followed by all new developments. It also identifies 30 sites within flood zones A and B and covers acceptable grounds for justification tests for development plans within each site. Where the proposed development is within or proximate to these sites, further detail is provided with in this report.

The proposed development will need to demonstrate compliance with the overarching objectives and recommendations of the SFRA. In particular, the below details have been extracted from the SFRA for consideration within the design of the proposed development:

- Section 4.5 of the SFRA covers major developments within flood zone A and B. It is **not appropriate for new highly vulnerable development to be located on greenfield land within flood zone A or B.** Regeneration of already urbanised areas within zones A and B may be justified.
- Section 4.6 of the SFRA covers highly vulnerable development in Flood Zone A and B. It states that "Proposals for development that results in a loss of fluvial floodplain within undefended flood zone A must also demonstrate that compensatory storage can be provided on a level for level basis."
- Section 4.10 of the SFRA covers climate change. It states that "For most development...the medium-range future scenario (20% increase in flows and/or 0.5m increase in sea level and/or 20% increase in rainfall depth) is an appropriate consideration."

2.3 Greater Dublin Strategic Drainage Study (April 2005)

The Greater Dublin Strategic Drainage Study was commissioned in 2001 to carry out an analysis of the existing foul and surface water drainage systems in the local authority areas of Dublin City, Fingal, South Dublin, Dun Laoghaire – Rathdown and the adjacent catchments in Counties Meath, Kildare, and Wicklow. The objectives of the study can be summarised as follows:

- To develop an environmentally sustainable drainage strategy for the region consistent with the EU Water Framework Directive
- To provide a consistent policy framework and standards which will apply throughout the region
- To develop tools for the effective management of the drainage systems including Geographical Information Systems (GIS), network models and digital mapping
- To develop the optimum drainage solution from a range of alternative scenarios having regard to the whole-life cost and environmental performance, the solution to be broken down into a set of implementation projects which can be prioritised and put in place

2.3.1 Dun Laoghaire - Rathdown County Development Plan

A Strategic Flood Risk Assessment and Management Plan was prepared as part of the Dun Laoghaire – Rathdown County Development Plan 2022-2028. This document states that part of the Bray to City Centre CBC scheme is located within Flood Zones A and B at the river crossings with Carysfort Maretimo Stream, River Shanganagh and River Rathmichael, refer to **Figure 2.1**, **Figure 2.2** and **Figure 2.3**.

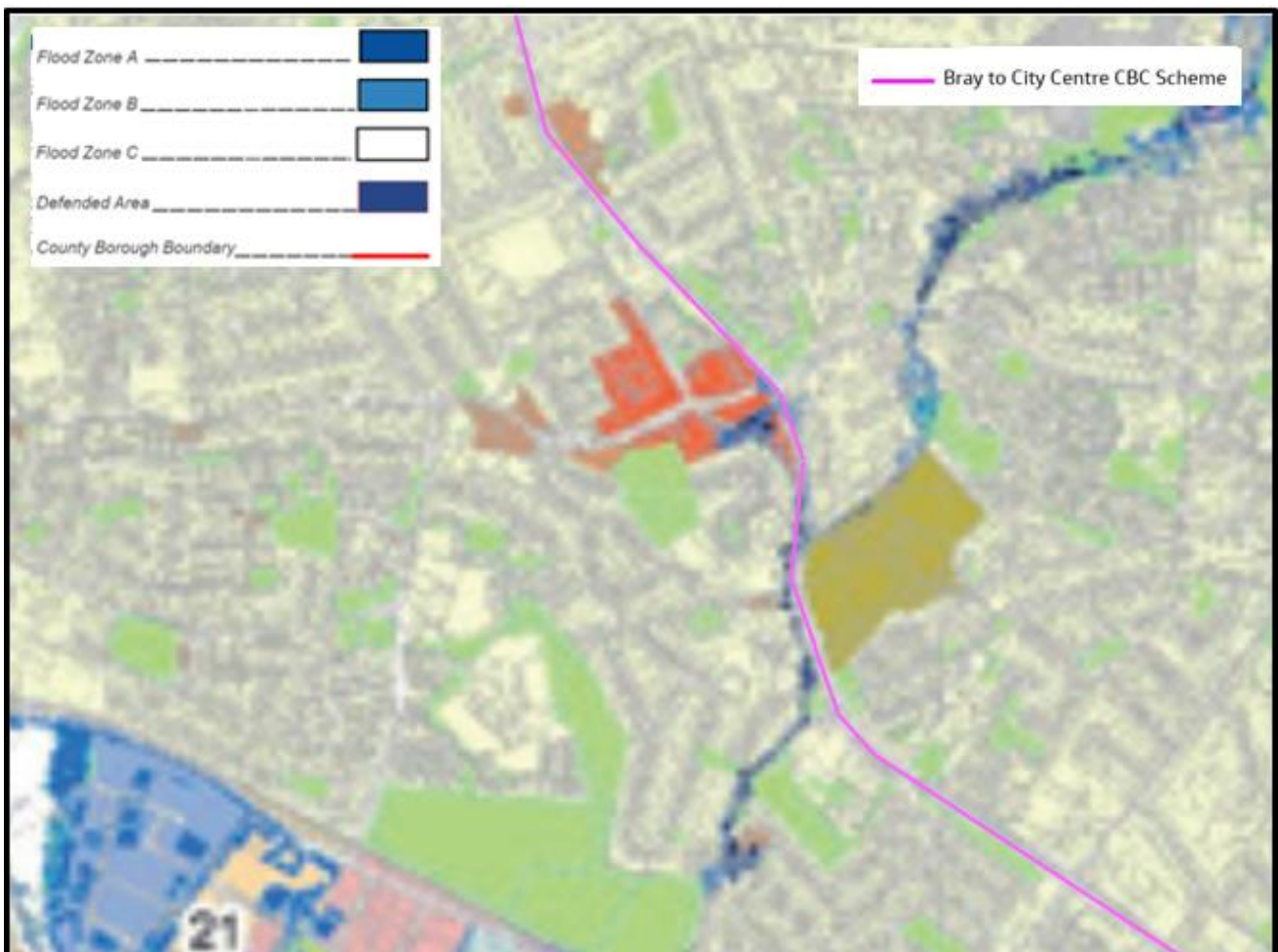


Figure 2.1 Dun Laoghaire - Rathdown Council Composite Flood Map (Carysfort Maretimo watercourse crossing).

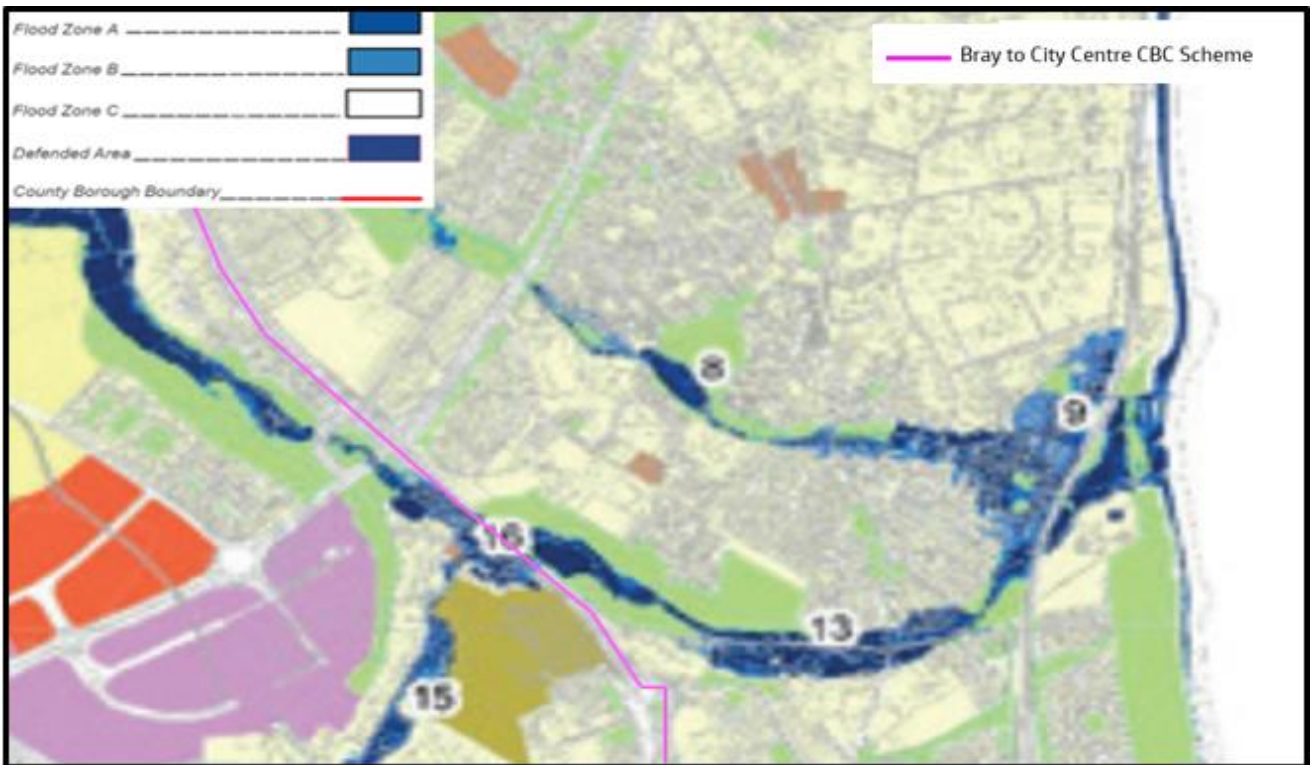


Figure 2.2 Dun Laoghaire - Rathdown Council Composite Flood Map (River Loughlinstown Rivers North and South crossing).

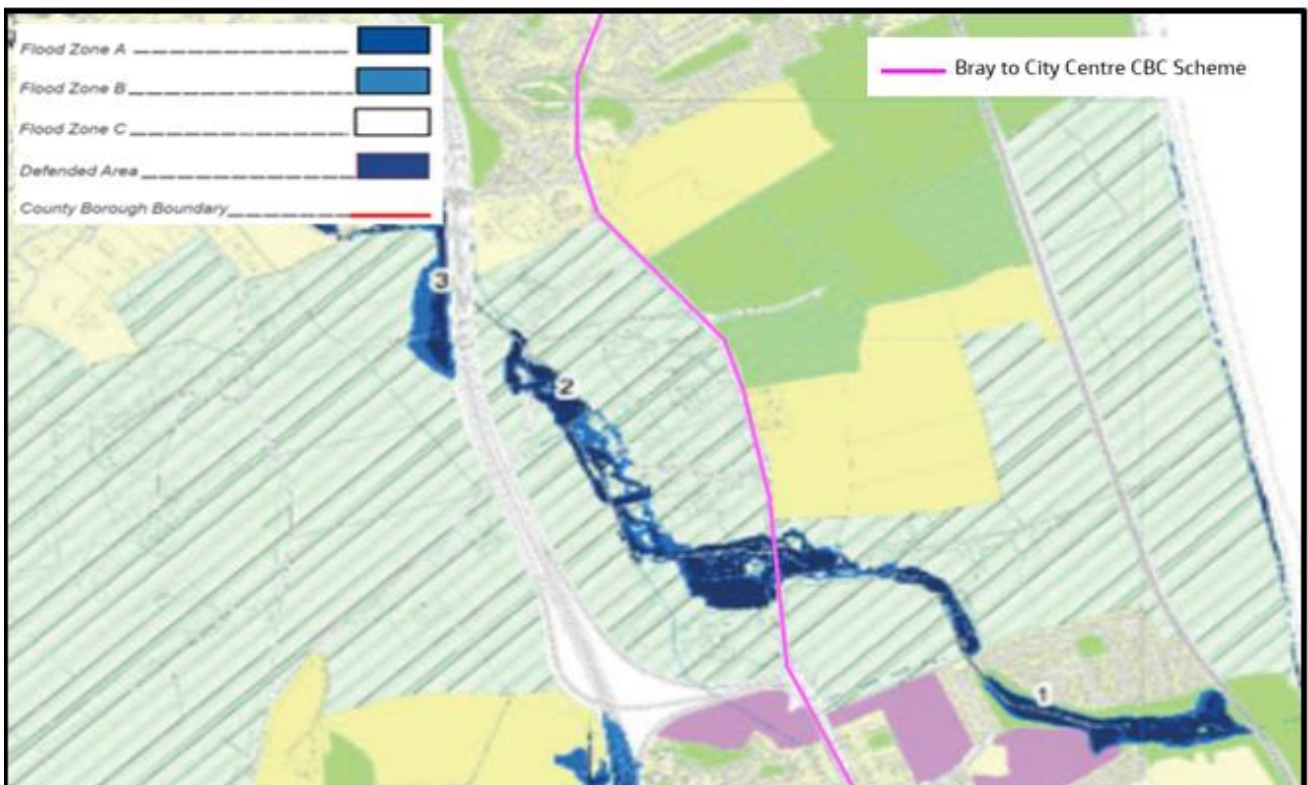


Figure 2.3 Dun Laoghaire - Rathdown Council Composite Flood Map (River Rathmichael crossing).

2.3.2 Wicklow County Development Plan

A Strategic Flood Risk Assessment and Management Plan was prepared as part of the Wicklow County Development Plan 2016-2022. This document states that part of the Bray to City Centre CBC scheme along Dublin Road (R761) and Castle Street is located within Flood Zone A, refer to **Figure 2.4**.

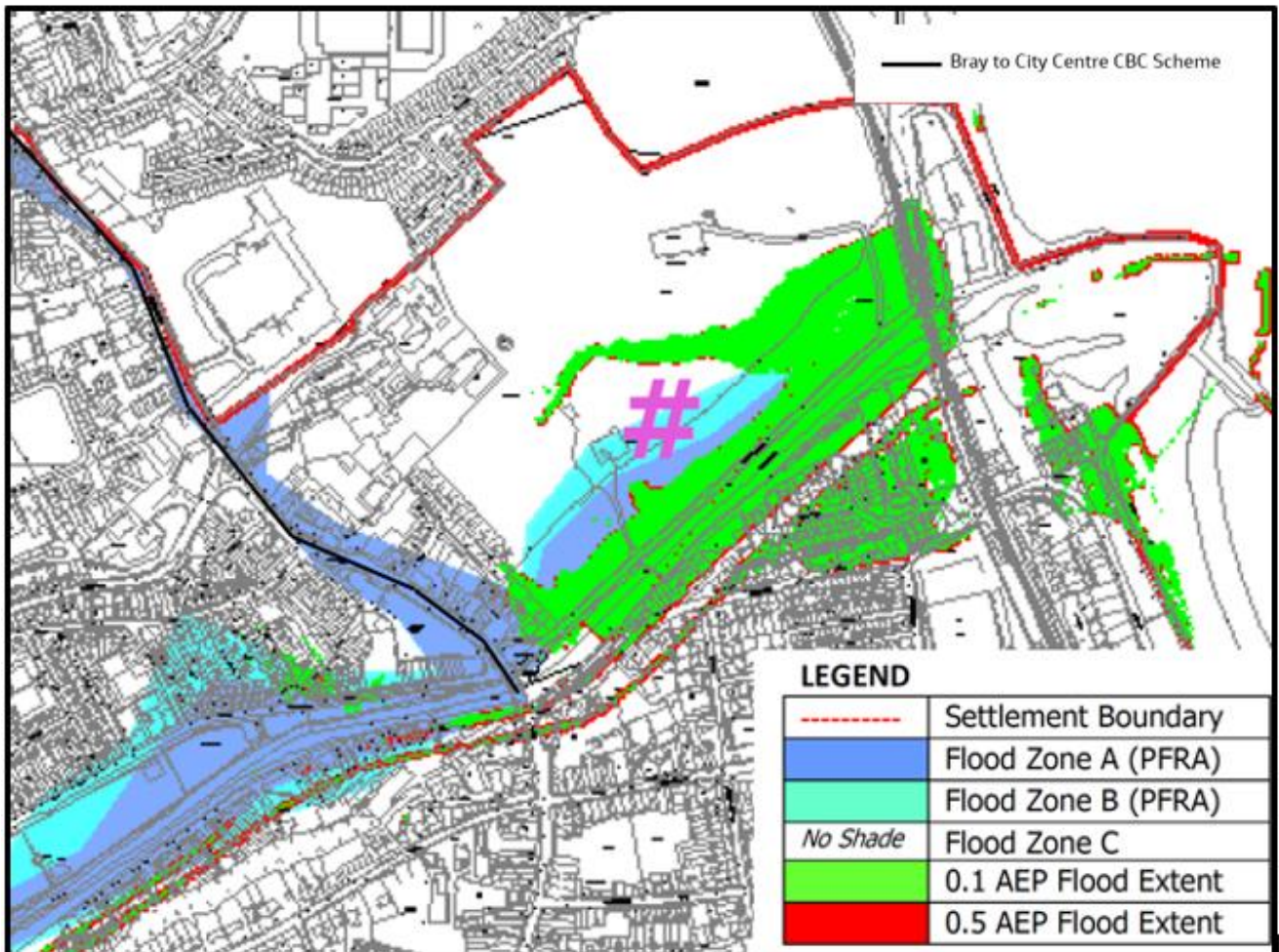


Figure 2.4 Bray City Composite Flood Map. (Wicklow County Development Plan 2016 – 2022).

2.3.3 Bray Municipal District Local Area Plan

A Strategic Flood Risk Assessment and Management Plan was prepared as part of the Bray Municipal District Local Area Plan 2017. This document confirms the information provided in the Wicklow County Development Plan 2016-2022 regarding the flood risk along the Bray to City Centre CBC scheme on Dublin Road (R761) and Castle Street, refer to **Figure 2.5**.

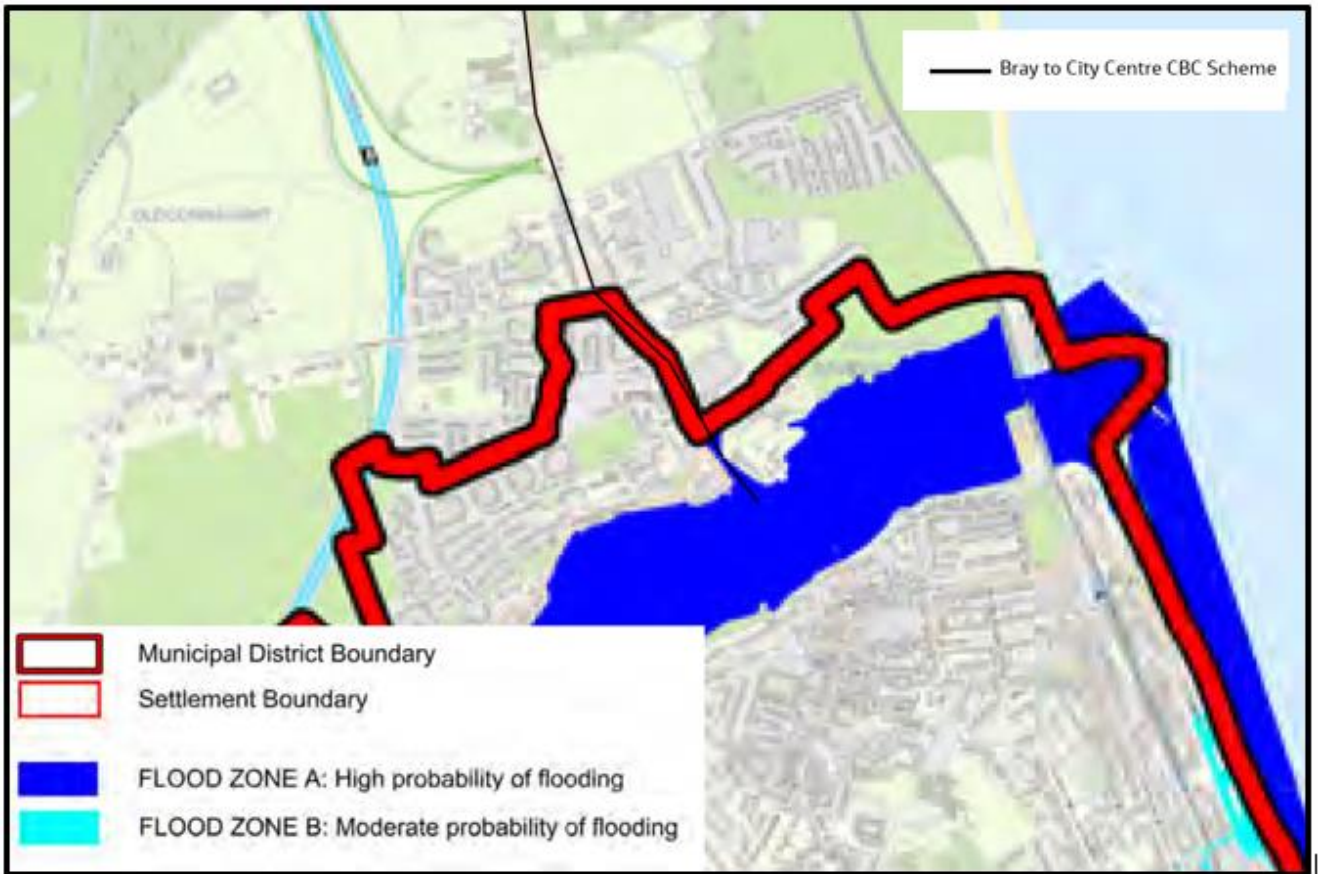


Figure 2.5 Bray City Composite Flood Map (Bray Municipal District Local Area Plan 2017).

3. Flood Risk Assessment Methodology

The Guidelines require the consequences of any flooding to be considered against three different receptors, namely people, their property and the environment. The planning process is mostly concerned with the location of these receptors, and the potential pathways and sources that could introduce a risk to them.

The Planning System and Flood Risk management Guidelines for Planning Authorities states that a staged approach should be used for the flood risk assessment process. The details of each stage are outlined below.

- **Stage 1 Flood Risk Identification** – this stage will identify any issues (flooding or surface water management) related to the proposed BusConnects development.
- **Stage 2 Initial Flood Risk Assessment** – This stage will seek confirmation on the sources of flooding identified in Stage 1 that may affect the proposed development. All existing information, and the accuracy of this, will be reviewed in detail and extent of the flood risk associated with the BusConnects development will be established. This stage will determine the nature of any further work required as part of the Flood Risk Assessment.
- **Stage 3 Detailed Flood Risk Assessment** – This stage will assess flood risk issues in sufficient detail and to provide a quantitative appraisal of potential flood risk to a proposed or existing development, of its potential impacts on flood risk elsewhere and of the effectiveness of any proposed mitigation measures. This will typically involve use of an existing or construction of a hydraulic model across a wide enough area to appreciate the catchment wide impacts and hydrological process involved.

3.1 Flood Zones

The guidelines define three different flood zones as follows:

- **Flood Zone A** – *'where the probability of flooding from rivers and the sea is highest (greater than 1% or 1 in 100 for river flooding or 0.5% or 1 in 200 for coastal flooding)'*
- **Flood Zone B** – *'where the probability of flooding from rivers and the sea is moderate (between 0.1% or 1 in 1000 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** – *'where the probability of flooding from rivers and the sea is low (less than 0.1% or 1 in 100 for both river and coastal flooding (Flood Zone C covers all areas of the plan that are not in zones A or B)'*

3.2 Vulnerability of BusConnects Bray to City Centre Core Bus Corridor

The proposed development comprises:

- Realignment of existing highway, cycle track and footpath
- Construction of new highway, cycle track and footpath
- Construction of new bus stops and other new street furniture
- Upgrade and construction of road junctions
- Construction of new retaining walls, and an extension to an underpass

As per table 3.1 of the Planning System and Flood Risk Management Guidelines for Planning Authorities and Section 1.6 DDCo SFRA, essential infrastructure such as primary transport is classed as a 'highly vulnerable development'.

A justification test is required where proposed highly vulnerable development is located within Flood Zone A or Flood Zone B.

4. Stage 1 Flood Risk Identification

4.1 Historic Flood Events

The OPW National Flood Hazard Mapping website (www.floodinfo.ie) was used to identify historical flooding on the proposed Bray to City Centre CBC. Eight flood events were identified on or in close proximity to the bus corridor as indicated in **Table 4.1** below. **Figure 4.1** shows the past flood events in close proximity to the Bray to City Centre Core Bus Corridor.



Figure 4.1 Extract of past flood events proximate to Bray to City Centre CBC (Source – OPW Flood Hazard mapping, floodinfo.ie)

This is not considered to be a full and comprehensive record of all historic flooding on the Bray to City Centre CBC; however, it provides a key part of the desk-based assessment.

Table 4.1 Record of historic flooding proximate to Bray to City Centre CBC (Source: floodinfo.ie)

Location	Type	Date	Description
Morehampton Road	Pluvial	11th June 1963	Refer to Figure 4.2. Refer to 131 mm rainfall collected between 12.00 to 17.00. covers lifting, basements flooded, gullies choked and damage from underground stormwater.
Stillorgan Road (R138)	Pluvial	11 th June 1963	Refer to Figure 4.2. Refer to 184.2 mm rainfall collected between 13.50 to 23.00. covers lifting, basements flooded, gullies choked and damage from underground stormwater.
Stillorgan Hill	River – Brewery Stream	November 2002	Refer to Figure 4.3 Localised blockage. Blocked/broken culvert along central median of Stillorgan Road (N11).
Brewery Road, Loughlinstown	River – Brewery Stream	1986, Recurring	Refer to Figure 4.3. Hurricane Charlie (1986) and a number of subsequent occasions flooding occurred due to overtopping of stream. Usually caused to screens blocked by storm debris. Affects Brewery Road and St Brigid's N.S. Potential remedial works in 2000 / 2002.
Bray Road (N11), Loughlinstown	River – Carrickmines/Shanganagh River	24 th October 2011	Refer to Figure 4.4. The source of the flood waters was the Carrickmines River, a tributary of the Shanganagh River. The river was overtopped. A pedestrian river crossing and overgrowth in the river channel at the rear of the flooded properties may have exacerbated flood levels.
Commons Road	River Shanganagh	27 th November 2002	Refer to Figure 4.4. The river burst onto the Commons Road because the levels had risen due to heavy rain, the road in this case was completely flooded.
Dublin Road (R119)	Crinken/Woodbrook Stream (Rathmichael Stream)	8 th April 2005 (Recurring)	Refer to Figure 4.5. Occasional flooding on road, near golf club entrance and in Woodbrook College grounds. Probably due to culvert blockage.
Castle Street (R761)	River – Dargle River	17 th November 1965 (Recurring)	Refer to Figure 4.5. Precipitation commenced at about 4h GMT on 16 th November and fell continuously for a period of between 16 and 17 hours. The serious flooding caused by the Dargle occurs over the last 2.5km approximately of the river, or from just upstream of 'The Slang' to the outfall in Bray Harbour. A solution to this issue is the River Dargle Flood Defence Scheme which was completed in October 2017 by Wicklow County Council And the OPW. This project involved the widening and deepening of the river channel, construction of flood walls and embankments along a 3.3 km stretch from Silverbridge at the N11 to the Harbour Bridge at Bray Harbour.

Further details of these flood events are provided in **Figure 4.2**, **Figure 4.3**, **Figure 4.4** and **Figure 4.5** below.

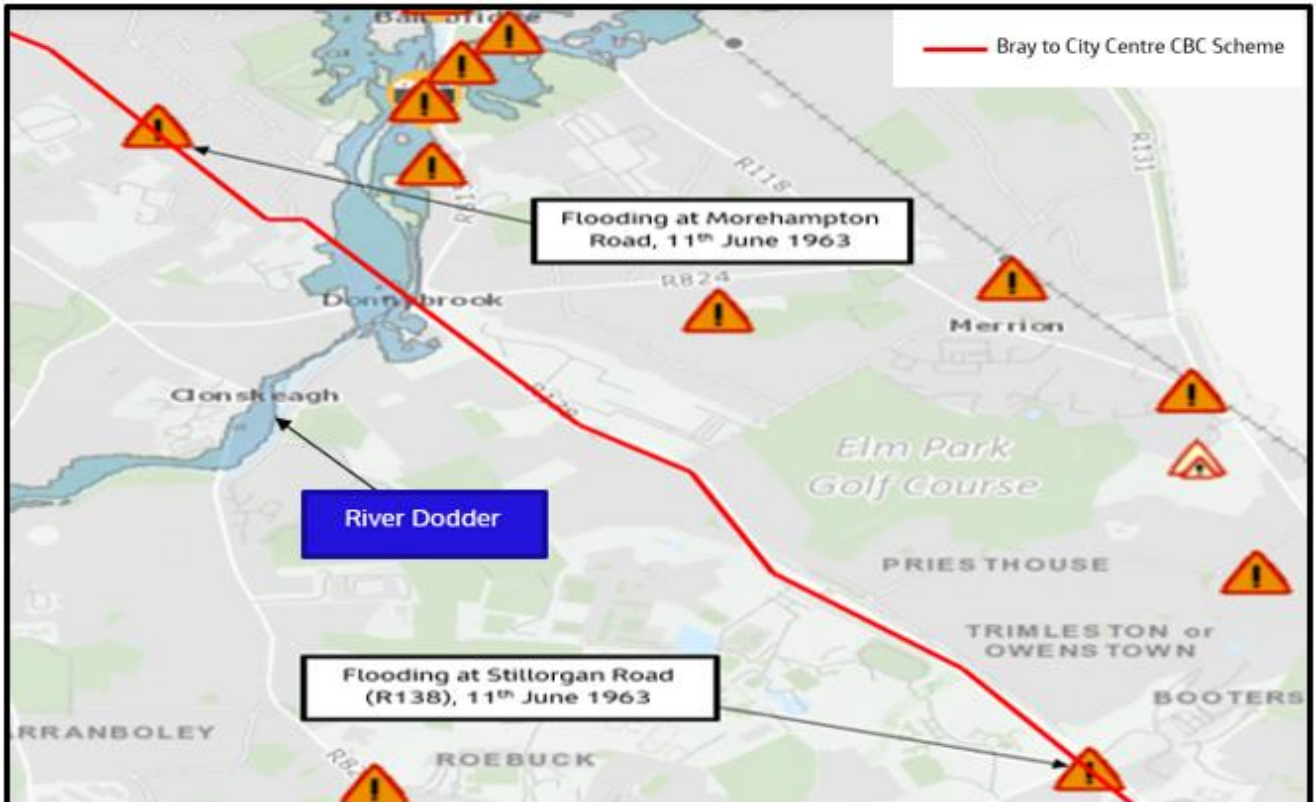


Figure 4.2 Locations of historic flooding at Morehampton Road and Stillorgan Road (R138)

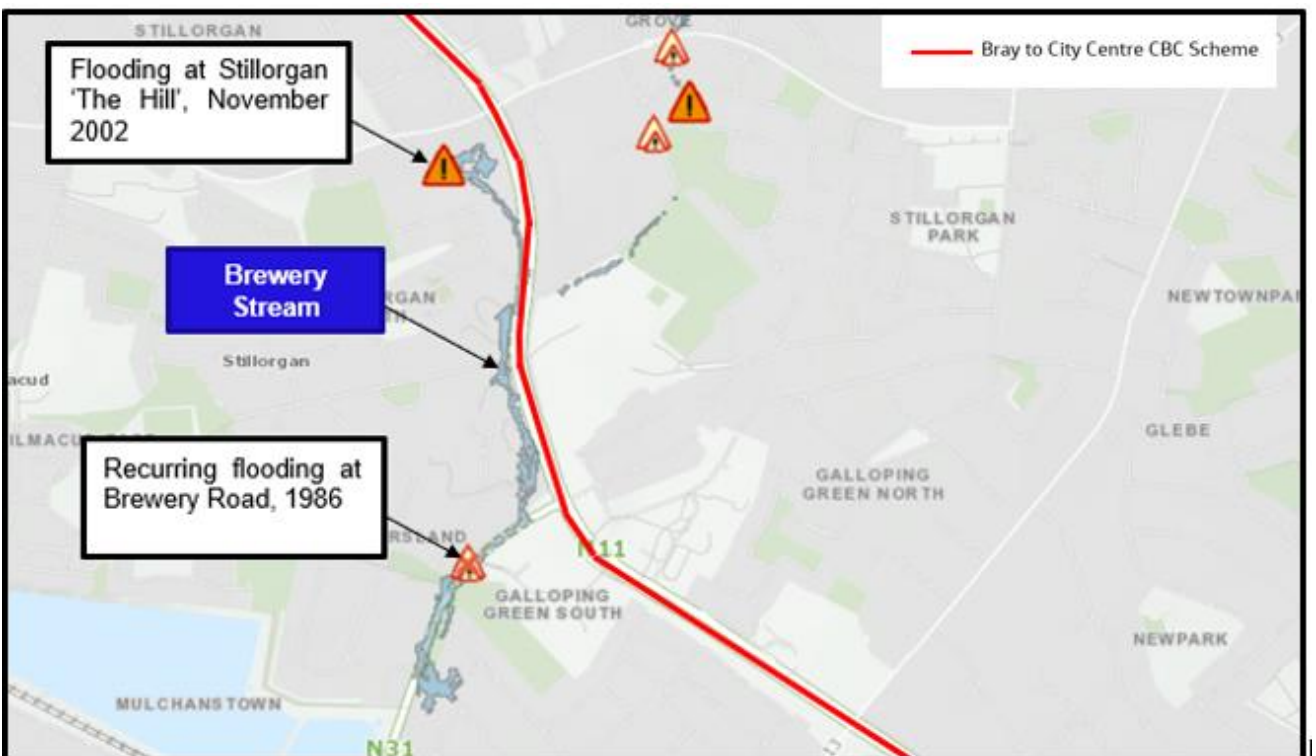


Figure 4.3 Location of historic flooding at Stillorgan Hill

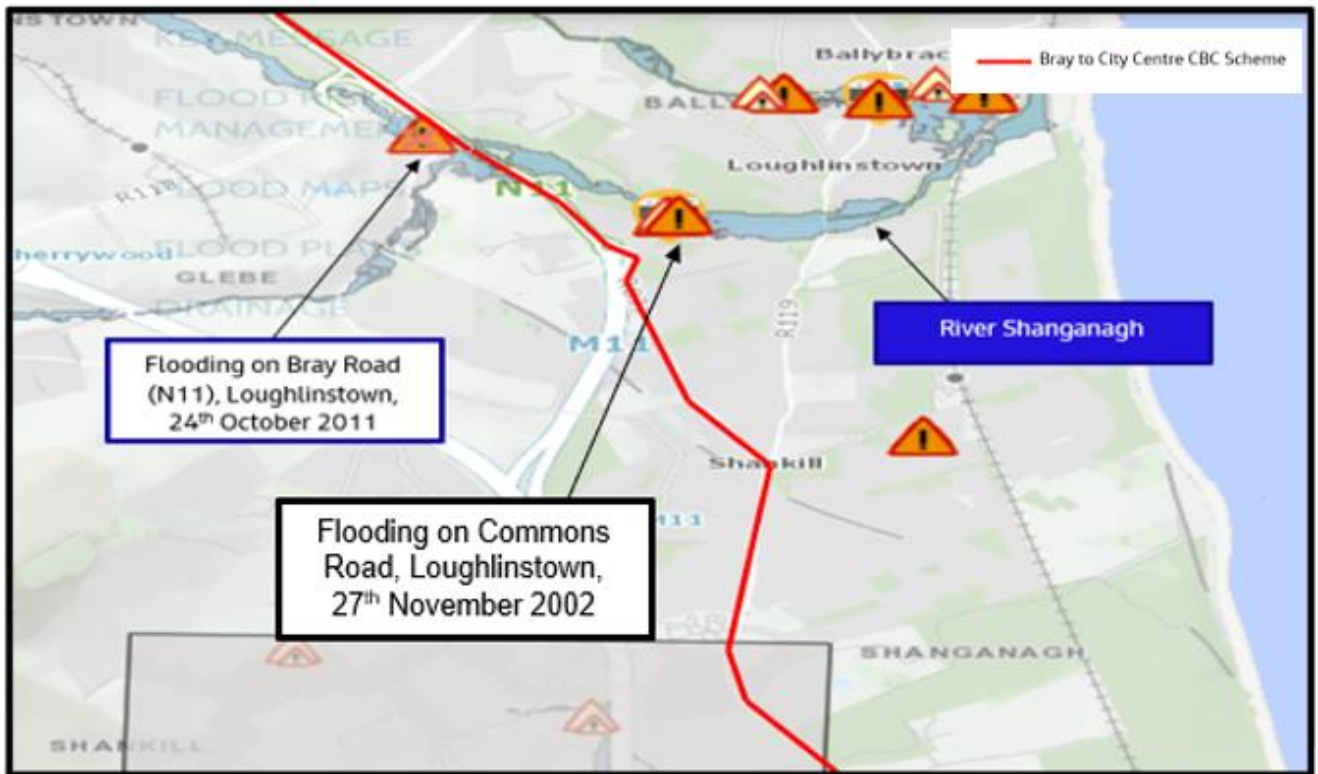


Figure 4.4 Location of historic flooding on Bray Road (N11), Loughlinstown

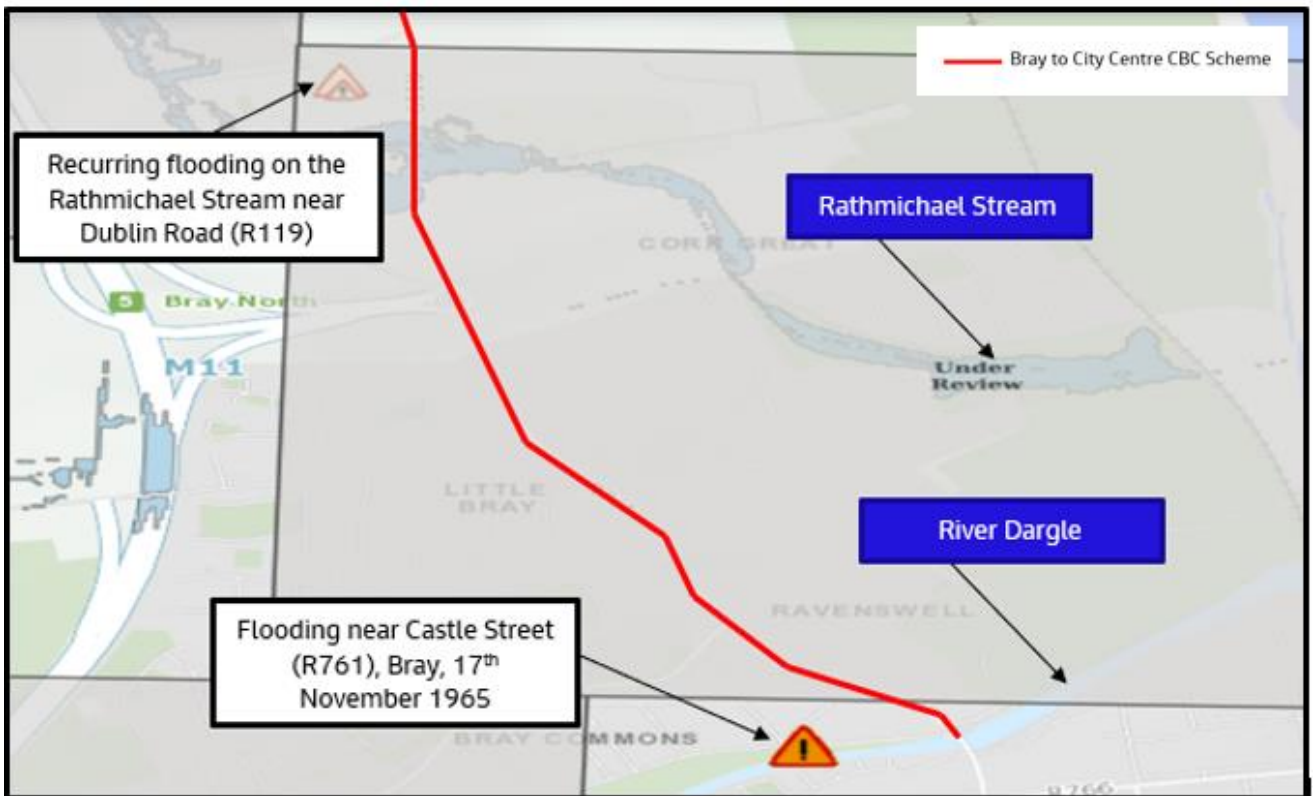


Figure 4.5 Location of historic flooding near Dublin Road (R119) and Castle Street (R761)

4.2 OPW CFRAM Study Mapping

Flood risk along the Bray to City Centre CBC was assessed as part of the OPW Eastern Catchment Flood Risk Assessment and Management (CFRAM) Study. The predicted flood extents for the Dodder River, Brewery Stream, Carrickmines Stream, Shanganagh River, Rathmichael Stream and River Dargle from the CFRAM study are presented in full in Appendix B, with extracts showing the predicted coastal and fluvial flood extents in **Figure 4.6**, **Figure 4.7**, **Figure 4.8**, **Figure 4.9** and **Figure 4.10**.

This shows that the proposed route is not at risk of coastal flooding however, it is at risk of fluvial flooding in the 0.1% and 1% AEP floods.

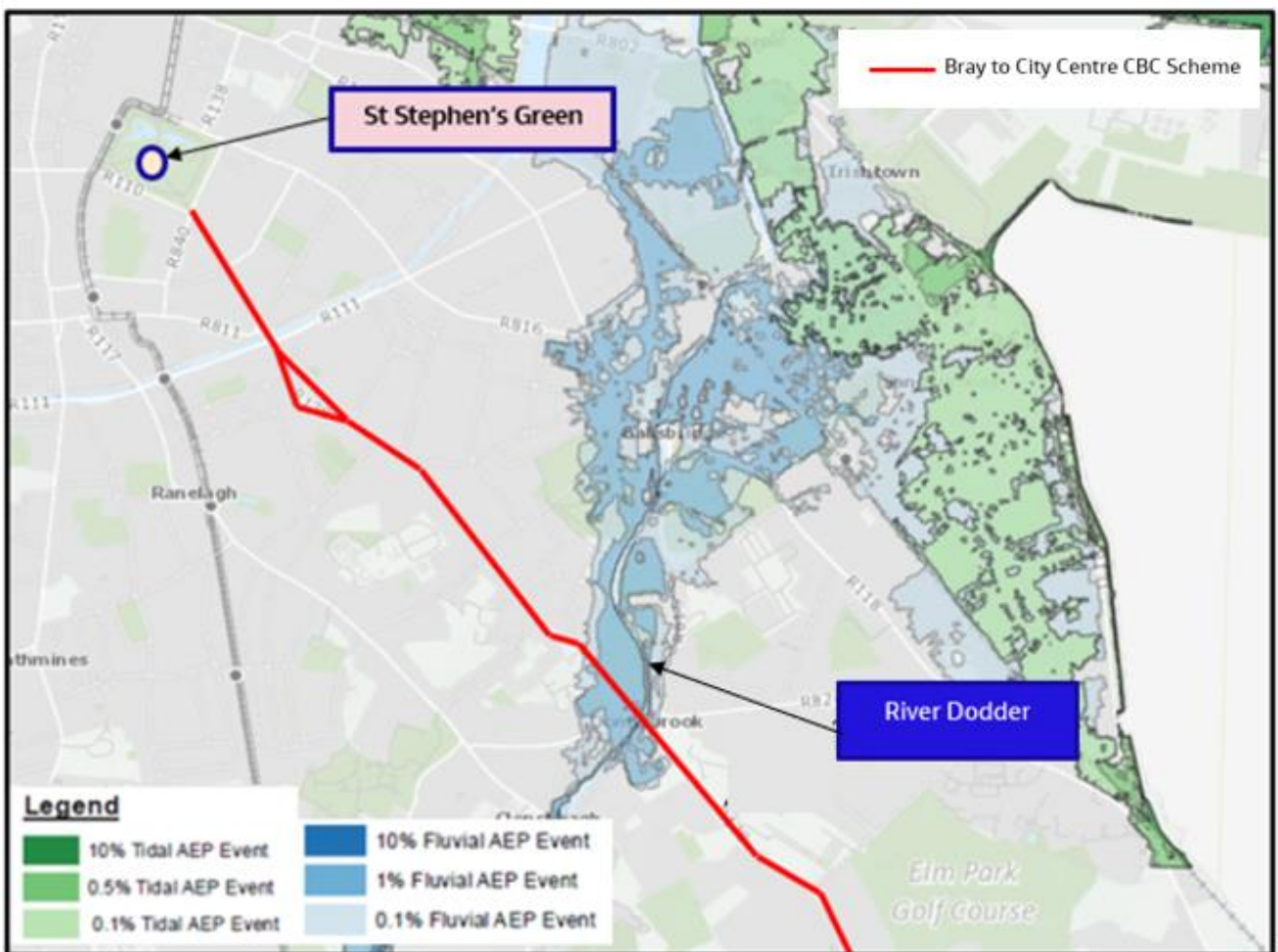


Figure 4.6 Extract of Coastal and fluvial flood mapping from Eastern CFRAM study for the Bray to City Centre CBC at the crossing with River Dodder

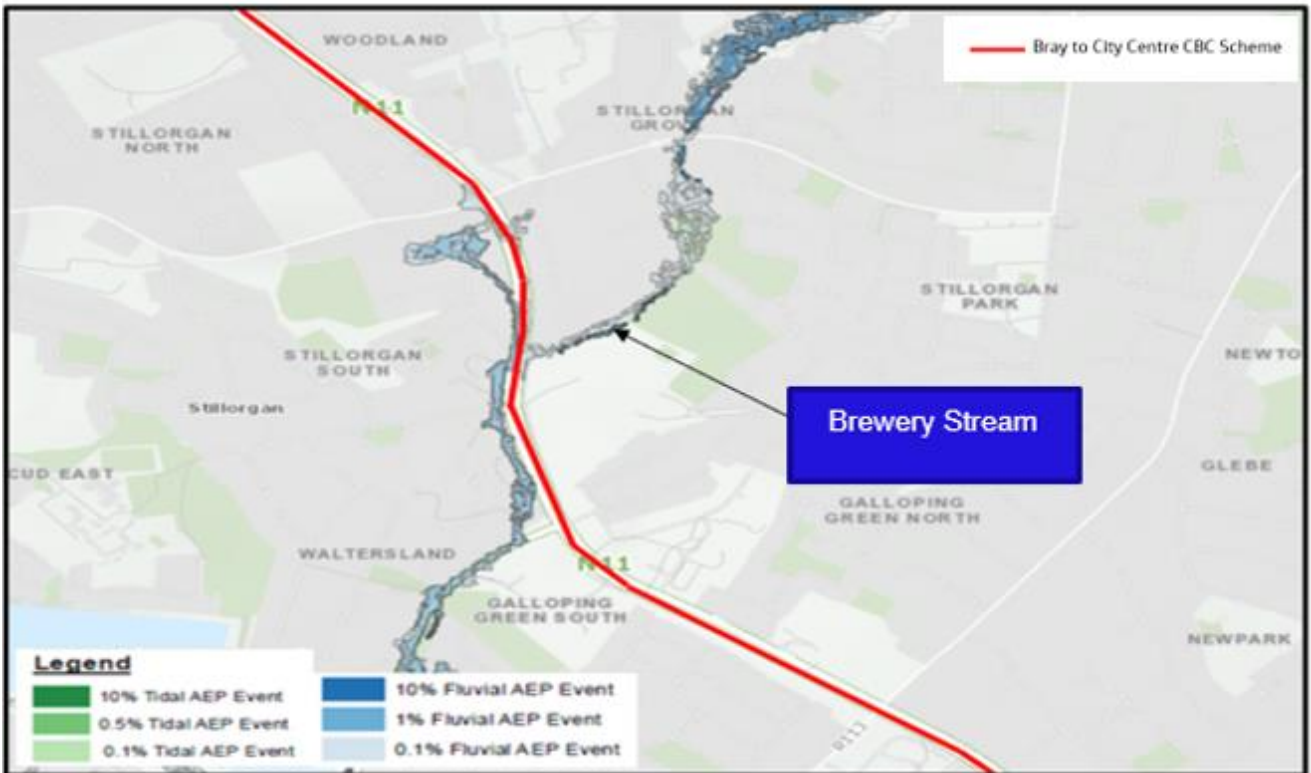


Figure 4.7 Extract of Coastal and Fluvial Flood Mapping from Eastern CFRAM study for the Bray to City Centre CBC along Stilllorgan Road (N11)

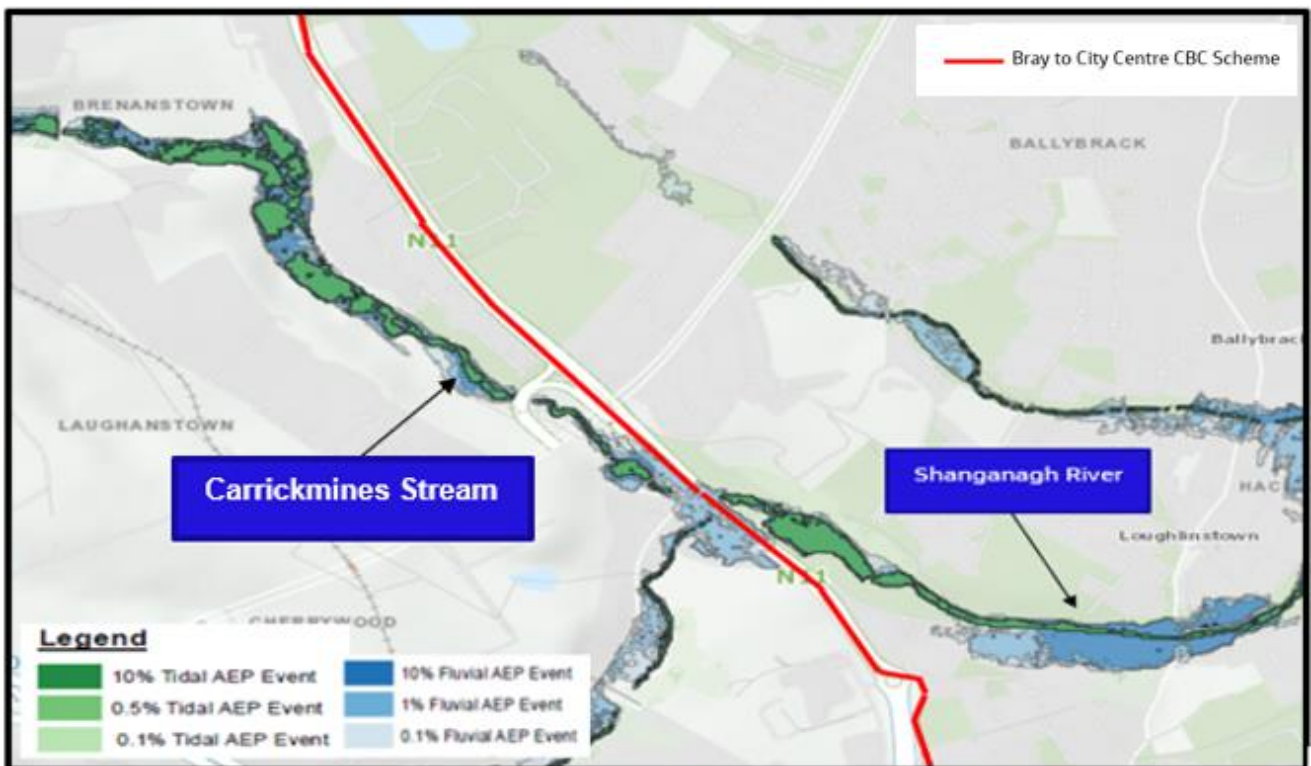


Figure 4.8 Extract of Coastal and fluvial flood mapping from Eastern CFRAM study for the Bray to City Centre CBC along Stilllorgan Road (N11)

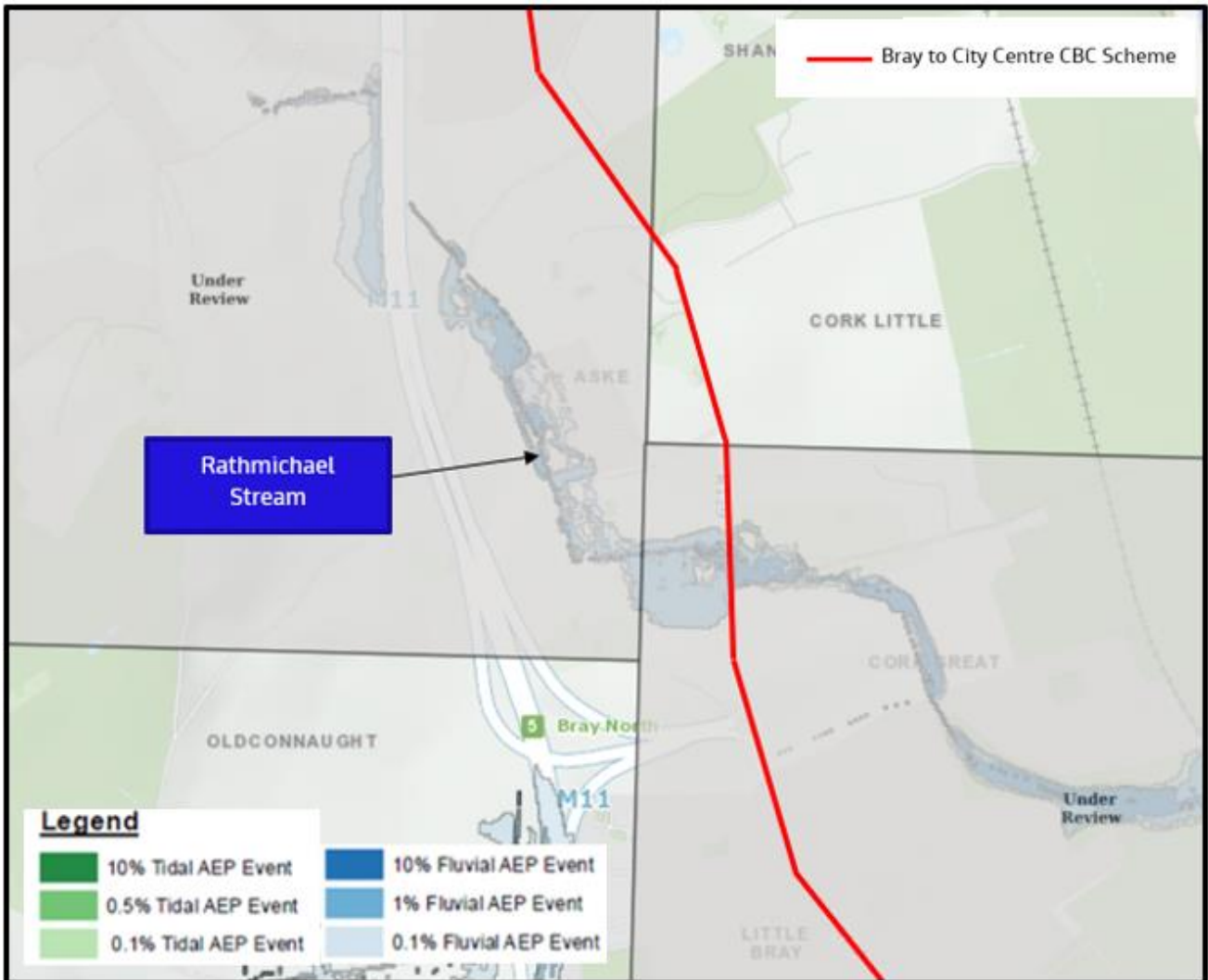


Figure 4.9 Extract of Coastal and fluvial flood mapping from Eastern CFRAM study for the Bray to City Centre CBC along Dublin Road (R119 & R761)

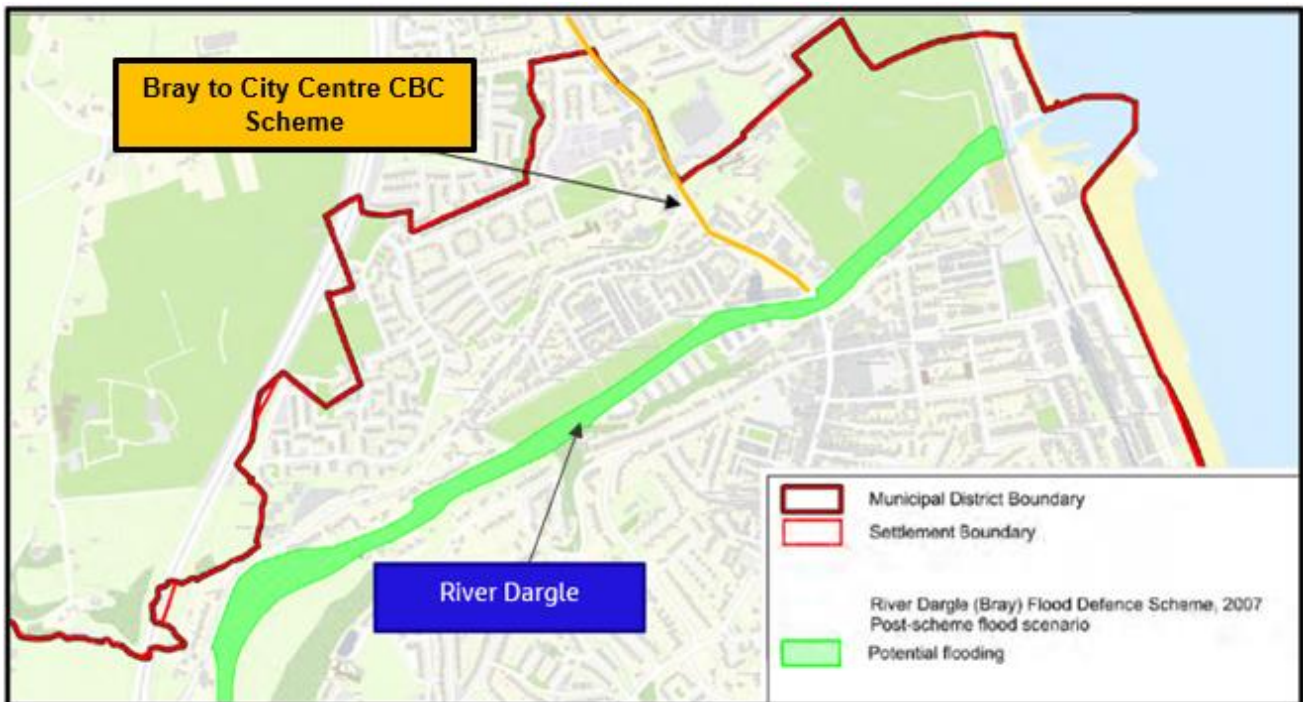


Figure 4.10 Extract of Flood Map in Bray Municipal District Local Area Plan 2017.

4.2.1 River Flood Extents

Seven locations have been identified where the Bray to City Centre CBC crosses a watercourse. These locations and an outline of the proposed works at these locations are summarised below in Table 4.2.

Table 4.2 Bray to City Centre CBC Watercourse Crossings

Watercourse	Chainage	Crossing Detail
River Dodder	02 + 400	Existing Bridge
Elm Park Stream	03 + 900	Existing Culvert
Brewery Stream	07 + 400	Existing Culvert
Carrickmines Stream	13 + 500	Existing Culvert
Shanganagh River	13 + 550	Existing Culvert
Rathmichael Stream / Cricken Woodbrook Stream	17 + 125	Existing Culvert
River Dargle	18 + 500 and surroundings	Existing Multi-span Arch Bridge

Sections 4.2.1.1 to 4.2.1.6 highlight the following six locations where any issues (flooding or surface water management) related to the proposed BusConnects development should be identified:

- River Dodder on Donnybrook Road (R138), Ch. A02+300 – A02+600.
- Elm Park Stream on Stillorgan Road (N11), Ch. A03 + 900.
- Brewery Stream on Stillorgan Road (N11), Ch. A07+050 – A07+350.
- Carrickmines and Shanganagh Rivers on Bray Road (N11), Loughlinstown, Ch. A13+400 – A13+800.

- Rathmichael Stream on Dublin Road (R119), Ch. A17+000 – A17+150.
- River Dargle on Castle Street, Ch.18 + 500 and surroundings

4.2.1.1 River Dodder at Donnybrook Road, Donnybrook (Ch A02+300 – A02+600).

The Proposed Scheme follows Donnybrook Road and the crosses the River Dodder in Donnybrook Village. The proposed works are illustrated in Figure 4.11 below.

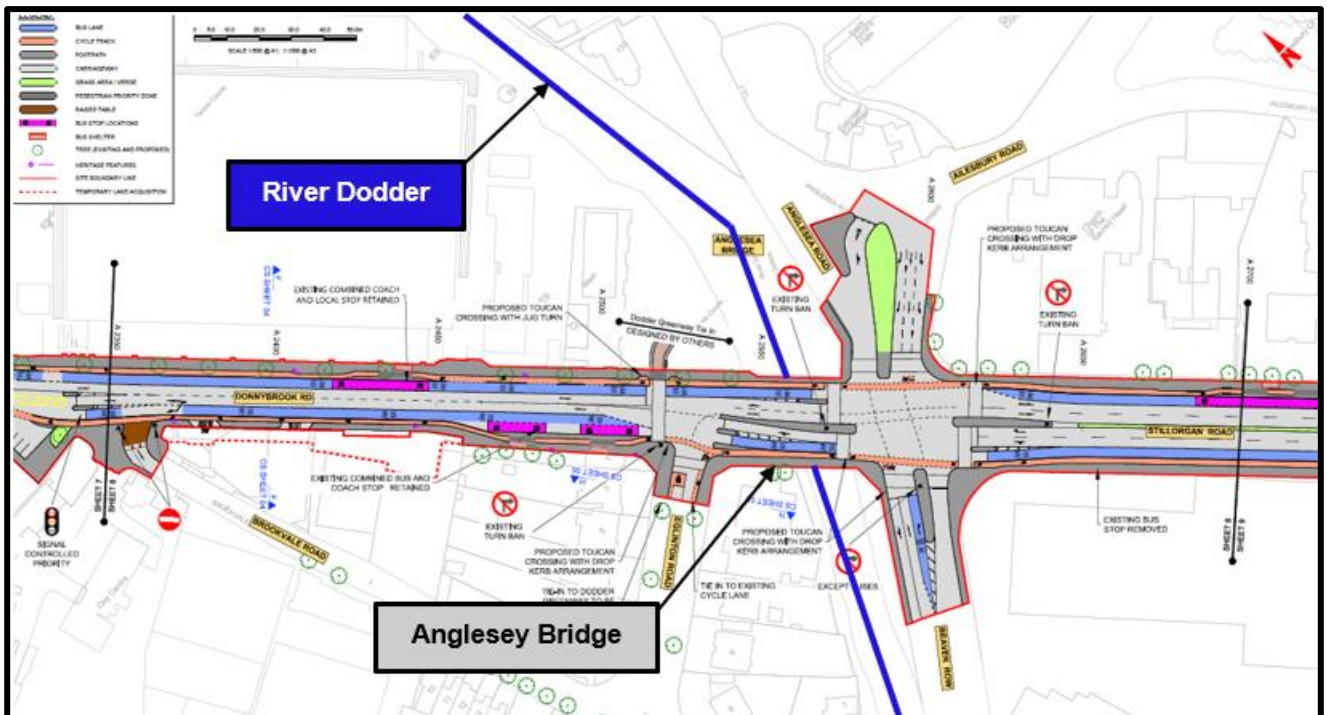


Figure 4.11 Proposed works at Donnybrook Road, Donnybrook

The proposed works are largely confined to the existing highway extent with the only land take required on the south side of Donnybrook Road between the Brookvale Road junction and the Eglinton Road junction into a garage forecourt. The existing land at this location consists of concrete paving or similar and the change in ground levels will be negligible. No modifications are proposed to the existing bridge structure over the River Dodder.

Figure 4.12 shows that the route is at risk of fluvial flooding in the 1% and 0.1% AEP floods, where it crosses the River Dodder.

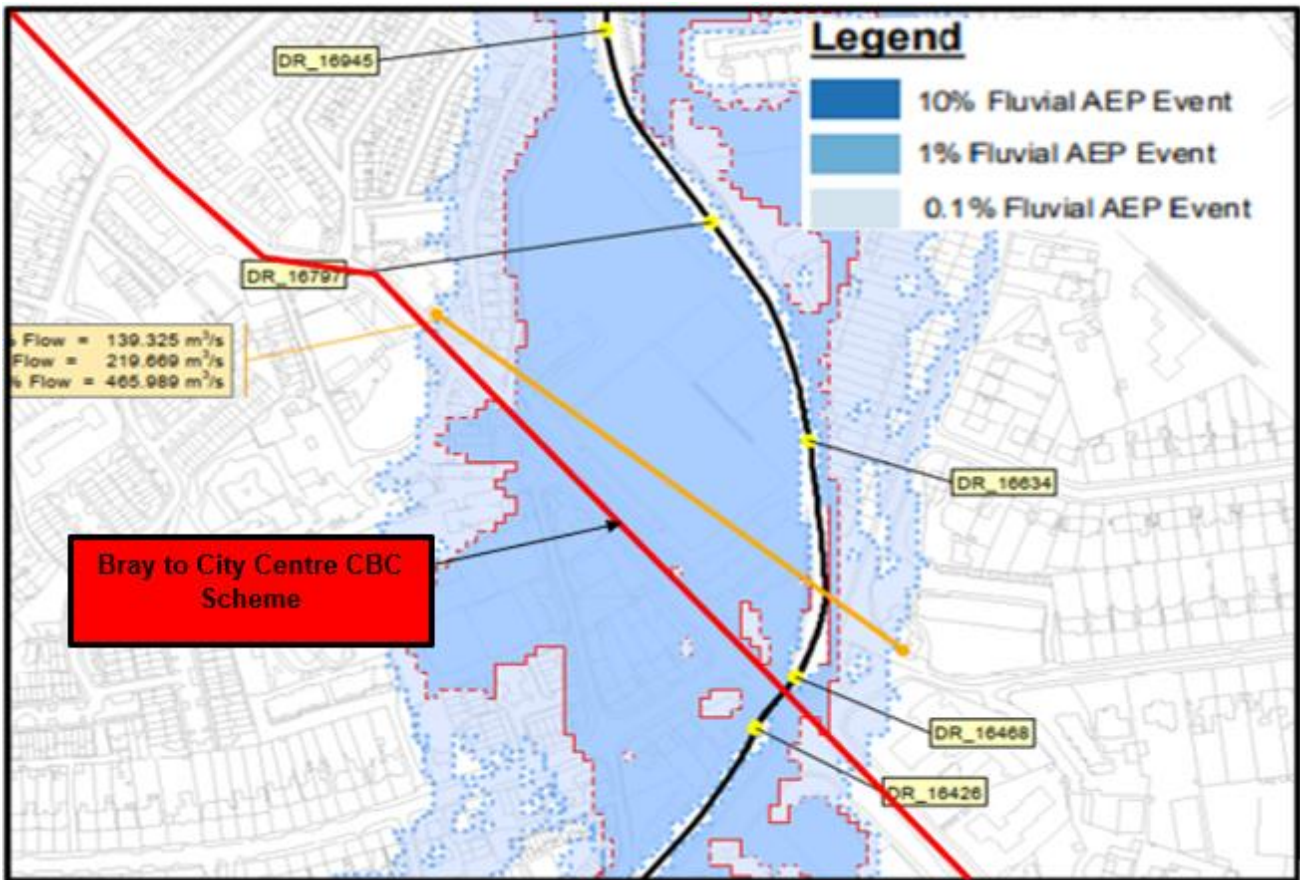


Figure 4.12 Extract of fluvial flood mapping from CFRAM study along Donnybrook Road, (Ch A02+300 – A02+600).

4.2.1.1.1 Elm Park Stream on Stillorgan Road (N11), (Ch. A03 + 900).

The Bray to City Centre CBC crosses the Elm Park Stream near University College Dublin. The stream is culverted where it is crossed by the Bray to City Centre CBC, refer to **Figure 4.13**. The proposed works are largely to confined to the existing highway extent and there will be no change to the existing culvert.

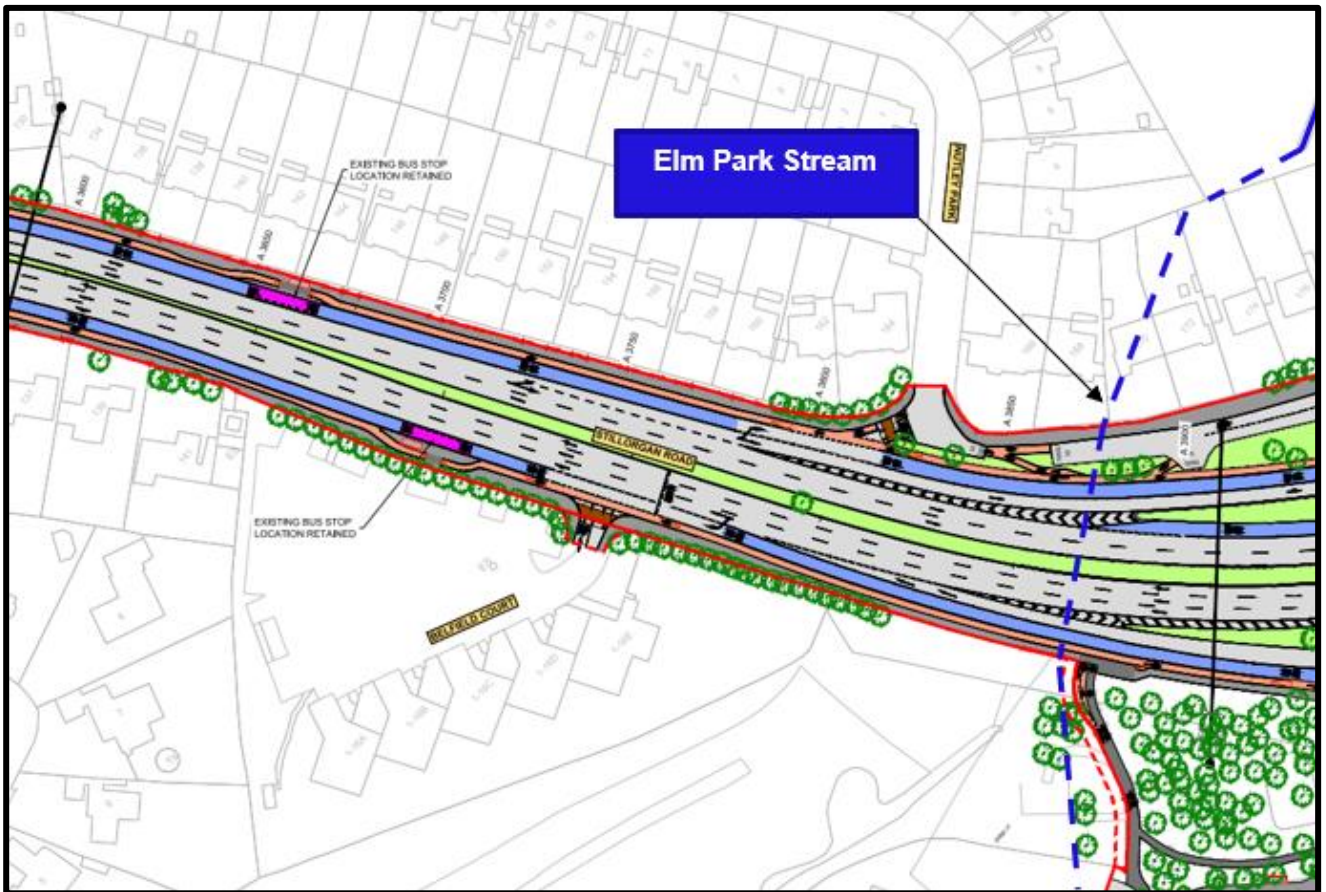


Figure 4.13 Elm Park Stream

There is no flood risk information available for the Elm Park Stream on the OPW CFRAM study maps and no historic records of flooding have been identified in this area from Elm Park Stream. Further information is required to to verify the flood risk from flowing of the Elm Park Stream to complete the Stage 2 assessment. A Stage 3 assessment is not envisaged, as there will be no works to the existing culvert.

4.2.1.2 Brewery Stream at Stillorgan Road, Stillorgan (Ch. A07+050 – A07+350).

The Proposed Scheme follows Stillorgan Road and crosses Brewery Stream in Stillorgan, north of the N31 junction. The Brewery Stream watercourse passes beneath Stillorgan Road in an existing culvert at this location. The proposed works are illustrated in **Figure 4.14** below.

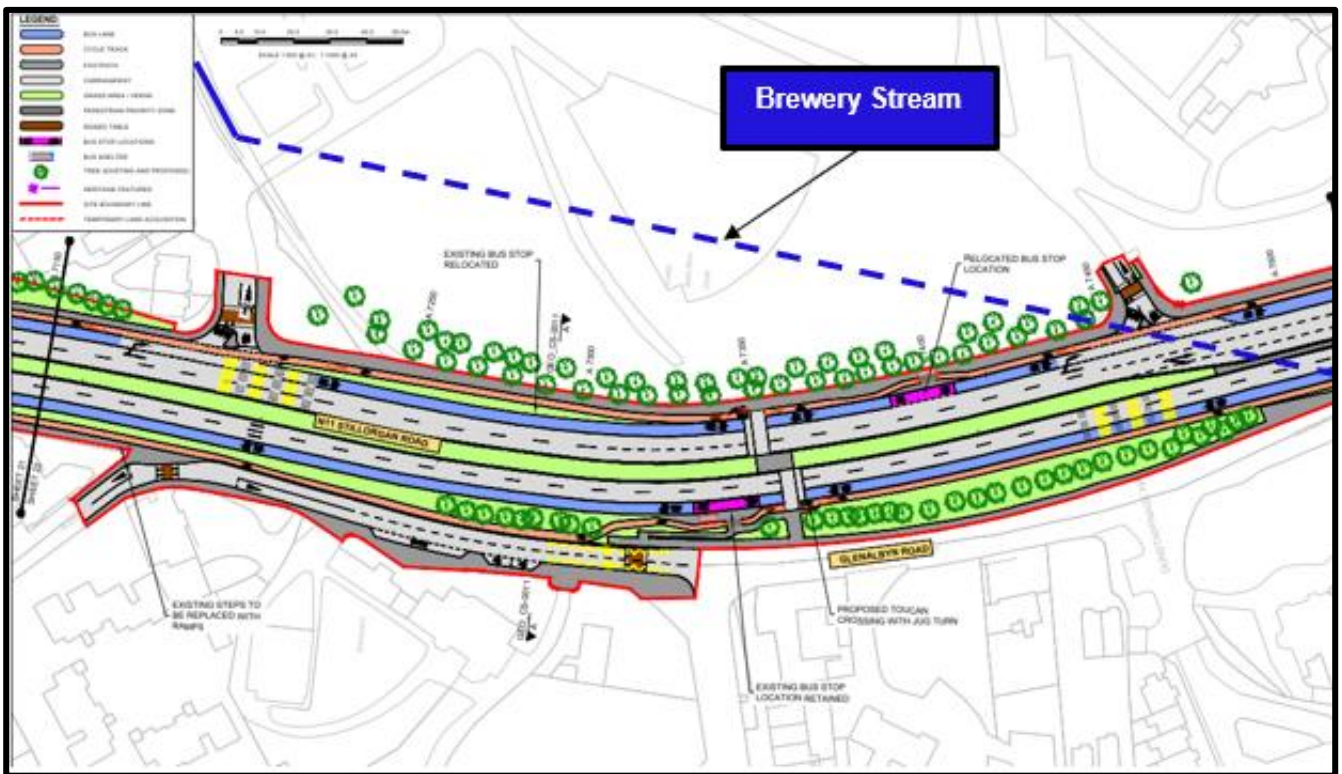


Figure 4.14 Proposed works at Stillorgan Road, Stillorgan

The proposed works are entirely confined to the existing highway extent at this location with no amendment proposed to the existing watercourse or culvert. The change in ground levels will be negligible.

Historic flooding issues have been identified at or immediately upstream of the site, specifically at Brewery Road (1986 and other subsequent occasions) and Stillorgan Hill (November 2002) These issues pre-exist the proposed development and are largely associated with culvert / screen blockage due to debris, based on anecdotal evidence.

It should be noted that anecdotal evidence has been received that remedial works have taken place at this location in the past (2000 to 2002). The absence of records of flooding in the intervening period may have resulted in this risk now being obsolete or reduced.

Figure 4.15 shows that the route is at risk of fluvial flooding in the 1% and 0.1% AEP floods, where it crosses the Brewery Stream.

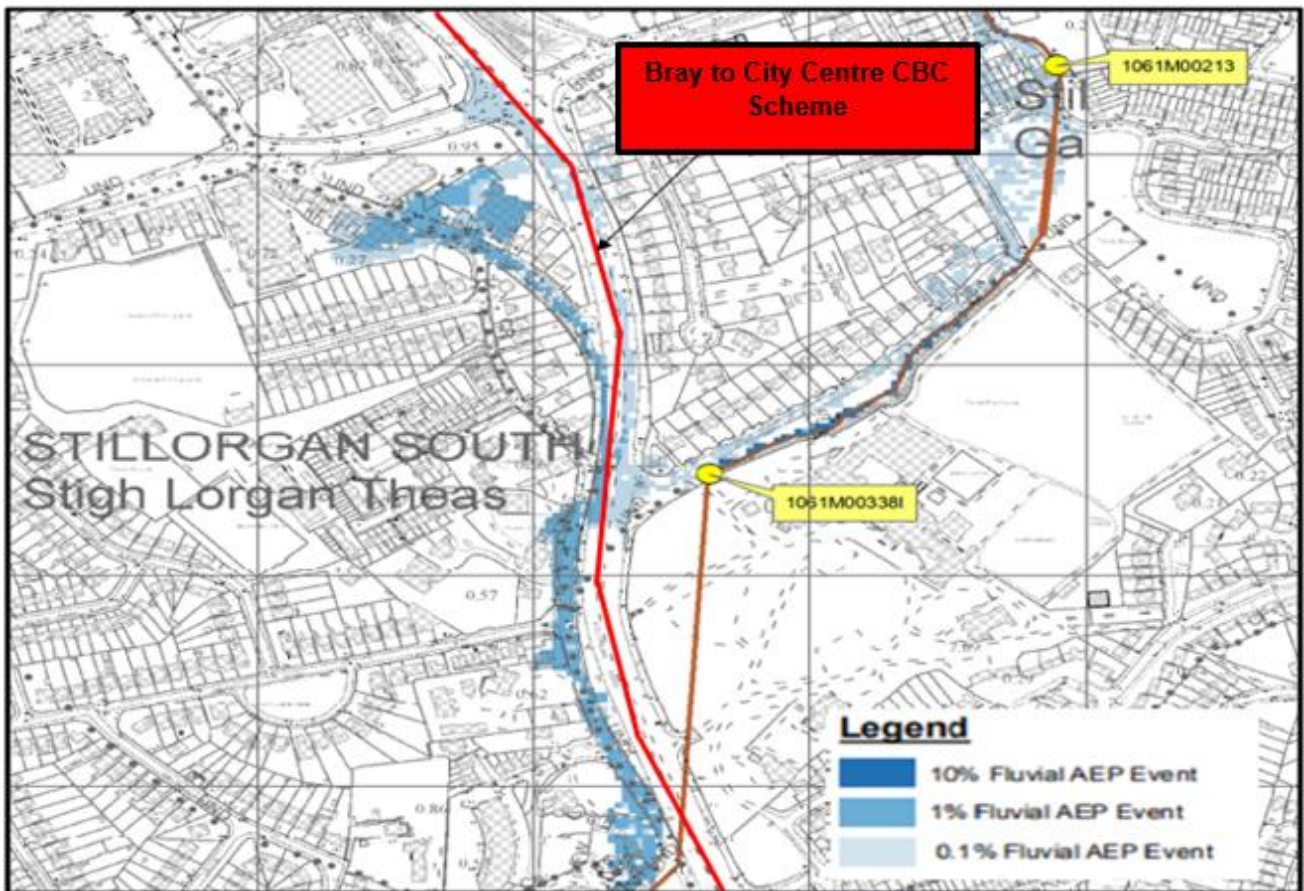


Figure 4.15 Fluvial flood mapping and past flood events at Stillorgan Road, Stillorgan

4.2.1.3 Carrickmines Stream & Shanganagh River at Bray Road, Loughlinstown (Ch A13+400 – A13 + 750)

The Proposed Scheme follows Bray Road and crosses the Carrickmines Stream and Shanganagh River in Loughlinstown, near the R116 Cherrywood Road junction. There is a confluence between the two watercourses just downstream (to the east) of Bray Road. Both watercourses are in existing culverts. The proposed works in this location are illustrated in Figure 4.16.

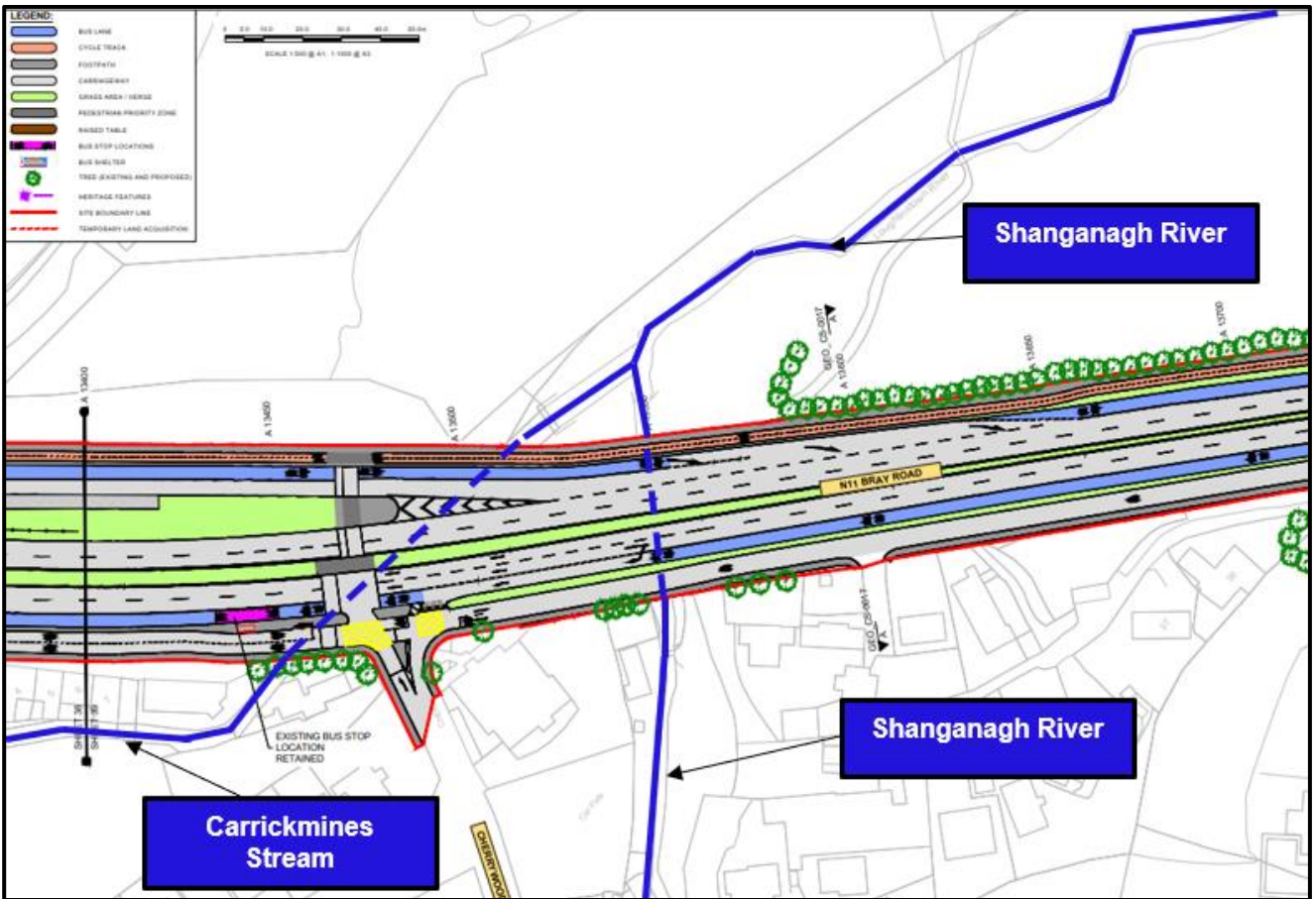


Figure 4.16 Proposed works at Bray Road, Loughlinstown

The proposed works are entirely confined to the existing highway extent at this location with no amendment proposed to either culvert or watercourse. The change in ground levels will be negligible.

Historic flooding issues have been identified at and immediately upstream of the site, specifically at the Cherrywood Road junction in October 2011. This flood event was investigated as part of the Eastern CFRAM study. Flows overtopped the bank on the south side of the N11 Bray Road to the north of Cherrywood Park, flooding an estimated 4 commercial properties and between 2 and 4 residential properties. A 500m length of the N11 road flooded to a depth of 300-400mm.

It should be noted that anecdotal evidence has been received that works to alleviate flood risk at Commons Road have taken place at this location in the past (2005). However, the 2011 flooding indicate that a residual flood risk remains.

Figure 4.17 shows that the route is at risk of fluvial flooding in the 1% and 0.1% AEP floods, where it crosses the Carrickmines Stream and Shanganagh River.

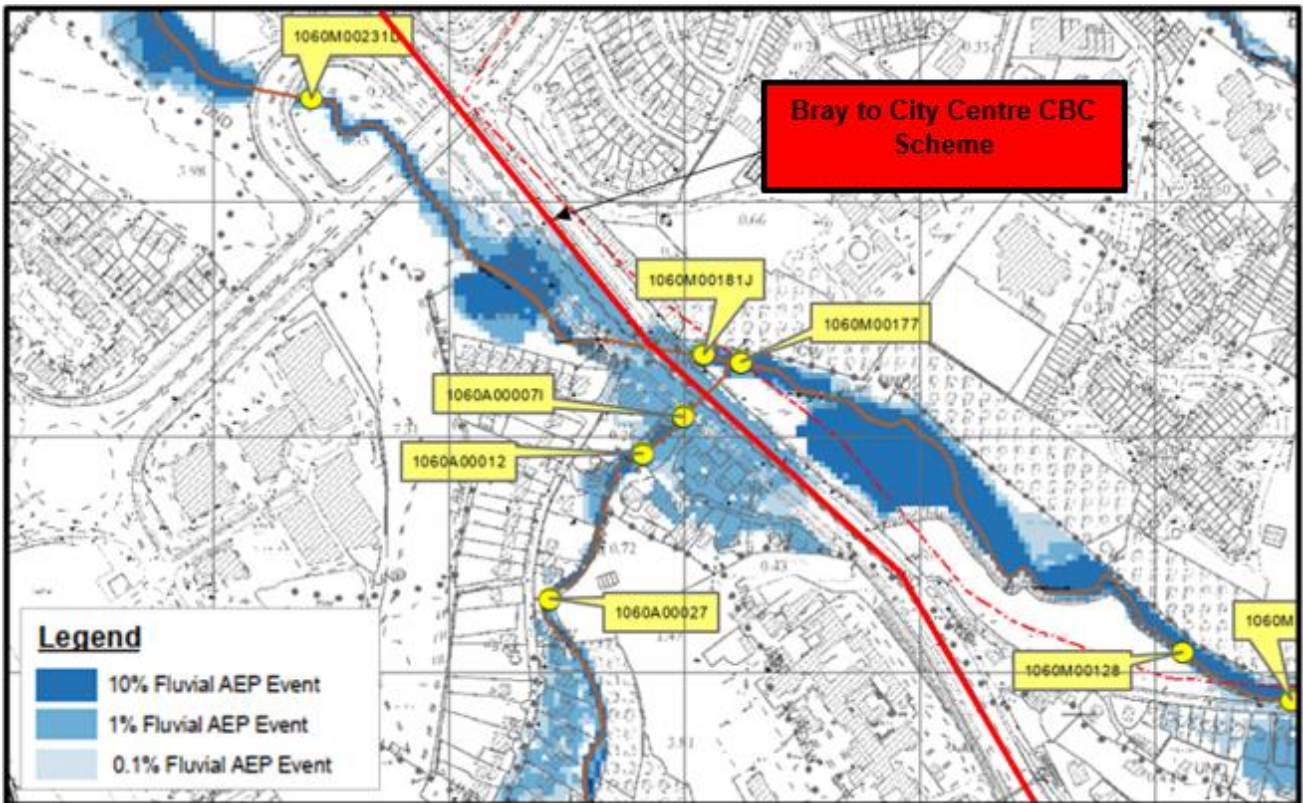


Figure 4.17 Fluvial flood mapping and past flood events at Bray Road, Loughlinstown

4.2.1.4 Rathmichael Stream / Crinken Woodbrook Stream at M11 Junction 5 (Bray North), Bray (Ch A16 + 850 – A17 + 100)

The Proposed Scheme follows the R119 Dublin Road and the crosses the Rathmichael Stream (also known as the Crinken Woodbrook Stream) to the north of the M11 Junction 5 (Bray North). The Rathmichael Stream is in an existing culvert where it is crossed by the Proposed Scheme. The proposed works in this location are illustrated in Figure 4.18 below.

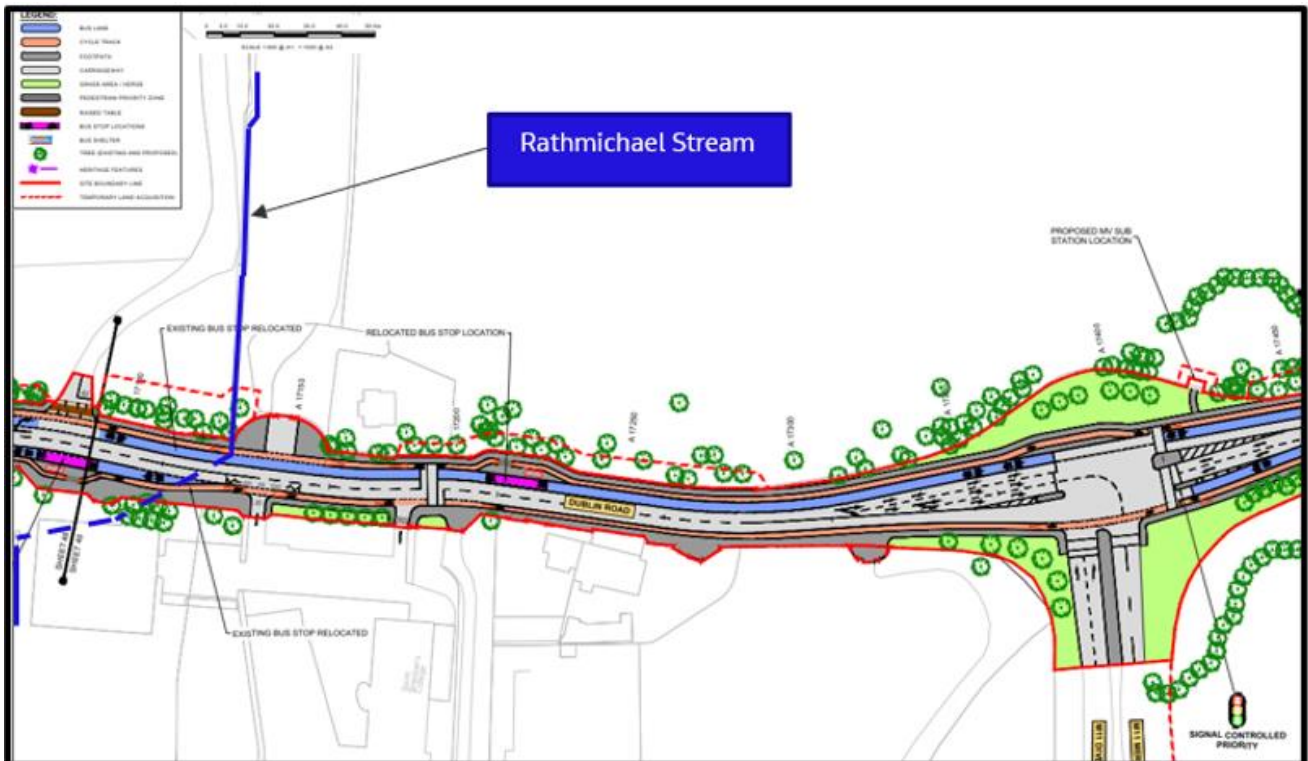


Figure 4.18 Proposed works at M11 Junction 5 (Bray North), Bray

The proposed works require local widening of the existing highway extent and associated land take on the east side of R119 Dublin Road between Woodbrook Downs and the M11 junction. The existing land at this location is primarily greenfield. There will be no works undertaken to the existing culvert on the Rathmichael Stream.

Occasional flooding of the road and school (Saint Brendan’s College) grounds have been reported in the past, with anecdotal evidence indicating this relates to culvert blockage.

No up to date CFRAM maps are available for the area of interest hence, Flood Zone Map provided by Dun Laoghaire-Rathdown is utilised to assess flood risk at the area of interest. **Figure 4.19** below shows that the Proposed Scheme at the crossing with Rathmichael stream is in Flood Zone A.

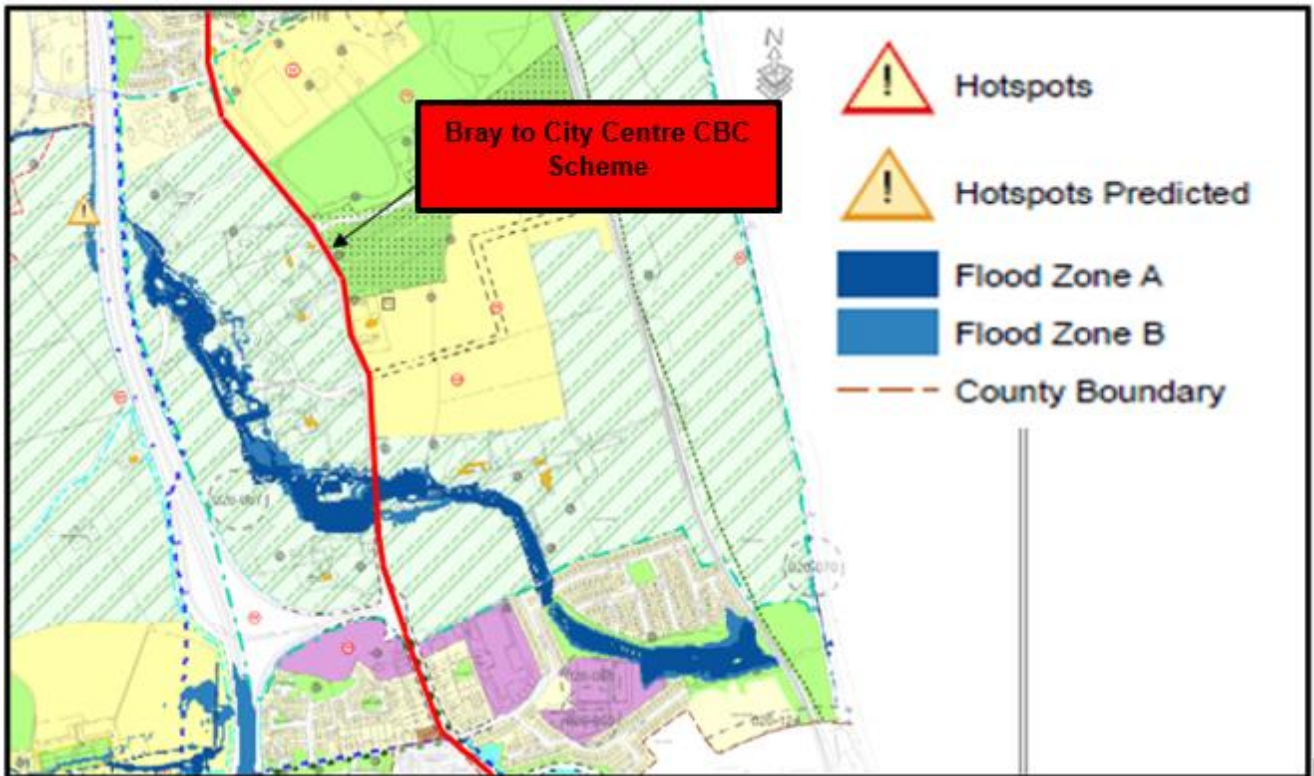


Figure 4.19 Fluvial flood mapping and past flood events at M11 Junction 5 (Bray North), Bray

4.2.1.5 River Dargle. Along Castle Street (around Ch A18 + 500)

The Proposed Scheme follows Castle Street and terminates at the crossroads with Ravenswell and Lower Dargle Roads. The proposed works are illustrated in **Figure 4.20** below.

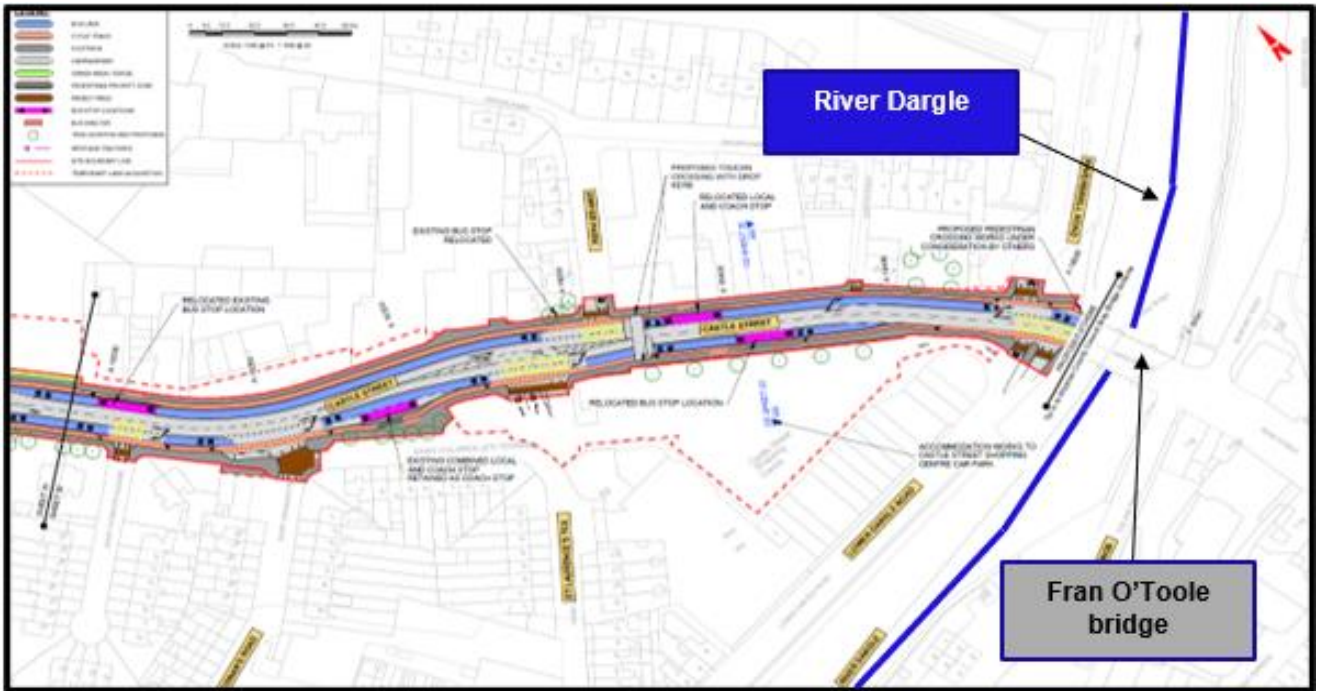


Figure 4.20 Proposed works at Castle Street, Bray

All works associated with the Proposed Scheme in this location are confined to the existing carriageway, apart from minor widening into the existing shopping centre car park on the northbound side of the carriageway and reconfiguration of the Castelstreet Shopping Centre Car Park which includes re-surfacing works. The Bray Bridge Improvement Scheme proposals are by others and do not form part of this assessment.

The existing CFRAM mapping is currently under review and is not available for this assessment however, the Bray Municipal District Local Area Plan 2017 includes the post-scheme flood scenario for River Dargle after the construction of the Flood Defence Scheme in 2007, refer to Figure 4.21.



Figure 4.21 Extract of Flood Map in Bray Municipal District Local Area Plan 2017

Figure 4.21 shows that the route is not at risk of flooding from River Dargle since the Flood Defence Scheme construction. However, updated OPW CFRAM outputs will be required to confirm flood risk at this location.

4.2.2 Coastal Flood Extents

The Eastern CFRAM Study Flood Extent and Depth Maps for coastal flood risk are available online (www.floodinfo.ie). No risk of coastal flooding was identified along this route from St. Stephen's Green down to Shankill refer to Figure 4.22 and Figure 4.23. No CFRAM maps are available for the area south to Shankill to assess coastal flood risk hence, coastal risk for the remainder of the Bray to City Centre CBC scheme will be assessed in section 4.4 with the Irish Coastal Protection Strategy Study (ICPSS).



Figure 4.22 Extract of coastal flood mapping from Eastern CFRAM study (St. Stephen's Green to Cabinteely)

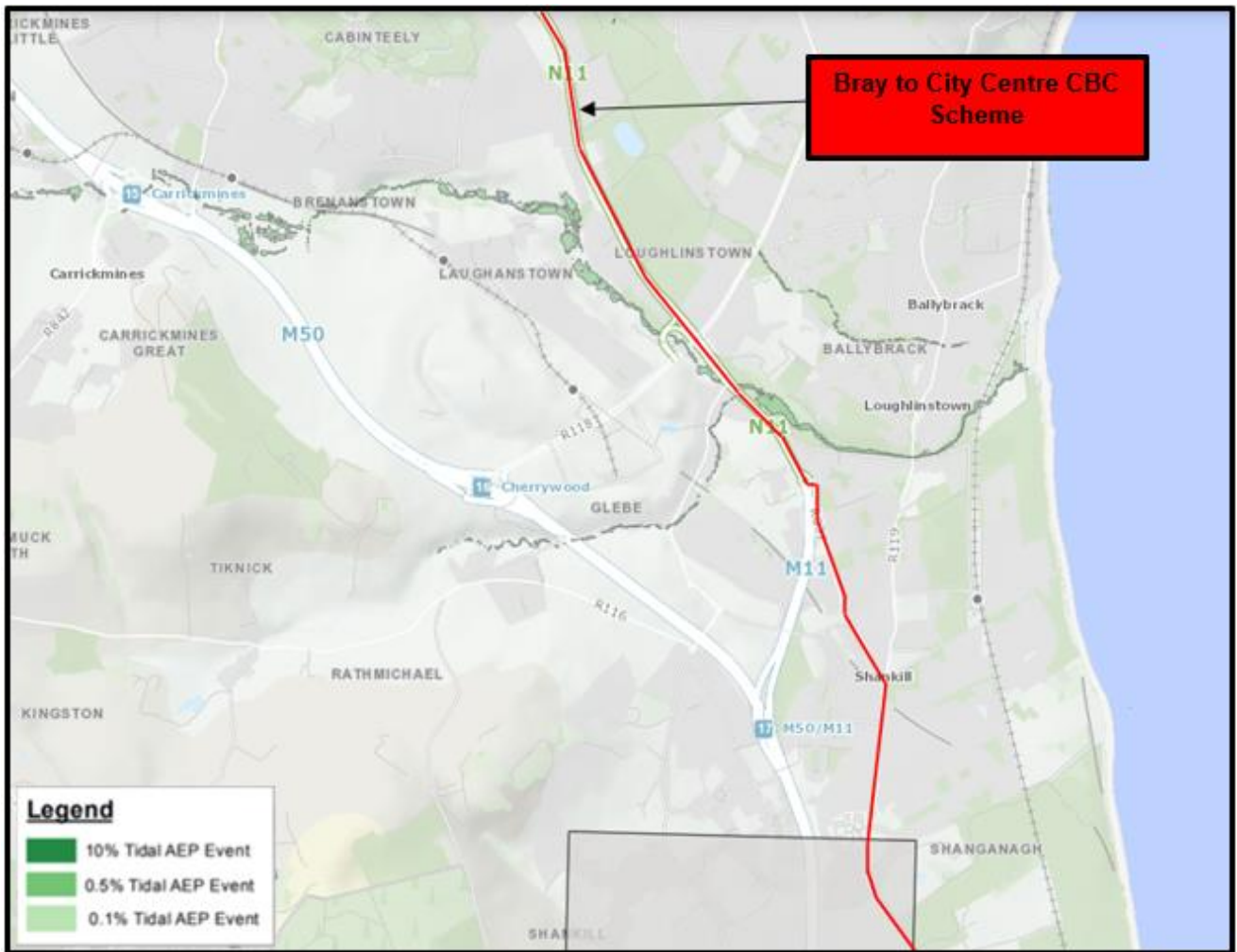


Figure 4.23 Extract of coastal flood mapping from Eastern CFRAM study (Cabinteely to Shankill).

4.3 Rainfall Flood Extents

Pluvial flooding occurs during periods of heavy rainfall, when the rainfall rate is greater than the infiltration capacity. It is usually associated with high intensity rainfall events (typically > 30mm/h) resulting in overland flow and ponding in depressions in the topography. In urban situations underground sewerage/drainage systems and surface watercourses may be completely overwhelmed.

Pluvial flood extents are available for areas of Dublin and provide an indication of the level of risk. Pluvial mapping extends from the City Centre as far as the UCD. The flood mapping considered flood risk in the 10%, 1% and 0.5% AEP rainfall events. The rainfall flood extents along the Bray to City Centre CBC scheme were reviewed using the OPW flood info website (available at www.floodinfo.ie) and the pluvial flood extents are illustrated in Figure 4.24.

It should be noted that this mapping should be used to identify potential risk but is not appropriate for a site-specific flood risk assessment. It is reasonable to assume that the remainder of the Proposed Scheme (between UCD and Bray) is exposed to a similar level of flood risk.

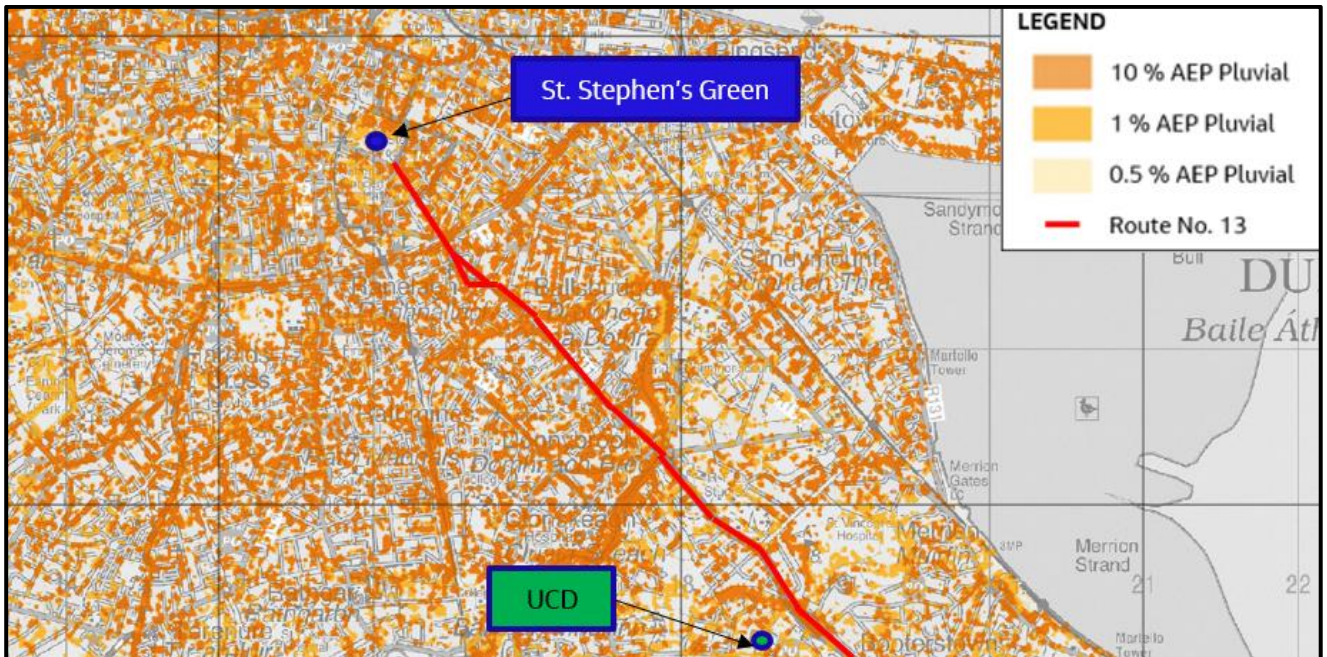


Figure 4.24 Extract of pluvial flood mapping on the Bray to City Centre CBC to UCD.

4.4 Irish Coastal Protection Strategy Study (ICPSS)

The Irish Coastal Protection Strategy Study (ICPSS) produced for the OPW in 2013 provides an overview of coastal flood hazard and risk in Ireland. Flood maps were produced for the 0.5% and 0.1% AEP flood events. A volume of maps is also available which represent a projected future scenario for the year 2100 and include allowances for projected future changes in climate. Specifically, these represent the Mid-Range Future Scenario and allow for 500mm rise in Mean Sea Level.

Flood mapping for the 0.5% and 0.1% AEP present day flood extent is illustrated in **Figure 4.25**, **Figure 4.26**, **Figure 4.27**, **Figure 4.28** and **Figure 4.29**. This also shows no coastal flood risk along the Proposed Scheme.

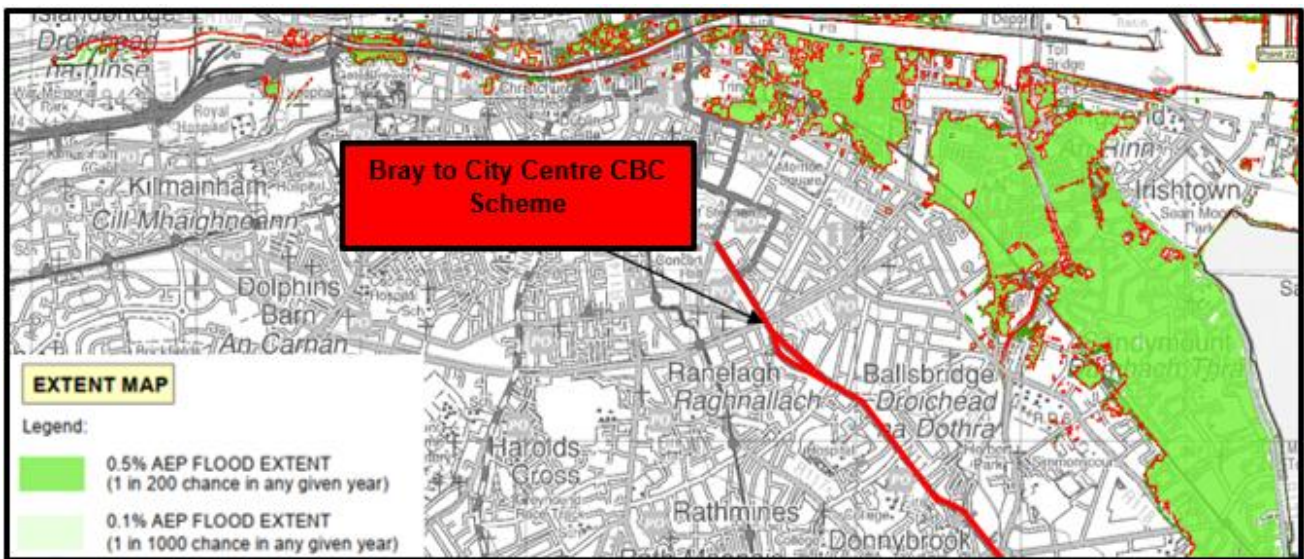


Figure 4.25 ICPSS coastal mapping. St. Stephen's Green to Donnybrook

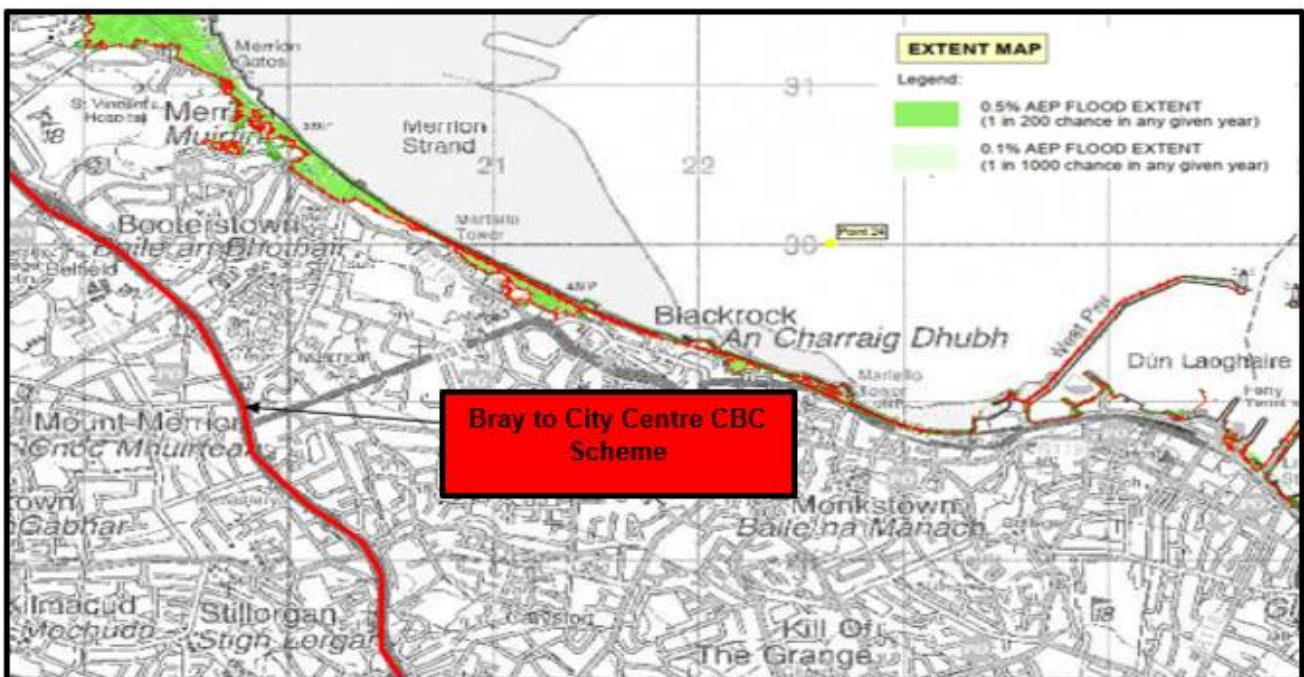


Figure 4.26 ICPSS coastal mapping. Bray to City Centre CBC scheme along Stillorgan Road

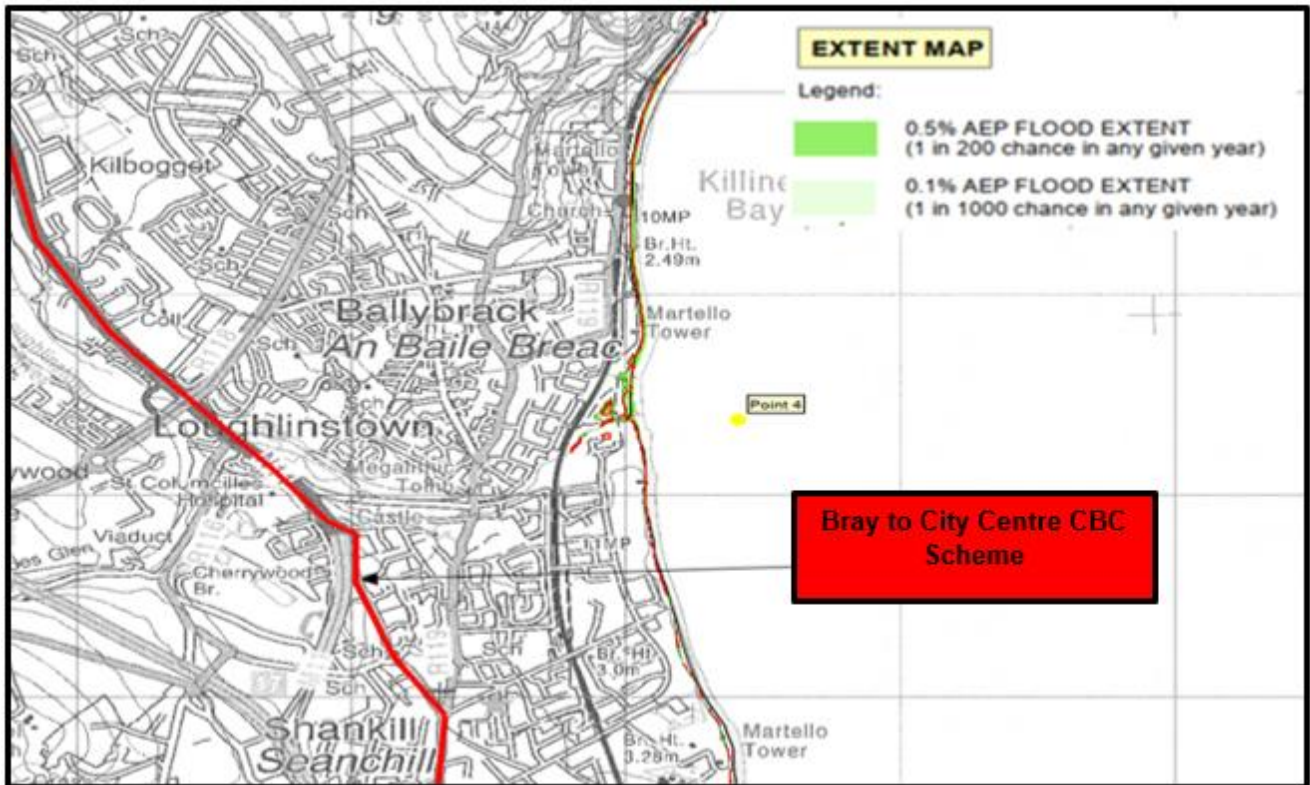


Figure 4.27 ICPSS coastal mapping. Bray to City Centre CBC scheme along Bray Road (N11) and across Shankill

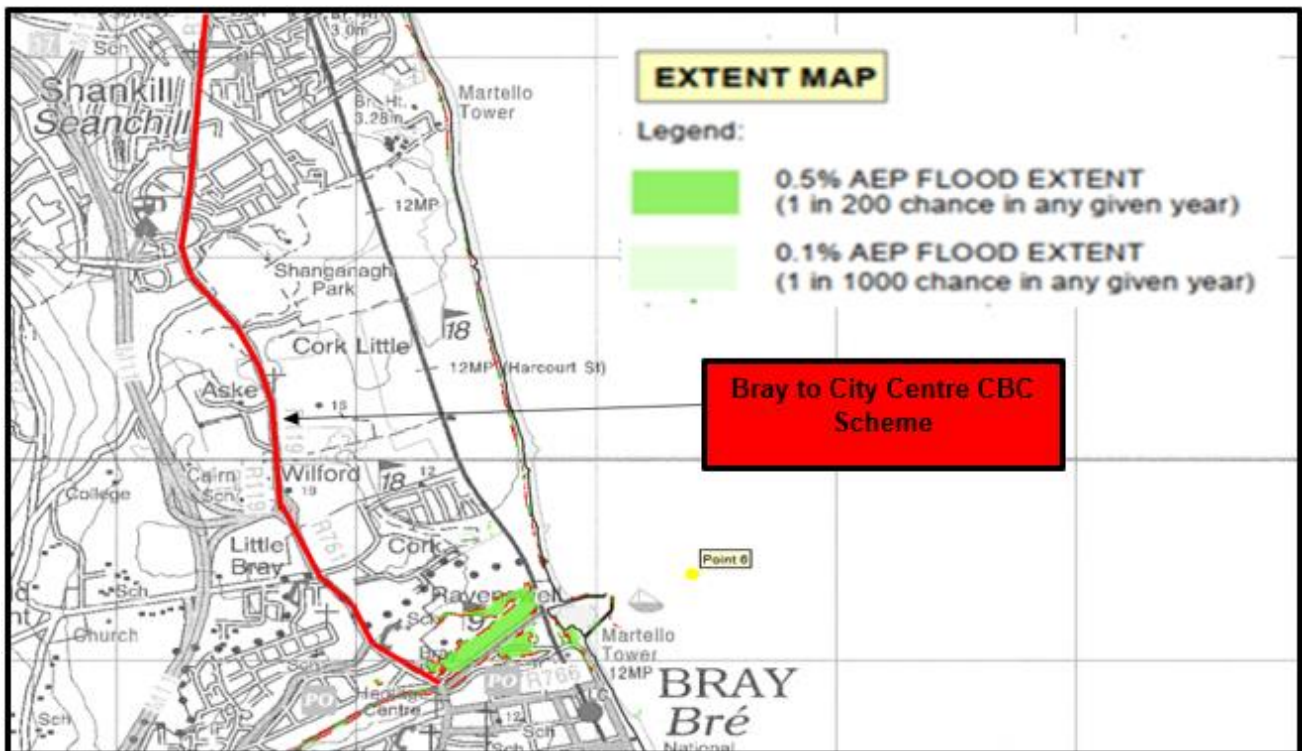


Figure 4.28 ICPSS coastal mapping Current Scenario. Bray to City Centre CBC scheme south to Shankill

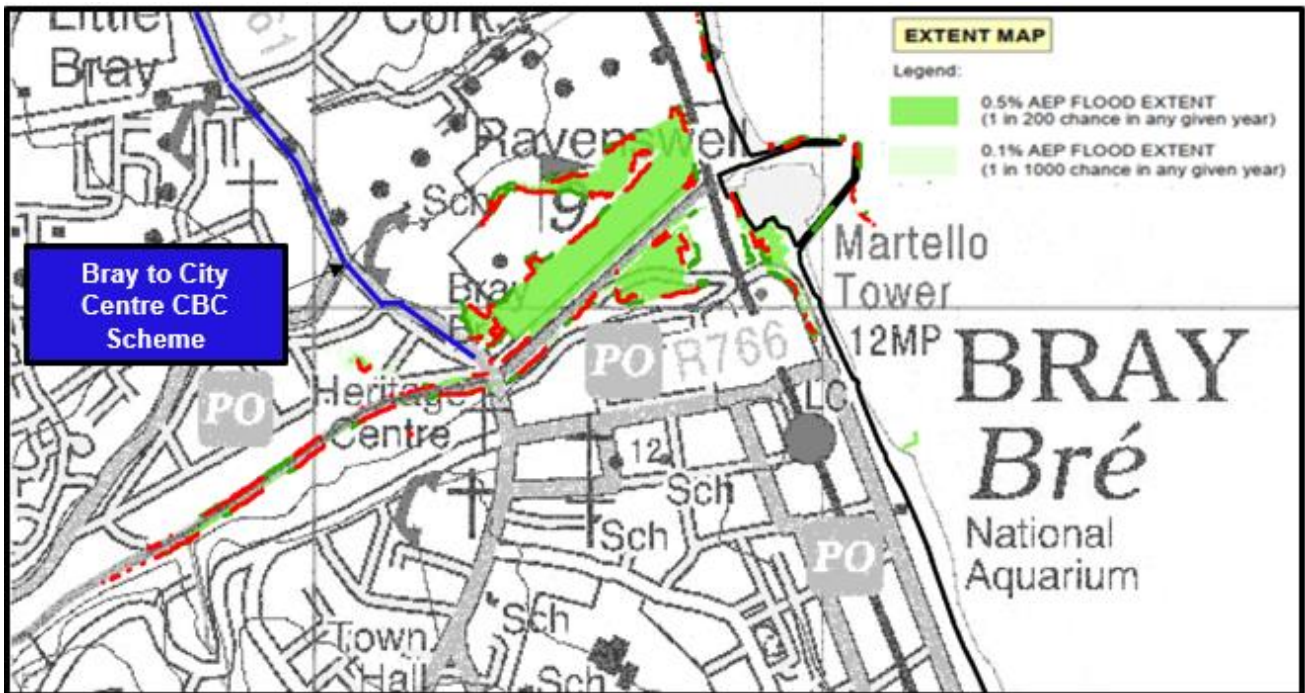


Figure 4.29 ICPSS coastal mapping Current Scenario. Bray to City Centre CBC scheme along Dublin Road and Castle Street.

4.5 Grand Canal

The Grand Canal passes beneath to the Proposed Scheme. Water levels along the canal are regulated by a series of lock gates and waste-weirs. There are no reported incidents of flooding from the Grand Canal and there are insufficient flows in the canal to pose a flood risk to the Proposed Scheme.

4.6 Strategic Flood Risk Assessments (SFRA)

4.6.1 Dublin City Development Plan

A Strategic Flood Risk Assessment and Management Plan was prepared as part of the Dublin Town Development Plan 2016-2022. This document states that part of the Bray to City Centre CBC scheme along Donnybrook Road is located within Flood Zones A and B, refer to **Figure 4.30**.

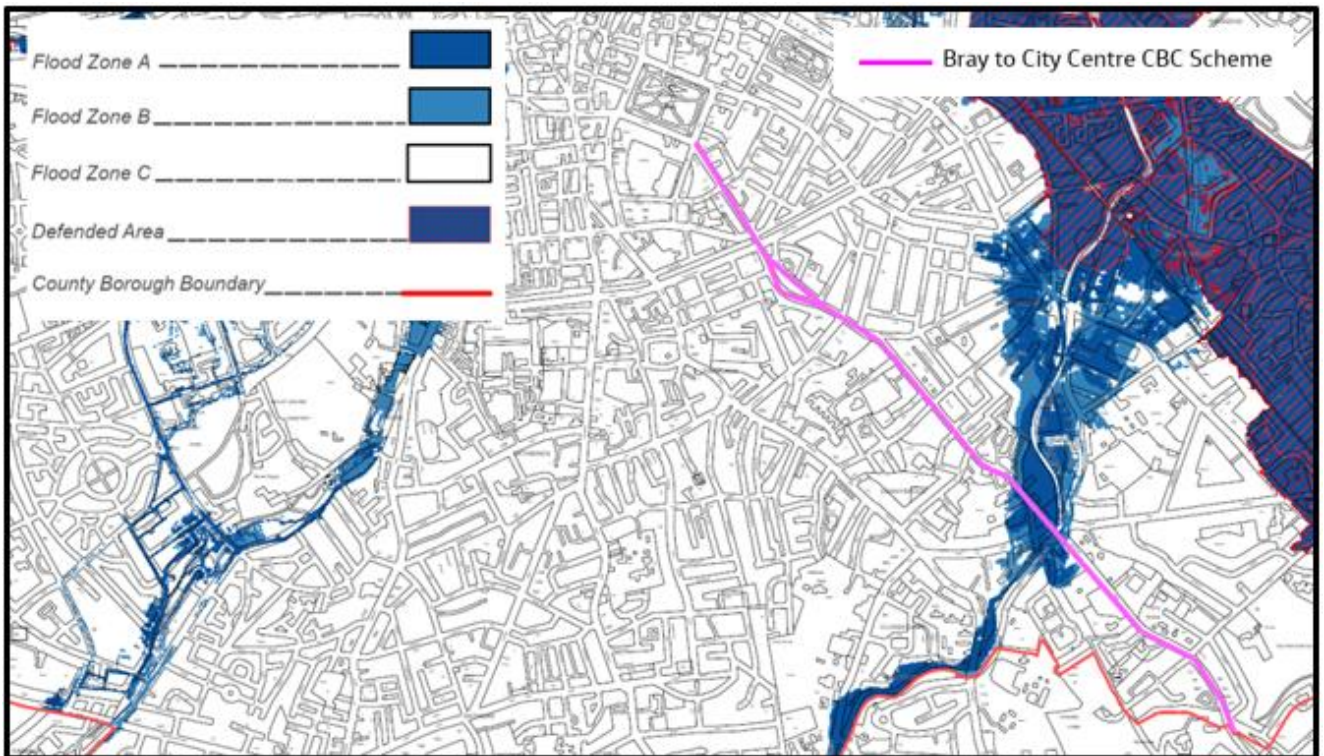


Figure 4.30 Dublin City Council Composite Flood Map.

A moderate risk of pluvial risk has been reported along much of the Bray to City Centre CBC scheme, refer to Figure 4.31. This is not unexpected as much of the existing surface water drainage network was designed to provide a low standard of protection (typically 20% AEP or less).

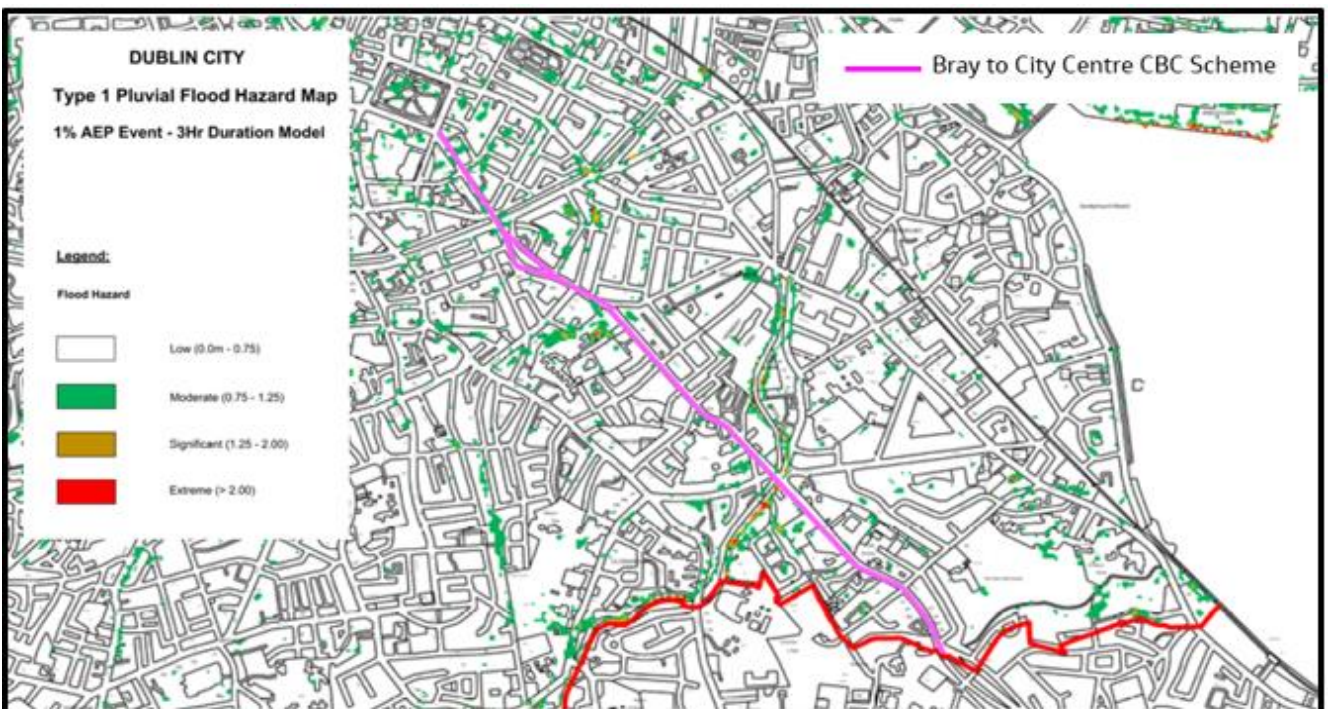


Figure 4.31 Dublin City Council Pluvial Flood Hazard Map.

4.6.2 Dun Laoghaire - Rathdown County Development Plan

A Strategic Flood Risk Assessment and Management Plan was prepared as part of the Dun Laoghaire – Rathdown County Development Plan 2022-2028. This document states that part of the Bray to City Centre CBC scheme is located within Flood Zones A and B at the river crossings with Carysfort Maretimo Stream, River Shanganagh and River Rathmichael, refer to **Figure 4.32**, **Figure 4.33** and **Figure 4.34**.

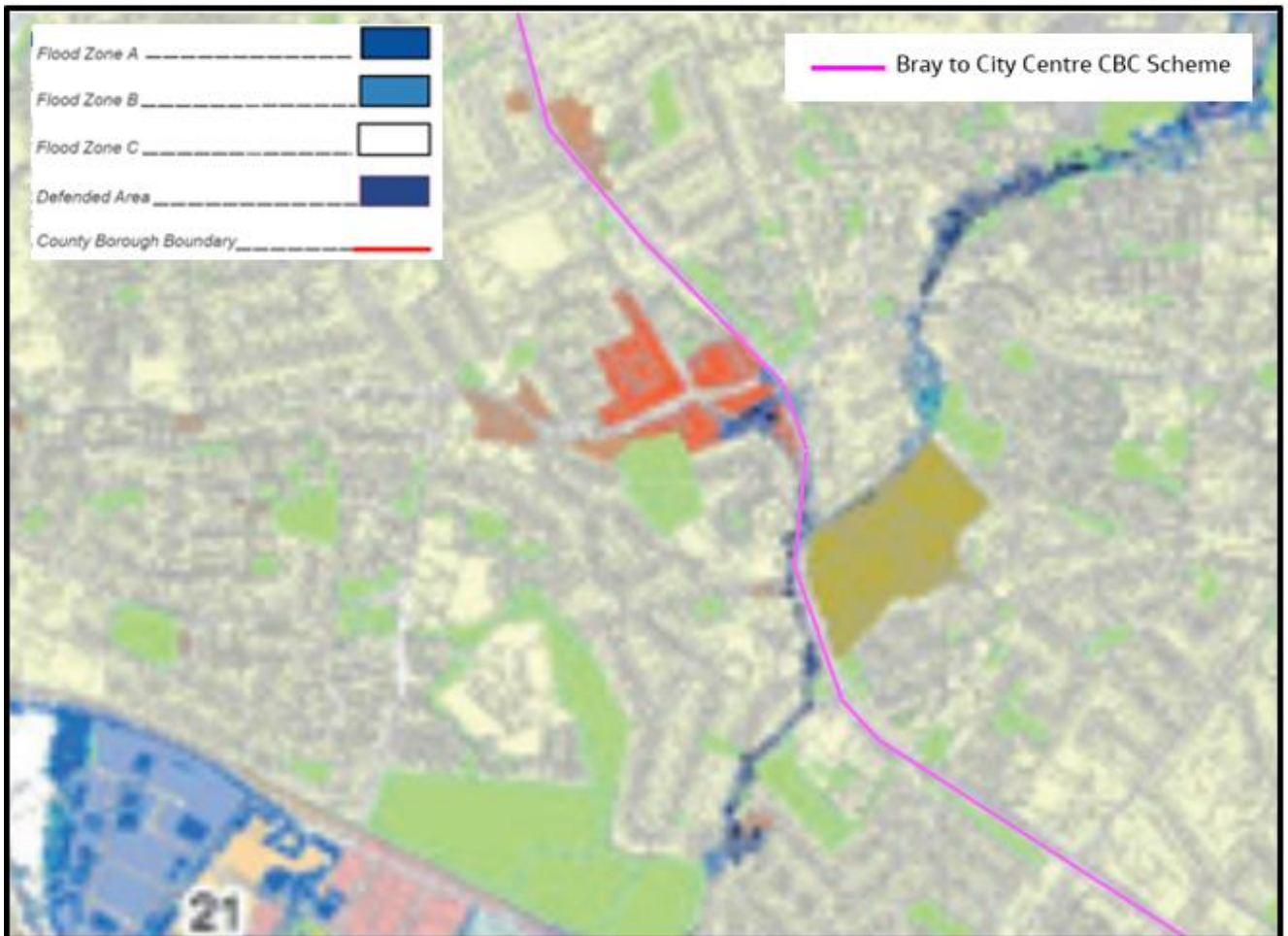


Figure 4.32 Dun Laoghaire - Rathdown Council Composite Flood Map (Carysfort Maretimo watercourse crossing).

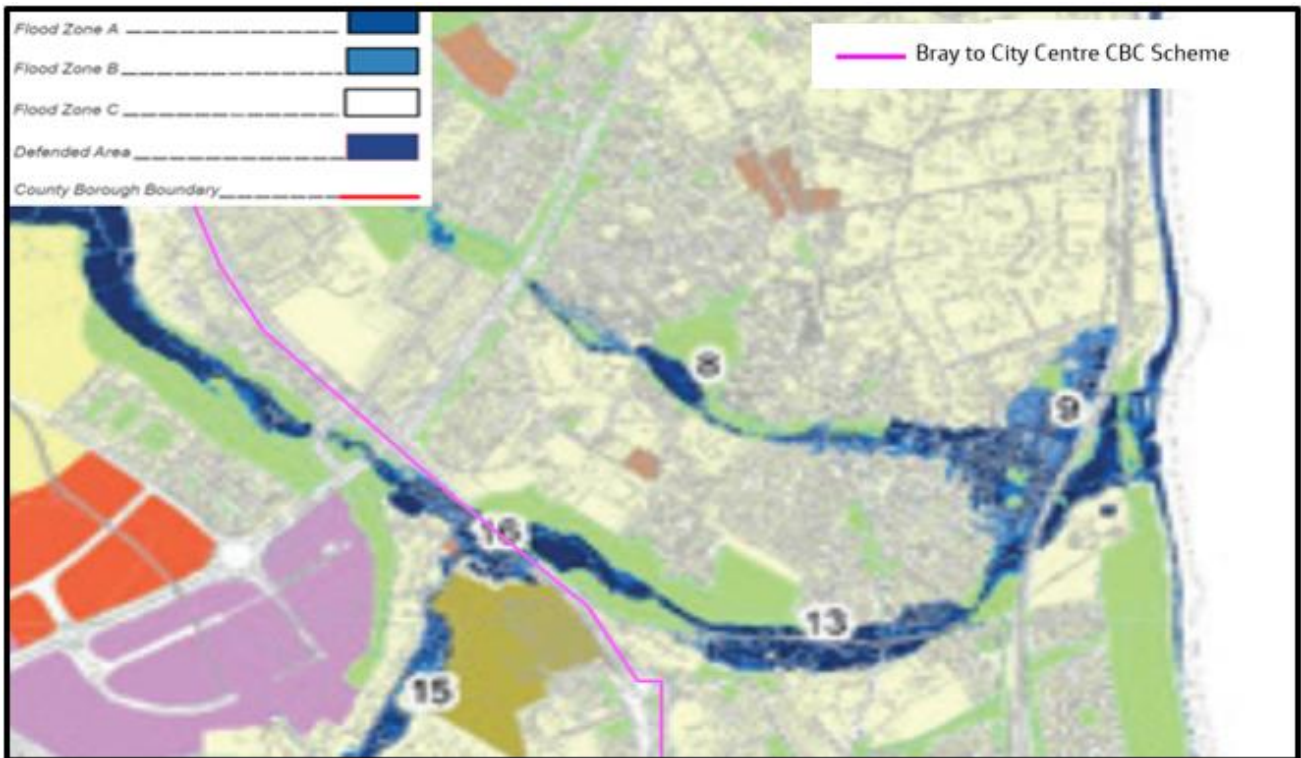


Figure 4.33 Dun Laoghaire - Rathdown Council Composite Flood Map (River Loughlinstown Rivers North and South crossing).

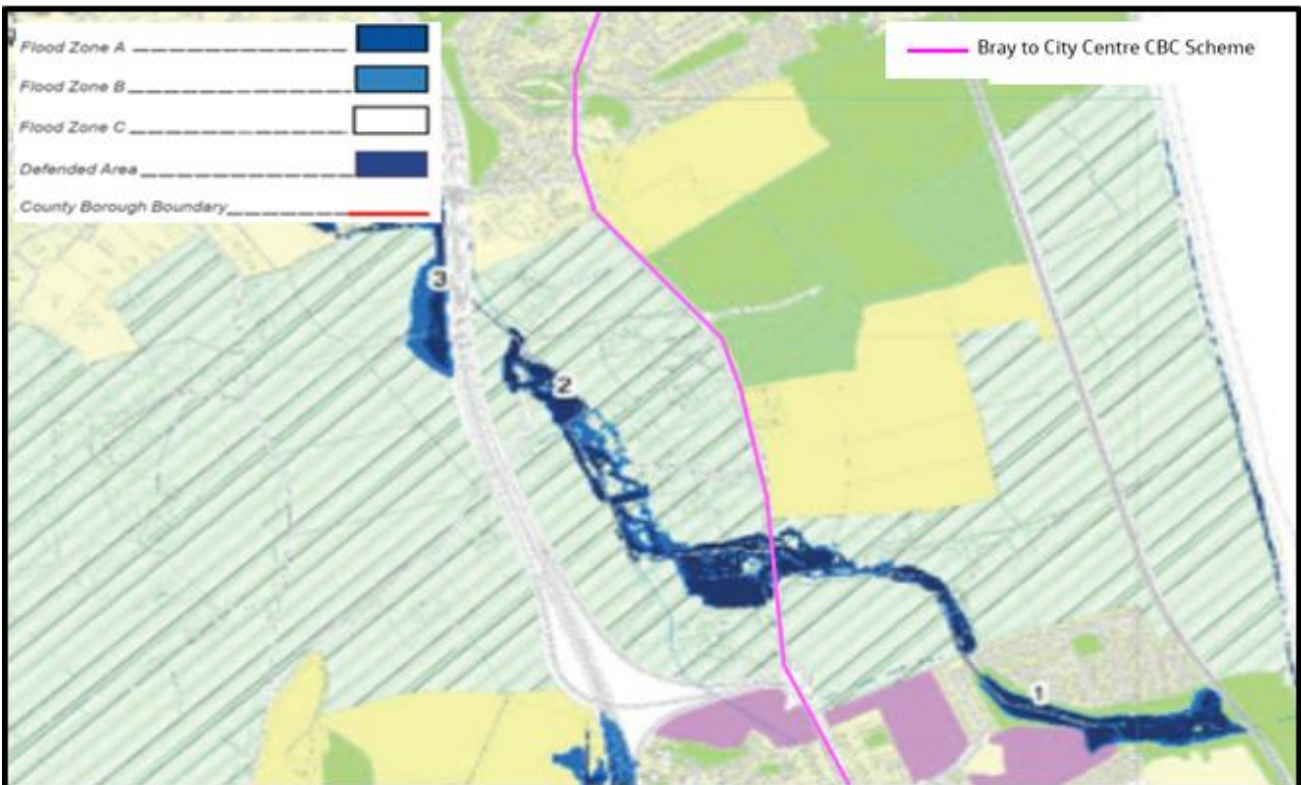


Figure 4.34 Dun Laoghaire - Rathdown Council Composite Flood Map (River Rathmichael crossing).

4.6.3 Wicklow County Development Plan

A Strategic Flood Risk Assessment and Management Plan was prepared as part of the Wicklow County Development Plan 2016-2022. This document states that part of the Bray to City Centre CBC scheme along Dublin Road (R761) and Castle Street is located within Flood Zone A, refer to **Figure 4.35**.

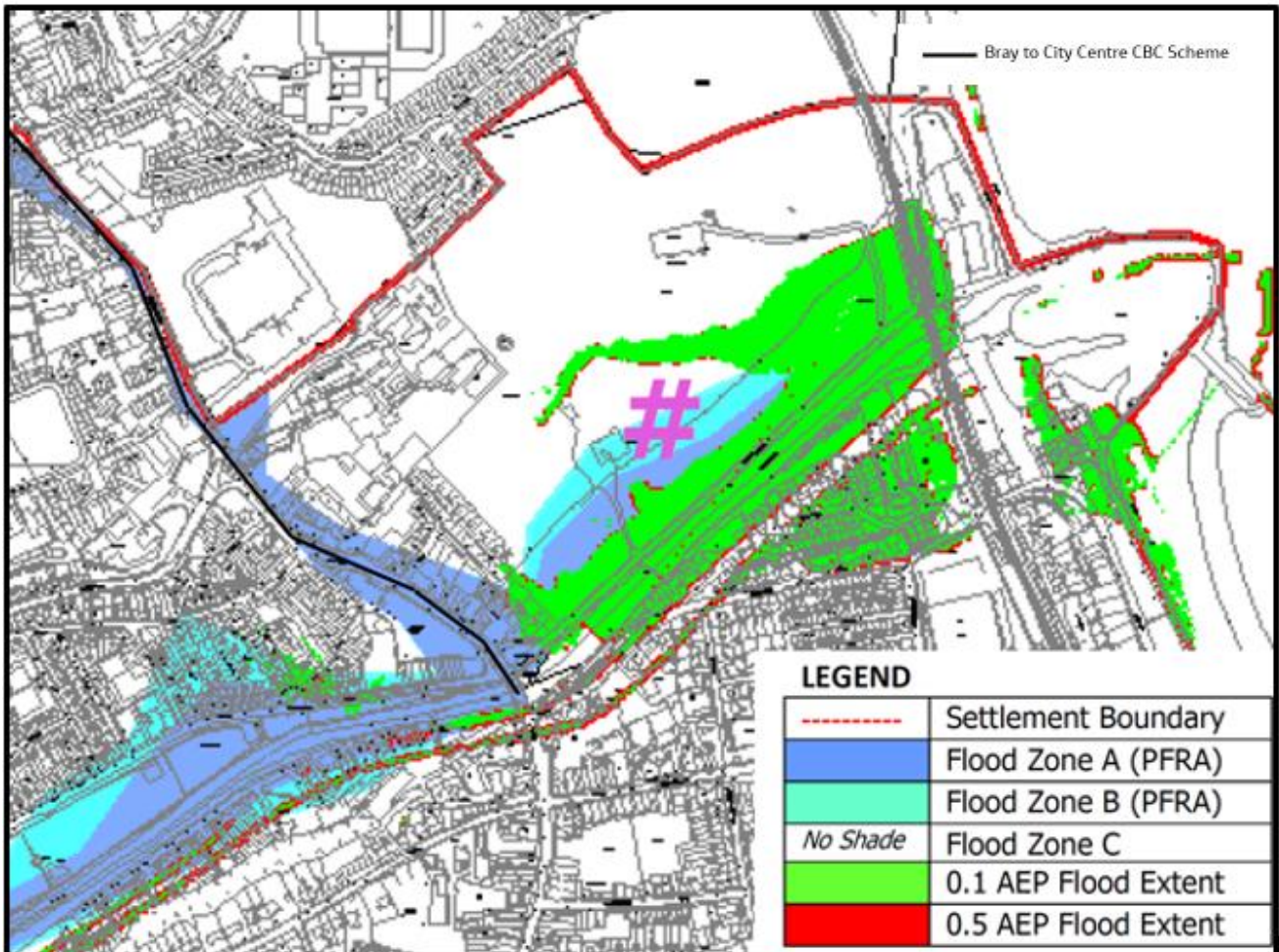


Figure 4.35 Bray City Composite Flood Map. (Wicklow County Development Plan 2016 – 2022).

4.6.4 Bray Municipal District Local Area Plan

A Strategic Flood Risk Assessment and Management Plan was prepared as part of the Bray Municipal District Local Area Plan 2017. This document confirms the information provided in the Wicklow County Development Plan 2016-2022 regarding the flood risk along the Bray to City Centre CBC scheme on Dublin Road (R761) and Castle Street, refer to **Figure 4.36**.



Figure 4.36 Bray City Composite Flood Map (Bray Municipal District Local Area Plan 2017).

5. Stage 2 Initial Flood Risk Assessment

This section assesses the risk of flooding to the proposed development site once the works are complete from a range of different sources, which is then used to develop a broader understanding of the risk characteristics to the proposed development.

5.1 Potential Sources of Flooding

Further to the Stage 1 assessment, there is no identified risk of coastal or groundwater flooding to the Bray to City Centre CBC. The potential sources of flooding are listed below:

- **Fluvial** – Risk from flooding has been identified at three locations across the scheme:
 - River Dodder on Donnybrook Road (R138), (Ch. A02+300 – A02+600). Risk of fluvial flooding in the 1% and 0.1% AEP floods.
 - Brewery Stream on Stillorgan Road (N11), (Ch. A07+050 – A07+350). Risk of fluvial flooding in the 1% and 0.1% AEP floods.
 - Carrickmines Stream and Shanganagh River on Bray Road (N11), Loughlinstown, (Ch. A13+400 – A13+800). Risk of fluvial flooding in the 1% and 0.1% AEP floods.
- **Pluvial** – OPW flood info website showed risk of pluvial flooding along the route in the 10% AEP floods however, it should be noted that this mapping should be used to identify potential risk but is not appropriate for a site-specific flood risk assessment. It is reasonable to assume that the remainder of the Bray to City Centre CBC (between UCD and Bray) is exposed to a similar level of flood risk.
- **Estuarine** - Estuarine flooding occurs due to a combination of tidal and fluvial flows, rivers, and the sea. A combination of a high flow and a high tide will force water back upstream, increasing water levels and leading to a river bursting its banks.
- **Artificial Drainage Systems** - Part of the proposed works are to be built on undeveloped areas. Any increases in the impermeable surfaces associated with the works shall be accounted for in new Sustainable Drainage (SuDS) infrastructure such as an attenuation system ensuring no change in existing runoff rates so the proposed development will not compromise the existing site drainage systems.

It can therefore be concluded that the risk of flooding to the site from artificial drainage systems is low.

5.2 Initial Fluvial Flood Risk Assessment

Three fluvial flood risk areas have been identified for the Bray to City Centre CBC namely:

- River Dodder on Donnybrook Road (R138), (Ch. A02+300 – A02+600).
- Brewery Stream on Stillorgan Road (N11), (Ch. A07+050 – A07+350).
- Carrickmines Stream and Shanganagh River on Bray Road (N11), Loughlinstown, (Ch. A13+400 – A13+800).

Further details including the level of flood risk are provided in the paragraphs below.

5.2.1 River Dodder on Donnybrook Road (R138), (Ch. A02+300 – A02+600).

The Stage 1 assessment indicated that Donnybrook Road (N11) (Ch. A02+300 – A02+600) is at risk of fluvial flooding. The Eastern CFRAM study modelled the Dodder River at its crossing with the Bray to City Centre CBC at Donnybrook Road. The predicted flood extent is shown in **Figure 5.1**.

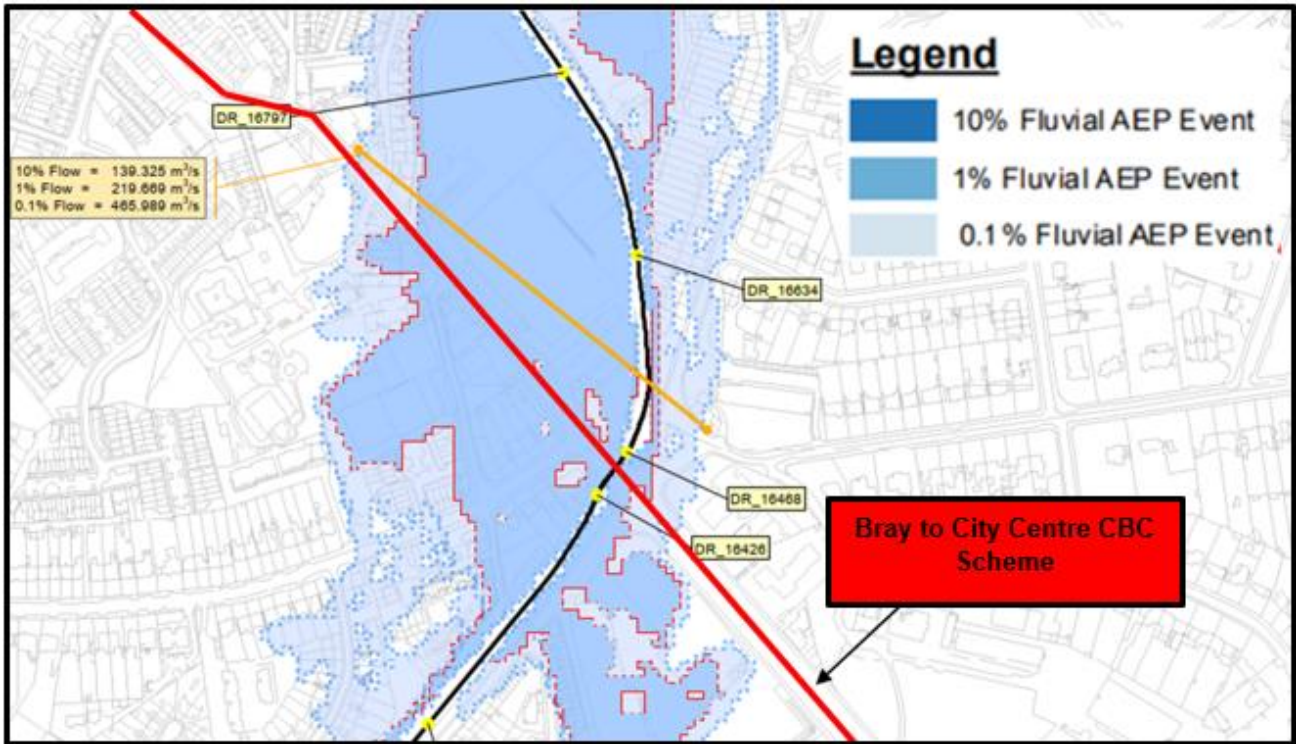


Figure 5.1 Eastern CFRAM study, Donnybrook Road (R138), (Ch. A02+300 – A02+600)

The predicted flood levels have been obtained from the OPW CFRAM Study (See Appendix B) for the 10%, 1% and 0.1% AEP flood event and has been compared against the finished road level for the Bray to City Centre CBC; refer to Table 5.1. It should be noted that the finished ground level is unchanged from the existing ground level within Ch. A02+300 – A02+600

Table 5.1 Design Dodder River Fluvial Flood Levels for Proposed Scheme, Donnybrook Road (R138), (Ch. A02+300 – A02+600)

AEP Event	Flood Level (mAOD)	Minimum Road Level (mAOD)	Difference / Freeboard Allowance (m)
10% (1 in 10)	7.67	9.02	+1.35
1% (1 in 100)	8.35		+0.67
0.1% (1 in 1000)	10.93		-1.91

* Values obtained from node DR_16426

The nearest model node (DR_16426) is upstream of the crossing meaning the reported water levels are likely to overestimate potential flood depths on Donnybrook Road.

As shown, Bray to City Centre CBC is not at risk of flooding in the 10% flood. Flooding is predicted to a depth of approximately 1.91m in the 0.1% AEP flood. As noted, due to the upstream location of the nearest model node, this is likely to be an overestimate of the potential level of flood risk.

The proposed scheme does not require modification of the Anglesea Bridge and the existing road levels will also be maintained. There will therefore be no impact on the existing risk or extent of flooding in this location from the Dodder River as a consequence of the Proposed Scheme.

Ch A02+300 – A02+600 Fluvial Flood Risk Assessment Summary:

- Between Ch. A02+300 – A02+600, the Bray to City Centre CBC is located in Flood Zone A;
- There is no change in flood risk to or arising from the Bray to City Centre CBC from the Dodder River as existing ground levels are unchanged and no modifications are undertaken to the existing bridge structure over the River;
- A Stage 3 FRA is not required as no works are proposed that will affect the hydraulic capacity of the existing bridge crossing of the Dodder River;
- No change in ground levels are proposed meaning there will also be no change in the extent of fluvial flooding.

5.2.2 Brewery Stream South at Stillorgan Road, Stillorgan (N11), (Ch. A07+050 – A07+350)

The Stage 1 assessment indicated that Stillorgan Road (N11), (Ch. A07+050 – A07+350) is at risk of fluvial flooding. The Eastern CFRAM study modelled the Brewery Stream at its crossing with the Bray to City Centre CBC at Stillorgan Road (N11). The predicted flood extent is shown in **Figure 5.2**.

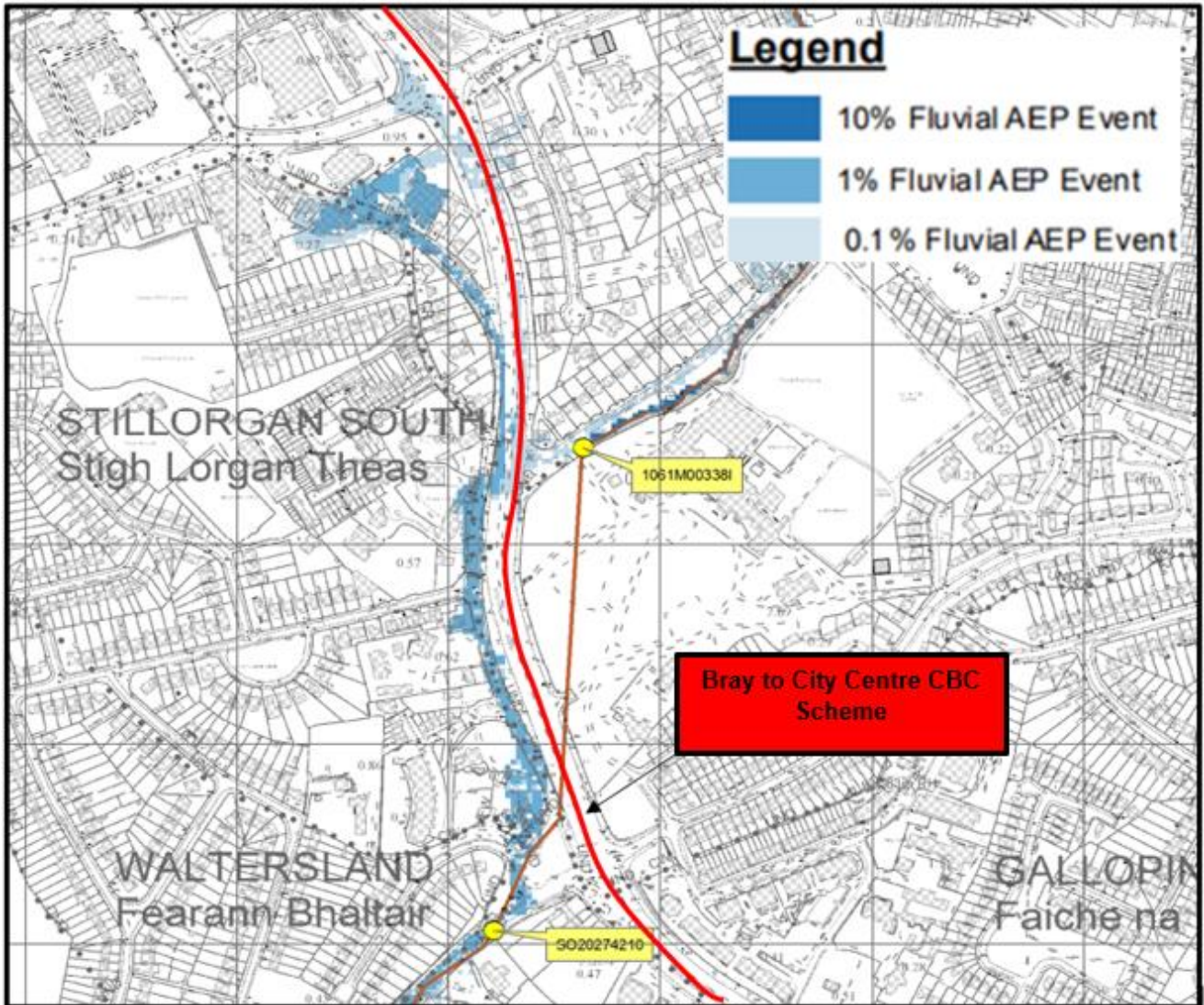


Figure 5.2 Eastern CFRAM study, Stillorgan Road (N11), (Ch. A07+050 – A07+350)

The predicted flood levels have been obtained from the OPW CFRAM Study (See Appendix B) for the 10%, 1% and 0.1% AEP flood event and has been compared against the minimum road level for the development; refer to Table 5.2. It should be noted that the finished ground level is unchanged from the existing ground level within Ch. A6 + 750 – A7 + 550.

Table 5.2 Design Brewery Stream at N11, Stillorgan Road, Stillorgan, Ch. A 6750 – A 7550

AEP Event	Flood Level (mAOD)	Minimum Road Level (mAOD)	Difference / Freeboard Allowance (m)
10% (1 in 10)	62.93	46.838	-16.09
1% (1 in 100)	63.12		-16.28
0.1% (1 in 1000)	63.28		-16.44

* Values obtained from node SO20274210.

The minimum road level is 46.386 mAOD. As the stream is culverted as it passes under the N11 road, it is likely flooding of the road occurs when culvert capacity is exceeded causing water flow overland to low points on the N11.

It is not appropriate to estimate the flood depth on the road from the existing information. This is because the existing culvert inlet and outlet are some distance from the N11, and flows would incur significant hydraulic losses before spilling onto the road. Given the relatively limited extent of flooding, it is reasonable to assume however that flood depths will be relatively shallow at around 300mm.

Ch. A07+050 – A07+350 Fluvial Flood Risk Assessment Summary:

- Between Ch. A07+050 – A07+350, the Bray to City Centre CBC is located in Flood Zone A;
- There is no change in flood risk to or arising from the Bray to City Centre CBC from the Brewery Stream as existing ground levels are unchanged and no modifications are undertaken to the existing culvert structure over the River;
- A Stage 3 FRA is not required as no works are proposed that will affect the hydraulic capacity of the existing road culvert;
- No change in ground levels are proposed meaning there will also be no change in the extent of fluvial flooding.

5.2.3 Carrickmines Stream & Shanganagh River at Loughlinstown (Ch. A13+400 – A13+800)

The Stage 1 assessment indicated that Bray Road (N11), (Ch. A13+400 – A13+800) is at risk of fluvial flooding. The Eastern CFRAM study modelled the Carrickmines Stream and Shanganagh River at their crossing with the Bray to City Centre CBC at Bray Road (N11). The predicted flood extent is shown in Figure 5.3.

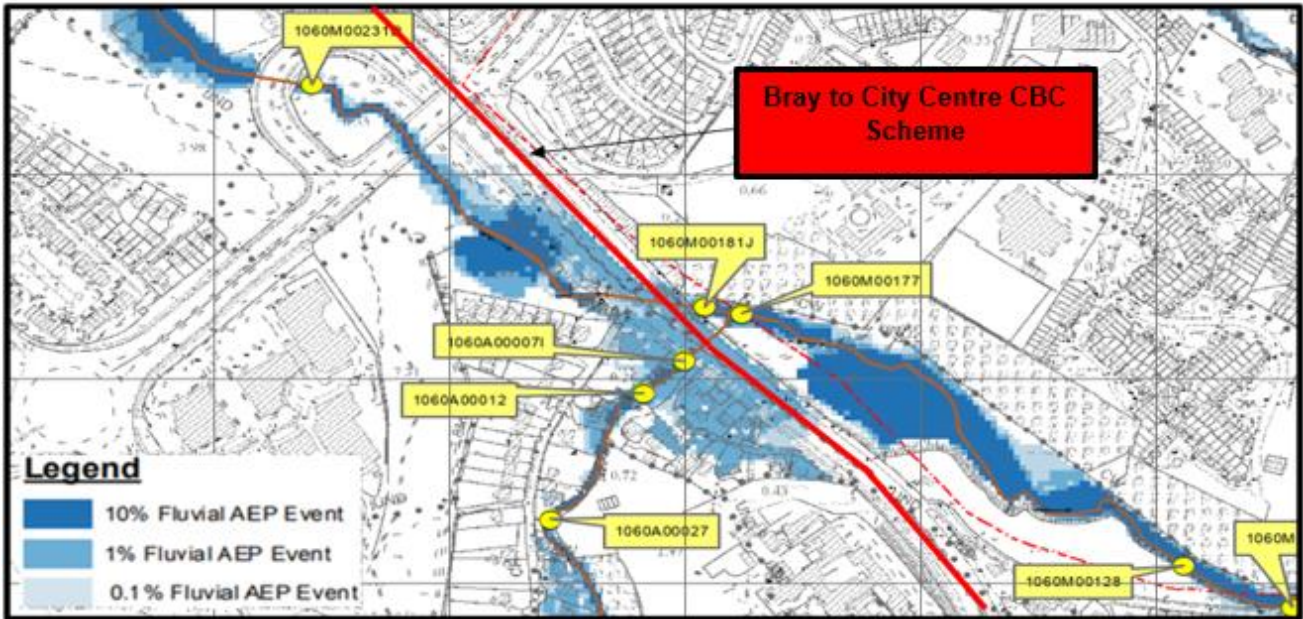


Figure 5.3 Eastern CFRAM study, Bray Road (N11), (Ch. A13+400 – A13+800).

The predicted flood levels have been obtained from the OPW CFRAM Study (See Appendix B) for the 10%, 1% and 0.1% AEP flood event for Carrickmines Stream and Shanganagh River. These have been compared against the minimum road level for the Bray to City Centre CBC; refer to Table 5.3 and Table 5.4. It should be noted that the finished ground level is unchanged from the existing ground level within Ch. A13+400 – A13+800.

Table 5.3 Design Carrickmines Stream Fluvial Flood Levels for the Proposed Scheme, Bray Road (N11), Ch. A13+400 – A13+800)

AEP Event	Flood Level (mAOD)	Minimum Road Level (mAOD)	Difference / Freeboard Allowance (m)
10% (1 in 10)	18.30	15.73	-2.57
1% (1 in 100)	18.77		-3.04
0.1% (1 in 1000)	19.31		-3.58

* Values obtained from node 1060M00231D

Table 5.4 Design Shanganagh River Fluvial Flood Levels for the Proposed Scheme, Bray Road (N11), Ch. A13+400 – A13+800)

AEP Event	Flood Level (mAOD)	Minimum Ground Level (mAOD)	Difference / Freeboard Allowance (m)
10% (1 in 10)	14.87	15.73	+0.86
1% (1 in 100)	16.72		-0.99
0.1% (1 in 1000)	16.86		-1.13

* Values obtained from node 1060A000071

The predicted flood 1% AEP flood level in the Shanganagh River is 16.72 mAOD which compares to the existing road level of between 15.73 mAOD. An appropriate 1% AEP flood level isn't available for the Carrickmines Stream

at the N11. However, it is reasonable to assume this will be similar to that in the Shanganagh River, given the proximity of the two watercourses.

Both watercourses are culverted where they pass under the N11 and it is likely flooding of the road occurs when culvert capacity is exceeded, causing water flow overland to low points on the N11.

Ch. A13+400 – A13+800 Fluvial Flood Risk Assessment Summary:

- Between Ch. A13+400 – A13+800, the Bray to City Centre CBC is located in Flood Zone A;
- There is no change in flood risk to or arising from the Bray to City Centre CBC from the Carrickmines Stream and Shanganagh River as existing ground levels are unchanged, and no modifications are undertaken to the existing culvert structures over the Rivers;
- A Stage 3 FRA is not required unless works are proposed to change the hydraulic capacity of the existing road culverts.
- No change in ground levels is proposed meaning there will also be no change in the extent of fluvial flooding.

5.3 Initial Pluvial Flood Risk Assessment

Pluvial flooding occurs during periods of heavy rainfall, when the rainfall rate is greater than the infiltration capacity. It is usually associated with high intensity rainfall events (typically > 30mm/h) resulting in overland flow and ponding in depressions in the topography. In urban situations underground sewerage/drainage systems and surface watercourses may be overwhelmed.

Heavy rainfall is known to cause frequent ponding on the existing highway network. Typically, these flood events are short duration but could temporarily render parts of the bus corridor inaccessible to users (particularly cyclists). **Table 5.5** shows sections of the Proposed Scheme on Leeson Street Upper, Stillorgan Road (N11) and Dublin Road which are at risk of flooding during a 0.5%, 1% and 10% AEP storms.

Table 5.5 Significant areas of pluvial flooding along the Proposed Scheme

Location	Comments
	<p>Leeson Street Upper</p>
	<p>Stillorgan Road (N11)</p>

Location	Comments
	<p>Dublin Road (R119 & R761)</p>

To reduce the risk of pluvial flooding would require extensive replacement and upgrade of the existing drainage networks along the full Bray to City Centre CBC. This is beyond the scope of the project.

In line with the Dublin City Development Plan and Dun Laoghaire – Rathdown SFRA, drainage from any new impermeable surfaces that are created by the scheme will be attenuated using Sustainable Drainage Systems (SuDS), as identified in The SuDS manual CIRIA 753. These measures will ensure no net increase in run off from the Proposed Scheme or additional flows being discharged to the existing drainage networks.

The existing risk of pluvial flooding to the Bray to City Centre CBC is therefore unchanged. There is no change of use proposed as part of the Bray to City Centre CBC therefore this level of risk is considered to be acceptable.

5.4 Artificial Drainage Systems

Flooding occurs from artificial drainage systems during periods of heavy rainfall, when the local drainage system reaches capacity and surcharges from manholes and/or gullies.

The wider route is currently served by an existing drainage system. Topographical survey results suggest that there are several locations where there are depressions that will naturally accumulate surface water along the Proposed Scheme. The potential risk of flooding from Artificial Drainage Systems is as stated in section 5.1.

5.5 Groundwater Flooding

Groundwater flooding can occur when groundwater rises up from the underlying water table or the water table rises above the surrounding ground level. This is usually associated with periods of prolonged rainfall or very high tides. As such, low lying areas are typically more susceptible to groundwater flooding. This tends to be localised and results from the interaction of site-specific factors such as local geology.

No previous mapping exercise is available to assess the groundwater flood risk. The impermeable nature of the soils that are present across Dublin mean that the risk of groundwater flooding is likely to be relatively low.

No previous groundwater specific flooding incidents have been identified as part of a desk-based study.

5.6 Estuarine flooding

The ICPSS in Section 4.4 of this report only identify one potential area of coastal flooding of the Proposed Scheme from the River Dargle.

The 0.5% AEP tidal flood level for the River Dargle is 2.85 mAOD which compares to the minimum road level along Castle Street of 8.5 mAOD. The Proposed Scheme is therefore not at risk from coastal flooding from the River Dargle.

A Flood Defence Scheme was completed for the River Dargle. The scheme comprised flood defences and channel improvements for 3.1 km of the River Dargle. These flood defences include 2 km of structural walls (contiguous pipes, sheet piles and reinforced concrete) and 2 km of embankments. The completed Scheme provides Bray Town with protection from the 100-year return period fluvial flood and the 200-year return period tidal flood.

Fluvial flooding is therefore likely to be the dominant flood risk to the Proposed Scheme from the River Dargle and therefore, a combination of high fluvial flows and the tide will not result in a higher level of flood risk compared to that generated solely from fluvial sources.

5.7 Flood Risk due to Climate Change

Future climate change is predicted to give rise to an increased risk of flooding through rising sea levels and an increase in river flows and the frequency and intensity of extreme rainfall. The OPW has identified two potential scenarios for the impacts of climate change that are known as the Mid-Range Future Scenario (MRFS) and High-End Future Scenario (HEFS). **Table 5.6** summarises the predicted impacts of both scenarios on predicted sea levels, river flows and rainfall depths over the next 100-years.

Table 5.6 Climate Change Forecast

Parameter	Mid-range Future Scenario (MRFS)	High-End Future Scenario (HRFS)
Mean Sea Level Rise	+500mm	+1000mm
River Flows	+20%	+30%
Extreme Rainfall Depths	+20%	+30%

Table 5.7 summarises the potential flood risk impacts with climate change on the proposed development.

Table 5.7 Climate Change Impact

Source of Flooding	Likely Impacts of Climate Change	Discussion
Coastal	No change	ICPSS did not predict any 0.1% AEP flood events close to the Proposed Scheme. 0.5 % AEP flood events were predicted however, the Flood Defence Scheme protects Bray town from tidal flood events up to 200-year return period.
Fluvial	Increase	<p>Future climate change has the potential to increase the risk from fluvial flooding to the proposed scheme:</p> <ul style="list-style-type: none"> • River Dodder, Brewery Stream, Carrickmines Stream and Shanganagh River were modelled for an 0.1% AEP event. The 100-year event peak water level plus climate change allowance will sit between the current 100-year and 1000-year event water levels therefore, the maximum peak water level at River Dodder for the 100-year event peak water level plus the climate change allowance just upstream of Anglesea Bridge will be 10.93 mAOD. Therefore, flooding would be predicted to a depth of approximately 1.91m in the 0.1% AEP flood. • The maximum peak water level at Brewery Stream plus the climate change allowance just upstream of the culvert under Stillorgan Road (N11) cannot be predicted as the existing culvert inlet and outlet are some distance from the N11, and flows would incur significant hydraulic losses before spilling onto the road. Given the relatively limited extent of flooding, it is reasonable to assume however that flood depths will increase and will be greater than 300mm. • Both watercourses are culverted where they pass under the N11 and it is likely flooding of the road occurs when culvert capacity is exceeded, causing water flow overland to low points on the N11.
Estuarine	No change	Fluvial flooding is likely to be the dominant flood risk to the Proposed Scheme from the River Dargle and therefore, a combination of high fluvial flows and the tide will not result in a higher level of flood risk compared to that generated solely from fluvial sources.
Pluvial	<p>No change (Proposed systems)</p> <p>Increase (Existing systems)</p>	<p>Future climate change will result in increased rainfall depths over the proposed development. The impacts are as follows:</p> <ul style="list-style-type: none"> • For existing drainage systems there will be an increase in the risk of flooding as no works are undertaken to increase their capacity. • For new drainage systems constructed as part of the development, this will not result in an increase in the risk

		of pluvial flooding. These will be designed to allow for the effects of future climate change.
Artificial Drainage Systems	No change (Proposed systems) Increase (Existing systems)	Any new impermeable surfaces associated with the works shall be catered for in additional stormwater infrastructure ensuring any additional runoff will not compromise the existing drainage systems. All additional stormwater drainage required on the site will be designed to cater for the effects of future climate change.
Groundwater	No Impact	The scheme is not at risk from groundwater flooding. Future climate change will not affect this conclusion.

5.8 Summary of Flood Risk

The flood risk to the proposed development is summarised in **Table 5.8** below.

Table 5.8 Summary of Flood Risk to Proposed Development

Flood Risk	Summary of Impact	Notes
Coastal	Low	The risk of coastal flooding is low
Fluvial	High	<p>The following reaches of the Bray to City Centre CBC are at risk from fluvial flooding from the different rivers:</p> <ul style="list-style-type: none"> Donnybrook Road (R138), Ch. A02 + 300 – A02 + 600. (Source, River Dodder). Stillorgan Road (N11), Ch. A07 + 050 – A07 + 350. (Source, Brewery Stream). Bray Road (N11), Loughlinstown, Ch. A13 + 400 – A13 + 750. (Source, Carrickmines Stream and Shanganagh River). Dublin Road (R119), (Ch. A16 + 850 – A17 + 100. (Source, Rathmichael Stream) <p>No change in ground levels is proposed as part of the scheme and there will be no change to the risk of flooding. As noted, the proposed works comprise extension to an existing highway, maintaining the existing level of flood risk is considered to be acceptable.</p>
Estuarine	Low	The risk of estuarine flooding is low.
Pluvial	Low	<p>Leeson Street Upper, Stillorgan Road (N11) and Dublin Road which are at risk of flooding during a 0.5%, 1% and 10% AEP storms events. Widescale improvement to the existing drainage network to alleviate this risk is considered to be beyond the scope of the Bray to City Centre CBC.</p> <p>All new drainage infrastructure will be designed in line with the BusConnects Drainage Strategy that includes recommendations from the Great Dublin Strategic Drainage Study an CIRIA 753.</p>

Artificial Drainage Systems	Low	All new drainage infrastructure will be designed in line with the BusConnects Drainage Strategy that includes recommendations from the Greater Dublin Strategy Drainage Study and Ciria 753 SuDS Manual.
Groundwater	Low	The risk of groundwater flooding is low

6. Stage 2: Potential Flood Risk Impacts from Development

Section 5 considered the flood risk to the Proposed Scheme. This section will consider the potential change in flood risk to the surrounding areas from the works for each source.

6.1 Impacts on Coastal Flooding

The Proposed Scheme is at not at risk from coastal flooding. The Proposed Scheme therefore has no impact on coastal flood risk.

6.2 Impacts on Fluvial Flooding

The Bray to City Centre CBC is at risk from fluvial flooding from River Dodder, Brewery Stream, Carrickmines Stream, Shanganagh River and Rathmichael Stream. The proposed development could result in an increase in the risk of fluvial flooding from these watercourses if they were to:

- Reduce the conveyance of the existing watercourse and floodplain network.
- Reduce the volume of floodplain storage availability.
- Increase site runoff rates and volume.

Section 5 showed that the Bray to City Centre CBC will not require any modification to existing Anglesey bridge and culvert crossings under the Proposed Scheme. The Bray to City Centre CBC will not result in any change in ground level within any existing flood risk areas either. The current predicted extent, depth and onset of flooding from the River Dodder, Brewery Stream, Carrickmines Stream & Shanganagh Rier and Rathmichael Stream will therefore not change as a result of the Bray to City Centre CBC.

Mitigation measures to ensure no increase in site runoff and volume are described in sections 6.4 and 6.5 below.

6.3 Impacts on Estuarine Flooding

The Proposed Scheme is mainly at risk from fluvial flooding therefore, it will not have any impact on estuarine flooding.

6.4 Impacts on Pluvial Flooding

In order to assess the increase in pluvial flood risk the following points need to be considered:

- Will the proposed development increase the rainfall runoff rate?
- Will the proposed development alter existing flow- or drainage paths?
 - As noted, the Proposed Scheme will result in an increase in the area of impermeable surfaces to accommodate improved bus, cycle and pedestrian access along the route. To ensure no associated increase in flood risk, the scheme developed an overarching Drainage Strategy¹ to ensure the implementation of sustainable Drainage Measures (SuDS). These measures which will be further developed through detailed design are in line with CIRIA SuDS manual C753 (2015), Great Dublin Regional Code of Practice and associated GDSDS Technical Documents. The proposed measures are designed to ensure no increase in existing runoff rates along the Proposed Scheme as consequence of the works.
 - There will therefore be no change in the risk of pluvial flooding as a consequence of the Proposed Scheme. Further detail of the measures proposed are contained in Section 6.5.

¹ BusConnects Core bus Corridor Drainage Design Basis, Rev 5, February 2021

6.5 Impacts on Flooding from Artificial Drainage Systems

As noted, any increase in impermeable surface areas associated with the works is catered for additional stormwater infrastructure ensuring any additional runoff will not compromise the existing system. Therefore, it can be concluded that the works will not give rise to any change in the risk of flooding arising from this source.

The increase in impermeable surface area has been offset by the use of SuDS, to ensure no changes on existing runoff rates that are discharged to any existing drainage system or outfall to a watercourse. The SuDS measures have been designed per CIRIA SuDS manual C753 (2015), Greater Dublin regional Code of Practice and associated GSDS Technical Documents.

The methodology to design the additional stormwater network and associated SuDS measures is set out in the projects overarching Drainage Strategy². For the Bray to City Centre CBC, the route was split into catchments based upon gradient, topography and outfall location. The additional impermeable area within each catchment was then identified and new storm water infrastructure provided. Prior discharge to the existing network or outfall to a watercourse, SuDS measures are applied to ensure no increase in existing runoff rates within or being discharged to the existing drainage network.

SuDS measures were selected following a hierarchy which favoured source type solutions close to the new impermeable areas - e.g. tree pits as opposed to tanks and other regional type solutions at the downstream end of the network. A conceptual model is presented in Table 6.1.

Table 6.1 The SuDS Management Train. Source: produced by Jacobs from CIRIA SuDS Manual 2015

Scale		SuDS Management Train
	Source	Rainwater Harvesting – capture and reuse within the local environment
		Pervious Surfacing Systems – structural surfaces that allow water to penetrate into the ground reducing discharge to a drainage system e.g. pervious pavement, tree pits
	Site	Infiltration Systems – structures which encourage infiltration into the ground e.g. Bioretention Basins
		Conveyance Systems – components that convey and control the discharge of flows to downstream storage components e.g. Swales
Regional	Storage Systems – components that control the flows before discharge e.g. attenuation ponds, tanks, oversized pipes or basins	

It should be noted that the selection of a SuDS measure was conditioned by local factors as, in some instances, private land ownership prevented the use of source or site solutions, with the only available option to oversize new pipes beneath the road surface to attenuate any additional flow. In all instances however, attenuation measures are implemented to ensure no increase in the net rate of runoff from any new impermeable areas.

The proposed drainage design for the Bray to City Centre CBC is presented in Drawings BCIDB-JAC-DNG_RD-0013_XX_00-DR-CD-9001 Drawing no 001 to 0054 showing new impermeable areas and their associated SuDS measures. All measures and their associated drainage networks have been designed using WINDES MicroDrainage Models and are sized to contain the 100-year storm with a 20% allowance for future climate change. A summary of these measures is also listed below:

² BusConnects Core bus Corridor Drainage Design Basis, Rev 5, February 2021

- **Section 1: Leeson Street Lower to UCD**

- Where kerblines to be realigned along Leeson Street Upper, Donnybrook Road, Morehampton Road, and Stillorgan Road (R138), Ch A00+000 – A03+100, existing gullies to be removed and to be replaced with side entry gullies.
- 23 m² of new impermeable area along Stillorgan Road (R138) to be drained to the existing surface network, Ch A03+100 – A03+200. Where kerblines to be realigned, existing gullies to be removed and to be replaced with side entry gullies.
- Where kerblines to be realigned along Stillorgan Road (R138), Ch A03+200 – A03+850, existing gullies to be removed and to be replaced with side entry gullies.
- Tree pits and a proposed 200 mm oversized storm water pipe are proposed along the eastern side of Stillorgan Road (R138) to be drained to the existing surface network via a proposed new 200 mm pipe, Ch A03+850 – A03+950, to provide a total of 2.0 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 85 m² impermeable area from the works to the existing storm water network.
- Capping layers are proposed along the western side of Stillorgan Road (R138), Ch A03+850 – A04+100, to provide a total of 330 m³ design attenuation volume based on a permissible outflow is 2l/s. The proposed drainage will drain runoff created by the additional 4291 m² impermeable area from the works to the existing storm water network.
- Tree pits and a proposed 200 mm oversized storm water pipe are proposed along the eastern side of Stillorgan Road (R138), Ch A03+950 – A04+100, to provide a total of 9.1 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 428 m² impermeable area from the works to the existing storm water network.
- Tree pits and a proposed 200 mm oversized storm water pipe are proposed along the eastern side of Stillorgan Road (R138) to be drained to the existing surface network via a proposed new 200 mm pipe, Ch A04+150 – A04+350, to provide a total of 2.0 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 364 m² impermeable area from the works to the existing storm water network.
- Tree pits and a proposed 200 mm oversized storm water pipe are proposed along the western side of Stillorgan Road (R138) to be drained to the existing surface network via a proposed new 200 mm pipe, Ch A04+150 – A04+350, to provide a total of 10.0 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 296 m² impermeable area from the works to the existing storm water network.

- **Section 2: UCD to Lower Kilmacud Road**

- A proposed 300 mm oversized storm water pipe along the eastern side of Stillorgan Road (R138) to be drained to the existing surface network via a proposed new 300 mm pipe, Ch A04+350 – A04+600, to provide a total of 20.0 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 678 m² impermeable area from the works to the existing storm water network.
- 240 m² of new impermeable area along the western side of Stillorgan Road (R138) to be drained to the existing surface network, Ch A04+350 – A04+600. Where kerblines to be realigned, existing gullies to be removed and to be replaced with side entry gullies.
- A proposed 200 mm oversized storm water pipe is proposed along the western side of Stillorgan Road (R138) to be drained to the existing surface network via a proposed new 200 mm pipe, Ch A04+600 – A04+925, to provide a total of 16 m³ design attenuation volume based on a permissible outflow of 2l/s. Both will drain runoff created by the additional 476 m² impermeable area from the works to the existing storm water network.

- A proposed 300 mm oversized storm water pipe is proposed along the western side of Stillorgan Road (R138) to be drained to the existing surface network via a proposed new 300 mm pipe, Ch A04+600 – A04+925, to provide a total of 16 m³ design attenuation volume based on a permissible outflow of 2l/s. Both will drain runoff created by the additional 476 m² impermeable area from the works to the existing storm water network.
- A proposed 300 mm oversized storm water pipe is proposed along the eastern side of Stillorgan Road (R138) to be drained to the existing surface network via a proposed new 300 mm pipe, Ch A04+600 – A04+925, to provide a total of 8 m³ design attenuation volume based on a permissible outflow of 2l/s. Both will drain runoff created by the additional 297 m² impermeable area from the works to the existing storm water network.
- Where eastern kerblines to be realigned along the Stillorgan Road (R138), Ch A04+925 – A05+050, existing gullies to be removed and to be replaced with side entry gullies.
- Where western kerblines to be realigned along the Stillorgan Road (R138), Ch A04+925 – A05+050, existing gullies to be removed and to be replaced with side entry gullies.
- A proposed 375 mm oversized storm water pipe is proposed along the western side of Stillorgan Road (R138) to be drained to the existing surface network via a proposed new 375 mm pipe, Ch A05+050 – A05+100, to provide a total of 14 m³ design attenuation volume based on a permissible outflow of 2l/s. Both will drain runoff created by the additional 125 m² impermeable area from the works to the existing storm water network.
- Where kerblines to be realigned along the eastern side of Stillorgan Road (R138), Ch A05+050 – A05+100, existing gullies to be removed and to be replaced with side entry gullies.
- A proposed 25 m³ attenuation tank is proposed along the western side of Stillorgan Road (R138) to be drained to the existing surface network via a proposed new 450 mm pipe, Ch A05+100 – A05+450, to provide a total of 61 m³ design attenuation volume based on a permissible outflow of 2l/s. Both will drain runoff created by the additional 448 m² impermeable area from the works to the existing storm water network.
- A proposed 300 mm oversized storm water pipe is proposed along the eastern side of Stillorgan Road (R138) to be drained to the existing surface network via a proposed new 300 mm pipe, Ch A05+100 – A05+450, to provide a total of 8 m³ design attenuation volume based on a permissible outflow of 2l/s. Both will drain runoff created by the additional 313 m² impermeable area from the works to the existing storm water network.
- Tree pits and a proposed 200 mm oversized storm water pipe are proposed along the eastern side of Stillorgan Road (R138) to be drained to the existing surface network via a proposed new 200 mm pipe, Ch A05+450 – A05+550, to provide a total of 3.0 m³ design attenuation volume based on a permissible outflow of 2l/s. Both will drain runoff created by the additional 95 m² impermeable area from the works to the existing storm water network.
- 27 m² of new impermeable area along Stillorgan Road (R138) to be drained to the existing surface network, Ch A05+550 – A05+700. Where kerblines to be realigned, existing gullies to be removed and to be replaced with side entry gullies.
- Where kerblines to be realigned the Stillorgan Road (R138), Ch A05+700 – A06+100, existing gullies to be removed and to be replaced with side entry gullies.
- Where kerblines to be realigned the Stillorgan Road (R138), Ch A06+100 – A06+150, existing gullies to be removed and to be replaced with side entry gullies.
- 21 m² of new impermeable area along Stillorgan Road (R138) to be drained to the existing surface network, Ch A06+100 – A06+150. Where kerblines to be realigned the Stillorgan Road (R138) existing gullies to be removed and to be replaced with side entry gullies.

- Tree pits and a proposed 200 mm oversized storm water pipe are proposed along the western side of Stillorgan Road (N11) to be drained to the existing surface network via a proposed new 200 mm pipe, Ch A06+150 – A06+250, to provide a total of 3.0 m³ design attenuation volume based on a permissible outflow of 2l/s. Both will drain runoff created by the additional 27 m² impermeable area from the works to the existing storm water network.
- A proposed 300 mm oversized storm water pipe are proposed along the eastern side of Stillorgan Road (N11) to be drained to the existing surface network via a proposed new 300 mm pipe, Ch A06+150 – A06+250, to provide a total of 3.3 m³ design attenuation volume based on a permissible outflow of 2l/s. Both will drain runoff created by the additional 34 m² impermeable area from the works to the existing storm water network.
- A proposed 400 mm oversized storm water pipe is proposed along the eastern side of Stillorgan Road (N11) to be drained to the existing surface network via a proposed new 400 mm pipe, Ch A06+250 – A06+550, to provide a total of 20 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 602 m² impermeable area from the works to the existing storm water network.
- A proposed 400 mm oversized storm water pipe is proposed along the western side of Stillorgan Road (N11) to be drained to the existing surface network via a proposed new 400 mm pipe, Ch A06+250 – A06+550, to provide a total of 22 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 626 m² impermeable area from the works to the existing storm water network.
- A proposed 400 mm oversized storm water pipe is proposed along the eastern side of Stillorgan Road (N11) to be drained to the existing surface network via a proposed new 400 mm pipe, Ch A06+550 – A06+700, to provide a total of 14 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 479 m² impermeable area from the works to the existing storm water network.
- A proposed 400 mm oversized storm water pipe is proposed along the western side of Stillorgan Road (N11) to be drained to the existing surface network via a proposed new 400 mm pipe, Ch A06+550 – A06+800, to provide a total of 6 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 202 m² impermeable area from the works to the existing storm water network.
- A proposed storm water pipe and filter drain are proposed along the eastern side of Stillorgan Road (N11) to be drained to the existing surface network via a proposed new storm water pipe, Ch A06+650 – A06+800, to provide a total of 8.2 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 170 m² impermeable area from the works to the existing storm water network.
- **Section 3: Lower Kilmacud Road Junction to Loughlinstown Roundabout**
 - Where kerblines to be realigned along Stillorgan Road (N11), Ch A06+800 – A06+850, existing gullies to be removed and to be replaced with side entry gullies.
 - A proposed 375 mm oversized storm water pipe is proposed along the western side of Stillorgan Road (N11) to be drained to the existing surface network via a proposed new 375 mm pipe, Ch A06+850 – A07+150, to provide a total of 17 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 267 m² impermeable area from the works to the existing storm water network.
 - A proposed 375 mm oversized storm water pipe is proposed along the western side of Stillorgan Road (N11) to be drained to the existing surface network via a proposed new 375 mm pipe, Ch A06+850 – A07+150, to provide a total of 24 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 733 m² impermeable area from the works to the existing storm water network.

- Where kerblines to be realigned along Stillorgan Road (N11), Ch A07+150 – A07+450, existing gullies to be removed and to be replaced with side entry gullies.
- 117 m² of new impermeable area along Stillorgan Road (N11) to be drained to the existing surface network, Ch A07+450 – A07+550. Where kerblines to be realigned, existing gullies to be removed and to be replaced with side entry gullies.
- A proposed 300 mm oversized storm water pipe is proposed along the western side of Stillorgan Road (N11) to be drained to the existing surface network via a proposed new 300 mm pipe, Ch A07+550 – A07+750, to provide a total of 9.1 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 166 m² impermeable area from the works to the existing storm water network.
- A proposed 300 mm oversized storm water pipe is proposed along the eastern side of Stillorgan Road (N11) to be drained to the existing surface network via a proposed new 300 mm pipe, Ch A07+550 – A07+750, to provide a total of 6 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 213 m² impermeable area from the works to the existing storm water network.
- 157 m² of new impermeable area along the eastern Stillorgan Road (N11) to be drained to the existing surface network, Ch A07+750 – A07+850. Where kerblines to be realigned, existing gullies to be removed and to be replaced with side entry gullies.
- 42 m² of new impermeable area along the western Stillorgan Road (N11) to be drained to the existing surface network, Ch A07+750 – A07+850. Where kerblines to be realigned, existing gullies to be removed and to be replaced with side entry gullies.
- Where kerblines to be realigned along Stillorgan Road (N11), Ch A07+850 – A08+150, existing gullies to be removed and to be replaced with side entry gullies.
- Where kerblines to be realigned along Stillorgan Road (R138), Ch A08+150 – A08+350, existing gullies to be removed and to be replaced with side entry gullies.
- 88 m² of new impermeable area along the western Stillorgan Road (N11) to be drained to the existing surface network, Ch A08+350 – A08+525. Where kerblines to be realigned, existing gullies to be removed and to be replaced with side entry gullies.
- A proposed 450 mm oversized storm water pipe is proposed along the eastern side of Stillorgan Road (N11) to be drained to the existing surface network via a proposed new 450 mm pipe, Ch A08+350 – A08+525, to provide a total of 20 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 197 m² impermeable area from the works to the existing storm water network.
- Catchment 36 Tree pits and a proposed 450 mm oversized storm water pipe are proposed along the eastern side of Stillorgan Road (R138) to be drained to the existing surface network via a proposed new 450 mm pipe, Ch A08+525 – A09+200, to provide a total of 60 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 1344m² impermeable area from the works to the existing storm water network.
- 45 m² of new impermeable area along the western Stillorgan Road (N11) to be drained to the existing surface network, Ch A09+200 – A09+300. Where kerblines to be realigned, existing gullies to be removed and to be replaced with side entry gullies.
- Tree pits and a proposed 150 mm storm water pipe are proposed along the centre of Stillorgan Road (N11) to be drained to the existing surface network via a proposed new 150 mm pipe, Ch A09+300 – A09+800, to provide a total of 10.0 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 323 m² impermeable area from the works to the existing storm water network.

- 156 m² of new impermeable area along the western Stillorgan Road (N11) to be drained to the existing surface network, Ch A09+800 – A10+500. Where kerblines to be realigned, existing gullies to be removed and to be replaced with side entry gullies.
- Tree pits and a proposed 300mm filter drain are proposed along the northern side of Bray Road (N11) to be drained to the existing surface network via a proposed new 300 mm pipe, Ch A10+500 – A10+800, to provide a total of 4 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 229 m² impermeable area from the works to the existing storm water network.
- Where kerblines to be realigned along Bray Road (N11), Ch A10+500 – A10+800, existing gullies to be removed and to be replaced with side entry gullies.
- Where kerblines to be realigned along Bray Road (N11), Ch A10+800 – A11+150, existing gullies to be removed and to be replaced with side entry gullies.
- Tree pits and a proposed 200mm filter drain are proposed along the centre of Bray Road (N11) to be drained to the existing surface network via a proposed new 200 mm pipe, Ch A11+150 – A11+300, to provide a total of 3.0 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 112 m² impermeable area from the works to the existing storm water network.
- Tree pits and a proposed 200mm new storm water pipe are proposed along the centre of Bray Road (N11) to be drained to the existing surface network via a proposed new 200 mm pipe, Ch A11+300 – A11+550, to provide a total of 4.0 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 177 m² impermeable area from the works to the existing storm water network.
- 52 m² of new impermeable area along the western Bray Road (N11) to be drained to the existing surface network, Ch A11+550 – A11+850. Where kerblines to be realigned, existing gullies to be removed and to be replaced with side entry gullies.
- 136 m² of new impermeable area along the western Bray Road (N11) to be drained to the existing surface network, Ch A11+850 – A12+200. Where kerblines to be realigned, existing gullies to be removed and to be replaced with side entry gullies.
- 60 m² of new impermeable area along the western Bray Road (N11) to be drained to the existing surface network, Ch A12+200 – A12+300. Where kerblines to be realigned, existing gullies to be removed and to be replaced with side entry gullies.
- 38 m² of new impermeable area along the western Bray Road (N11) to be drained to the existing surface network, Ch A12+300 – A12+500. Where kerblines to be realigned, existing gullies to be removed and to be replaced with side entry gullies.
- 4 m² of new impermeable area along the western Bray Road (N11) to be drained to the existing surface network, Ch A12+500 – A12+900. Where kerblines to be realigned, existing gullies to be removed and to be replaced with side entry gullies.
- A proposed 300mm new oversized pipe is proposed along the western side of Bray Road (N11) to be drained to the existing surface network via a proposed new 300 mm pipe, Ch A12+900 – A13+200, to provide a total of 8.0 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 534 m² impermeable area from the works to the existing storm water network.
- A proposed 300mm new oversized pipe is proposed along the eastern side of Bray Road (N11) to be drained to the existing surface network via a proposed new 300 mm pipe, Ch A13+200 – A13+450, to provide a total of 6.0 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 247 m² impermeable area from the works to the existing storm water network.

- A proposed 300mm new oversized pipe is proposed along the western side of Bray Road (N11) to be drained to the existing surface network via a proposed new 300 mm pipe, Ch A13+450 – A13+700, to provide a total of 8.0 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 351 m² impermeable area from the works to the existing storm water network.
- A proposed 300mm new oversized pipe is proposed along the western side of Bray Road (N11) to be drained to the existing surface network via a proposed new 300 mm pipe, Ch A13+700 – A13+875, to provide a total of 13.0 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 474 m² impermeable area from the works to the existing storm water network.
- Where kerblines to be realigned along Bray Road (N11), Ch A13+875 – A14+200, existing gullies to be removed and to be replaced with side entry gullies.
- A proposed 300mm filter drain is proposed along the western side of Dublin Road (R837) to be drained to the existing surface network via a proposed new 300 mm pipe, Ch A14+200 – A14+475, to provide a total of 12 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 414 m² impermeable area from the works to the existing storm water network.
- A proposed 11 m³ attenuation tank is proposed along the western side of Dublin Road (R837) to be drained to the existing surface network via a proposed new 375 mm pipe, Ch A14+475 – A14+700, to provide a total of 25 m³ design attenuation volume based on a permissible outflow of 2l/s. Both will drain runoff created by the additional 718 m² impermeable area from the works to the existing storm water network.
- A proposed 300mm new oversized pipe is proposed along the eastern side of Dublin Road (R837) to be drained to the existing surface network via a proposed new 300 mm pipe, Ch A14+700 – A15+100, to provide a total of 14.0 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 596 m² impermeable area from the works to the existing storm water network.
- A proposed filter drain is proposed along the northern side of the Stonebridge Road to be drained to the existing surface network via a proposed new drain, Ch E00+050 – E00+200, to provide a total of 23.0 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 673 m² impermeable area from the works to the existing storm water network.
- **Section 4: Loughlinstown Roundabout to Dargle river Crossing**
 - 109 m² of new impermeable area along the eastern Shanganagh Road to be drained to the existing surface network, Ch A15+000. Where kerblines to be realigned, existing gullies to be removed and to be replaced with side entry gullies.
 - 117 m² of new impermeable area along the eastern Dublin Road (R837) to be drained to the existing surface network, Ch A15+100 – A15+150. Where kerblines to be realigned, existing gullies to be removed and to be replaced with side entry gullies.
 - 107 m² of new impermeable area along the eastern Dublin Road (R837) to be drained to the existing surface network, Ch A15+150 – A15+700. Where kerblines to be realigned, existing gullies to be removed and to be replaced with side entry gullies.
 - 116 m² of new impermeable area along the eastern Dublin Road (R837) to be drained to the existing surface network, Ch A15+700 – A15+900. Where kerblines to be realigned, existing gullies to be removed and to be replaced with side entry gullies.
 - Tree pits and a proposed 300mm filter drain are proposed along the western side of the Dublin Road (R837) to be drained to the existing surface network via a proposed new 300 mm pipe, Ch

- A15+900 – A16+050, to provide a total of 5.0 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 388 m² impermeable area from the works to the existing storm water network.
- A proposed 300mm and 400mm new oversized pipes and new filter drain is proposed along the Dublin Road (R837) to be drained to the existing surface network via a proposed new 300- or 400-mm pipe, Ch A16+050 – A16+475, to provide a total of 120.0 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 2717 m² impermeable area from the works to the existing storm water network.
 - A proposed 300mm new oversized pipes is proposed along the eastern side of the Dublin Road (R837) to be drained to the existing surface network via a proposed new 300 mm pipe, Ch A16+475 – A16+750, to provide a total of 14.0 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 647 m² impermeable area from the works to the existing storm water network.
 - A proposed 500mm new oversized pipes is proposed along the western side of the Dublin Road (R837) to be drained to the existing surface network via a proposed new 500 mm pipe, Ch A16+475 – A17+100, to provide a total of 55.0 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 1486 m² impermeable area from the works to the existing storm water network.
 - A proposed 500mm new oversized pipes is proposed along the eastern side of the Dublin Road (R837) to be drained to the existing surface network via a proposed new 500 mm pipe, Ch A16+750 – A17+100, to provide a total of 110.0 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 2332 m² impermeable area from the works to the existing storm water network.
 - Tree pits and a proposed 200mm storm water pipe are proposed along the western side of the Dublin Road (R837) to be drained to the existing surface network via a proposed new 200 mm pipe, Ch A17+100 – A17+200, to provide a total of 5.0 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 183 m² impermeable area from the works to the existing storm water network.
 - A proposed 500mm new oversized pipes is proposed along the eastern side of the Dublin Road (R837) to be drained to the existing surface network via a proposed new 500 mm pipe, Ch A17+200 – A17+500, to provide a total of 14.0 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 535 m² impermeable area from the works to the existing storm water network.
 - A proposed 20 m³ attenuation tank and a filter drain are proposed along the eastern side of Dublin Road (R837) to be drained to the existing surface network via a proposed new pipe, Ch A17+500 – A17+750, to provide a total of 40 m³ design attenuation volume based on a permissible outflow of 2l/s. Both will drain runoff created by the additional 1259 m² impermeable area from the works to the existing storm water network.
 - A proposed filter drain is proposed along the eastern side of the Dublin Road (R837) to be drained to the existing surface network via a proposed new 225 mm pipe, Ch A17+750 – A17+950, to provide a total of 4.0 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 271 m² impermeable area from the works to the existing storm water network.
 - Tree pits and a proposed filter drain are proposed along the eastern side of the Dublin Road (R837) to be drained to the existing surface network via a proposed new 225 mm pipe, Ch A17+950 – A18+100, to provide a total of 24.0 m³ design attenuation volume based on a permissible outflow is 2l/s. Both will drain runoff created by the additional 874 m² impermeable area from the works to the existing storm water network.

- 195 m2 of new impermeable area along the eastern Castle Street to be drained to the existing surface network, Ch A18+100 – A18+350. Where kerblines to be realigned, existing gullies to be removed and to be replaced with side entry gullies.
- 90 m2 of new impermeable area along the eastern Castle Street to be drained to the existing surface network, Ch A18+350 – A18+450. Where kerblines to be realigned, existing gullies to be removed and to be replaced with side entry gullies.

6.6 Impacts on Groundwater Flooding

The proposed works do not involve any new works below existing ground levels that would cause an increase in the risk of groundwater flooding.

6.7 Summary of Potential Flood Risk Impacts from Development

The flood risk impacts from the proposed development are summarised in **Table 6.2**.

Table 6.2 Summary of potential flood risk impacts on surrounding areas as a result of the development

Flood Risk	Potential Scheme Impact	Discussion & Mitigation (where Required)	Residual Scheme Impact (with mitigation)
Coastal	No Impact	No impact as the proposed development is not at risk of coastal flooding.	No impact
Fluvial	No Impact	No impact on channel or floodplain storage and conveyance from the works.	No impact
Estuarine	No impact	No change in ground levels or new structures are proposed that will impact on the current flood extent	No impact
Pluvial	Increase	As noted, the upgrade works has the potential to increase the rate of runoff from the creation of additional impermeable surfaces. The proposed scheme will however include full mitigation in the form of to ensure no change to the existing runoff rates.	No impact
Artificial Drainage Systems	No impact	Any additional drainage will include SuDS measures to maintain existing site runoff rates.	No impact
Groundwater	No impact	Below-ground elements of the works are localised and will not impact ground water movements.	No impact

7. Flood Risk Management and Evaluation

7.1 The Sequential Approach to Development Planning

As shown in Figure 7.1, the FRA indicates that part of the Proposed Scheme will be located in Flood Zones A and B. *'The Planning System and Flood Risk Management: Guidelines for Planning Authorities and Technical Appendices, 2009'* classifies the proposed development as 'highly vulnerable' with respect to flooding.

Application of the sequential approach within the FRM Guidelines would be to steer the Proposed Scheme away from flood zones A and B. This is not practicable however, as the works comprise modification and extension to an existing highway. Raising the level of the highway to reduce the risk of flooding is also not practicable as this would have a significant detrimental impact on adjacent properties.

Document reference PL 2/2014 issued by the Department of Housing, Local Government and Heritage (9th March 2021), sought to provide clarification on the use of Flood Mapping in planning applications and application of flood zones within older developed areas of towns and cities. Document PL 2/2014 noted that where developments concern the extension to existing assets, the sequential approach cannot be used to locate them in lower areas of flood risk. The Justification Test will therefore not apply, however a commensurate assessment of the risk of flooding from the development to ensure no adverse impacts.

Given the scale and strategic importance of the Proposed Scheme to transport provision in Dublin and classification as a "highly vulnerable" development in accordance with the FRM, whilst not strictly required based on PL 2/2014, an assessment of the proposed scheme in the spirit of a justification test was undertaken to demonstrate that the development was compatible with the existing level of flood risk.

7.2 Justification of the Proposed Works

Parts of the Proposed Scheme are located in Flood Zones A and B. Whilst not a requirement based on PL 2/2014, an assessment of the proposed scheme in the spirit of a justification test was undertaken to demonstrate that the development was compatible with the existing level of flood risk.

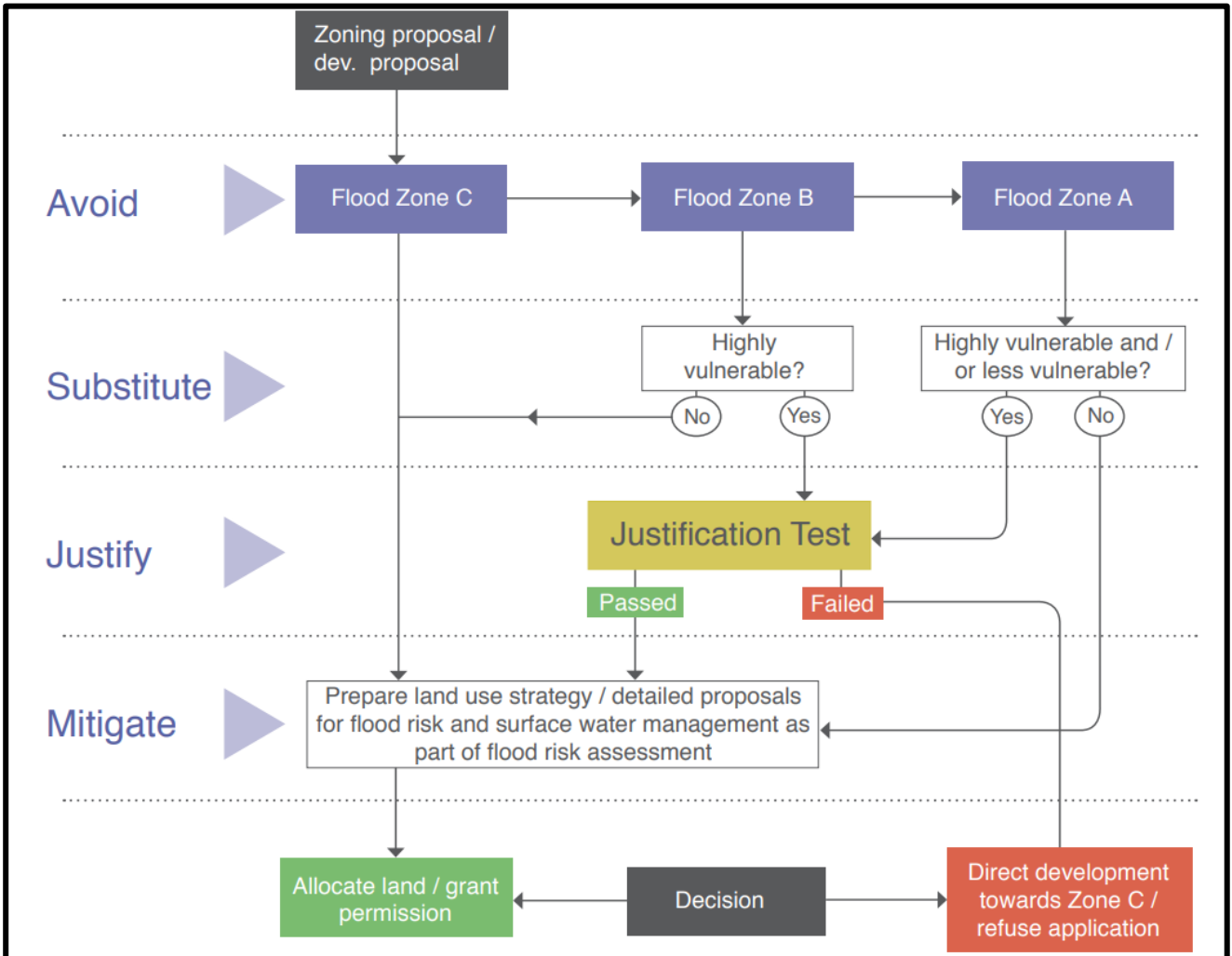


Figure 7.1: FRA in accordance with 'The Planning System and Flood Risk Management: Guidelines for Planning Authorities and Technical Appendices, 2009'

7.2.1 Justification Test

'The Planning System and Flood Risk Management, Guidelines for Planning Authorities' (2009)', 5.15, Box 5.1 as amended by PL 2/2014 sets out the criteria for the Justification Test. An assessment of the proposed development against these criteria is presented in **Table 7.1**.

Table 7.1 Assessment against Justification Test Criteria

Criteria to be satisfied	Justification	Criteria Met
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.	The Proposed Scheme comprises re-orientation and extension to an existing highway. The lands are zoned accordingly for this purpose.	Yes
The development will not increase flood risk elsewhere, and, if practicable, will reduce overall flood risk.	The works will not increase the flood risk from any source.	Yes
The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably practicable.	<p>The works comprise modifications to an existing highway and, as noted, it is not practicable to reduce the level of flood risk to the Proposed Scheme.</p> <p>The wider objective of the Proposed Scheme is to promote more sustainable forms of transport and reduce the number of cars. In this regard, the Proposed Scheme can be regarded as meeting these criteria as it will reduce the number of vehicles potentially exposed to flooding.</p> <p>SuDS measures implemented as part of the scheme will also improve the quality of runoff, delivering a net benefit to the environment.</p>	Yes
The development proposed includes measures to ensure that residual risks to the area and/or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures and provisions for emergency services access.	The works will incorporate SuDS to ensure there is no increase runoff rates as a consequence of the works. Therefore, there will be no increase in flood risk from an increase in the area of impermeable surfaces as part of the works.	Yes
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.	The proposed development meets the objectives set out in the Dublin City Development Plan 2016-2022, Dun Laoghaire-Rathdown 2022-2028, Wicklow County Development Plan 2016-2022 and Bray Municipal District Local Area Plan 2017 as it forms a key part of achieving the required rate of sustainable urban growth by promoting active travel and public transport.	Yes

Whilst a Justification Test is not considered to be necessary for the proposed scheme. The proposed development is still considered to meet the criteria of the Justification Test set out in Box 5.1 in the 'Planning System and Flood Risk Management – Guidelines for Planning Authorities (Nov 09)'.

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

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

1. The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative development plan, which has been adopted or varied taking account of these Guidelines.
2. The proposal has been subject to an appropriate flood risk assessment that demonstrates:
 - (i) The development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk.
 - (ii) The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible.
 - (iii) The development proposal includes measures to ensure that residual risks to the area and/or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures and provisions for emergency services access; and
 - (iv) The development proposed addresses the above in a manner that is also compatible with the achievement of wider planning objectives in relation to development of good urban design and vibrant and active streetscapes.

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

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

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

8. Stage 3 Detailed Flood Risk Assessment Recommendations

Stage 3 comprises a detailed flood risk assessment for the proposed development, and how to mitigate against flood risks from coastal and fluvial sources.

This stage of the flood risk assessment will assess:

- Plans of the proposed development including the extent, road levels (existing and proposed)
- Impact of the proposed development on the surrounding areas
- Justification tests
- Residual risks
- Flood exceedances

Table 8.1 summarises the Stage 3 assessment requirements based on the current design. This will need to be reviewed and verified following the final scheme design fix.

Table 8.1 Stage 3 Assessment Requirements

Location	Works	Assessment	Information Required
River Dodder	No works proposed to the existing River Crossing in the flood zone.	No Stage 3 FRA required.	None
Elm Park Stream	No works proposed to the existing Stream Crossing in the flood zone.	No Stage 3 FRA required. Further assessment required to verify flood risk. Hand calculations and a study of culvert capacity is likely to be sufficient for this purpose to complete the Stage 2 assessment.	Topographic survey of the existing culvert and CFRAM models.
Brewery Stream	No works proposed to the existing Stream Crossing in the flood zone.	No Stage 3 FRA required.	None
Shanganagh River / Carrickmines Stream	No works proposed to the existing Stream Crossing in the flood zone. Opportunity to improve existing culvert	No Stage 3 FRA required.	CFRAM model to confirm flood levels to confirm the Stage 2 assessment.
Rathmichael Stream	No works proposed to the existing Stream Crossing in the flood zone.	No Stage 3 FRA required.	CFRAM model to confirm flood levels to confirm the Stage 2 assessment.
River Dargle Crossing	No works proposed to the existing Stream Crossing in the flood zone.	No Stage 3 FRA required.	Updated CFRAM outputs to confirm

			flood risk to confirm the Stage 2 assessment.
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9. Conclusions and Recommendations

9.1 Conclusions

The following sources and level of flood risk along the Proposed Scheme are:

- A risk of pluvial flooding due to the limited capacity of the existing highway drainage network.
- A risk of fluvial flooding from the Dodder River, Brewery Stream, Carrickmines Stream & Shanganagh River and Rathmichael Stream to parts of the scheme.

Pluvial Flooding

There is a high risk of pluvial flooding along the entire Proposed Scheme. This is a function of the capacity of the existing surface water network, which is typically designed to contain a 20% AEP storm. It is beyond the scope of the Proposed Scheme to increase the capacity of the existing surface water network.

The Proposed Scheme will result in the creation of additional impermeable surfaces for local sections of road widening. SuDS measures have been implemented to ensure that there is no change in existing runoff rates as a consequence of the scheme. This will ensure no increase in the risk of pluvial flooding.

Fluvial Flooding

The Proposed Scheme is at risk from fluvial flooding from Dodder River, Brewery Stream, Carrickmines Stream & Shanganagh River and Rathmichael Stream. The scheme is located in Flood Zones A and/or B.

Risk from fluvial flooding has yet to be confirmed at Ch. A03 + 900 from Elm Park Stream by a Stage 3 Flood Risk Assessment and risk from fluvial flooding around Ch A18 + 500 from River Dargle has yet to be confirmed by the reviewed OPW CFRAM maps as they are currently under review at this location. These reviewed maps should provide the water levels for the different fluvial AEP events between Ch A16 + 850 and A17 + 100 from Rathmichael Stream as they are currently under review.

The Proposed Scheme will not affect the hydraulic capacity of Dodder River, Elm Park Stream, Brewery Stream, Carrickmines Stream & Shanganagh River, Rathmichael Stream, River Dargle or any structures which cross it. No works are proposed to modify any existing bridges that would reduce their hydraulic capacity. The existing level of the road will also be maintained. The Proposed Scheme will therefore not result in any change to the existing risk of fluvial flooding.

As noted, the proposed works typically comprise local widening of the existing highway. It is not possible to raise the level of the highway to reduce the existing level of flood risk. It is also beyond the scope of the Proposed Scheme to implement a wider flood relief scheme for the Dodder River, Elm Park Stream, Brewery Stream, Carrickmines Stream & Shanganagh River, Rathmichael Stream, River Dargle.

Climate Change

Climate change will result in an increased risk of flooding to the Proposed Scheme due to:

- Increased river flows.
- Increased rainfall depths and intensity.
- Increased sea levels.

The impact of climate change on coastal flooding is not considered to be significant as the current risk to the Proposed Scheme is so low.

Increased rainfall depths and intensities will increase the risk of pluvial flooding from the existing surface water drainage network. New drainage measures which installed as part of the scheme, including any SuDS, are designed to allow for future climate change.

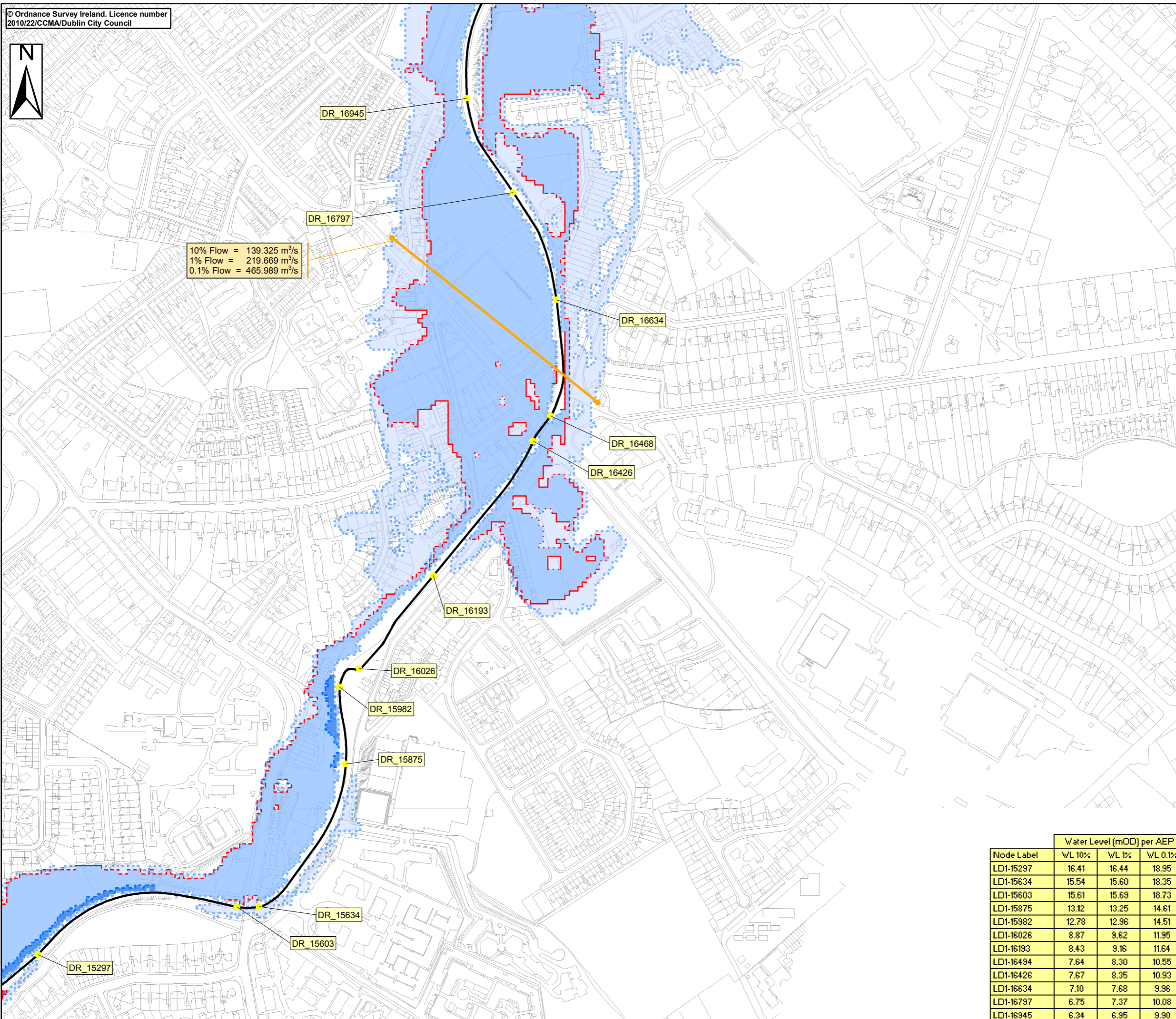
There will be an increased risk of fluvial flooding to the Proposed Scheme as a consequence of climate change. As noted, it is not possible to reduce the current risk of fluvial flooding to the Proposed Scheme as the existing road levels need to be maintained. The Proposed Scheme will not exacerbate the impacts of climate change on the risk of fluvial flooding.

Appendix A. Information Sources Checklist

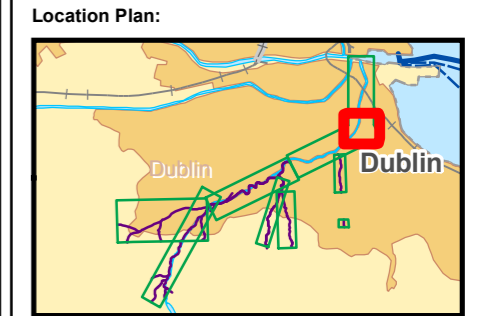
No.	Information Source	Status	Reference/Comments
1	OPW Preliminary Flood Risk Assessment indicative fluvial flood maps	X	Not available
2	National Coastal Protection Strategy Study flood and coastal erosion risk maps.	X	Not available
3	Predictive and historic flood maps, and Benefiting Lands Map	✓	Flooding History was provided by OPW floodinfo.ie
4	Predictive flood maps produced under the CFRAM studies	✓	CFRAM maps are available and have been used.
5	River Basin Management Plans and reports	✓	River Basin Management Plan for Ireland (2018-2021)
6	Indicative assessment of existing flood risk under Preliminary Flood Risk Assessment	X	
7	Previous Strategic Flood Risk Assessments	✓	<ul style="list-style-type: none"> • Dublin City Development Plan 2016-2022 (Strategic Flood Risk Assessment). • Dun Laoghaire – Rathdown County Development Plan 2022 – 2028 (Strategic Flood Risk Assessment). • Wicklow County Development Plan 2016 – 2022 (Strategic Flood Risk Assessment). • Bray Municipal District Local Area Plan 2017 (Strategic Flood Risk Assessment).
8	Expert advice from OPW who may be able to provide reports containing the results of detailed modelling and flood-mapping studies including critical damage areas, and information on historic flood events and local studies etc.	X	
9	Topographical maps, in particular digital elevation models produced by aerial survey or ground survey techniques.	✓	Topographic Survey Data dated 13 October 2020 is available.
10	Information on flood defence condition and performance	N/A	
11	Alluvial deposit maps	N/A	

12	'Liable to Flood' markings on the old 6" Inch Map	X	
13	Local Libraries and newspaper reports	√	Adequate information on Flooding History was provided by OPW floodmaps.ie
14	Interviews with local people, local history/ natural history societies etc.	X	
15	Walkover survey to assess potential sources of flooding, likely routes for flood water and the site's key features, including flood defences, and their condition	X	

Appendix B. OPW CFRAM Mapping



10% Flow = 139.325 m³/s
 1% Flow = 219.669 m³/s
 0.1% Flow = 465.989 m³/s



- Legend:**
- 10 % AEP Flood Extent (1 in 10 chance in any given year)
 - 1 % AEP Flood Extent (1 in 100 chance in any given year)
 - 0.1 % AEP Flood Extent (1 in 1000 chance in any given year)
 - Defended Area
 - High Confidence (<20m) (10% AEP)
 - Medium Confidence (<40m) (10% AEP)
 - Low Confidence (>40m) (10% and 0.1% AEP)
 - High Confidence (<20m) (1% AEP)
 - Medium Confidence (<40m) (1% AEP)
 - Low Confidence (>40m) (1% AEP)
 - River Centreline
 - Node Point
 - OS_2975 Node Label (refer to table)
 - Flow reporting location
- 10% Flow = 1.20
 1% Flow = 1.96
 0.1% Flow = 2.17
 Peak flow during design flood extent

USER NOTE:
 USERS OF THESE MAPS SHOULD REFER TO THE DETAILED DESCRIPTION OF THEIR DERIVATION, LIMITATIONS IN ACCURACY AND GUIDANCE AND CONDITIONS OF USE PROVIDED AT THE FRONT OF THIS BOUND VOLUME. IF THIS MAP DOES NOT FORM PART OF BOUND VOLUME, IT SHOULD NOT BE USED FOR ANY PURPOSE.



Project:
DODDER CATCHMENT FLOOD RISK ASSESSMENT AND MANAGEMENT STUDY

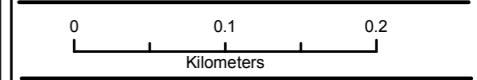
Map:
PRESENT DAY DODDER

Map Type: FLOOD EXTENT
Source: FLUVIAL FLOODING
Map Area: URBAN AREA
Scenario: CURRENT

Drawn By: A.A.B **Date:** 26 November 2010
Checked By: A.J. **Date:** 26 November 2010
Approved By: A.G.B **Date:** 26 November 2010

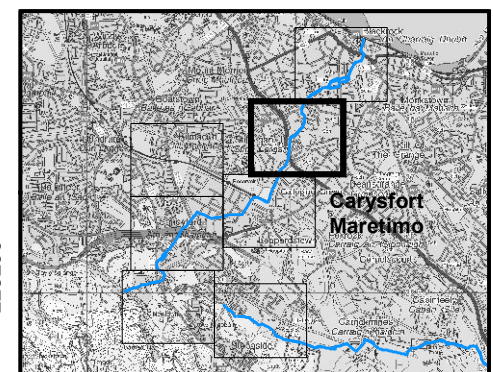
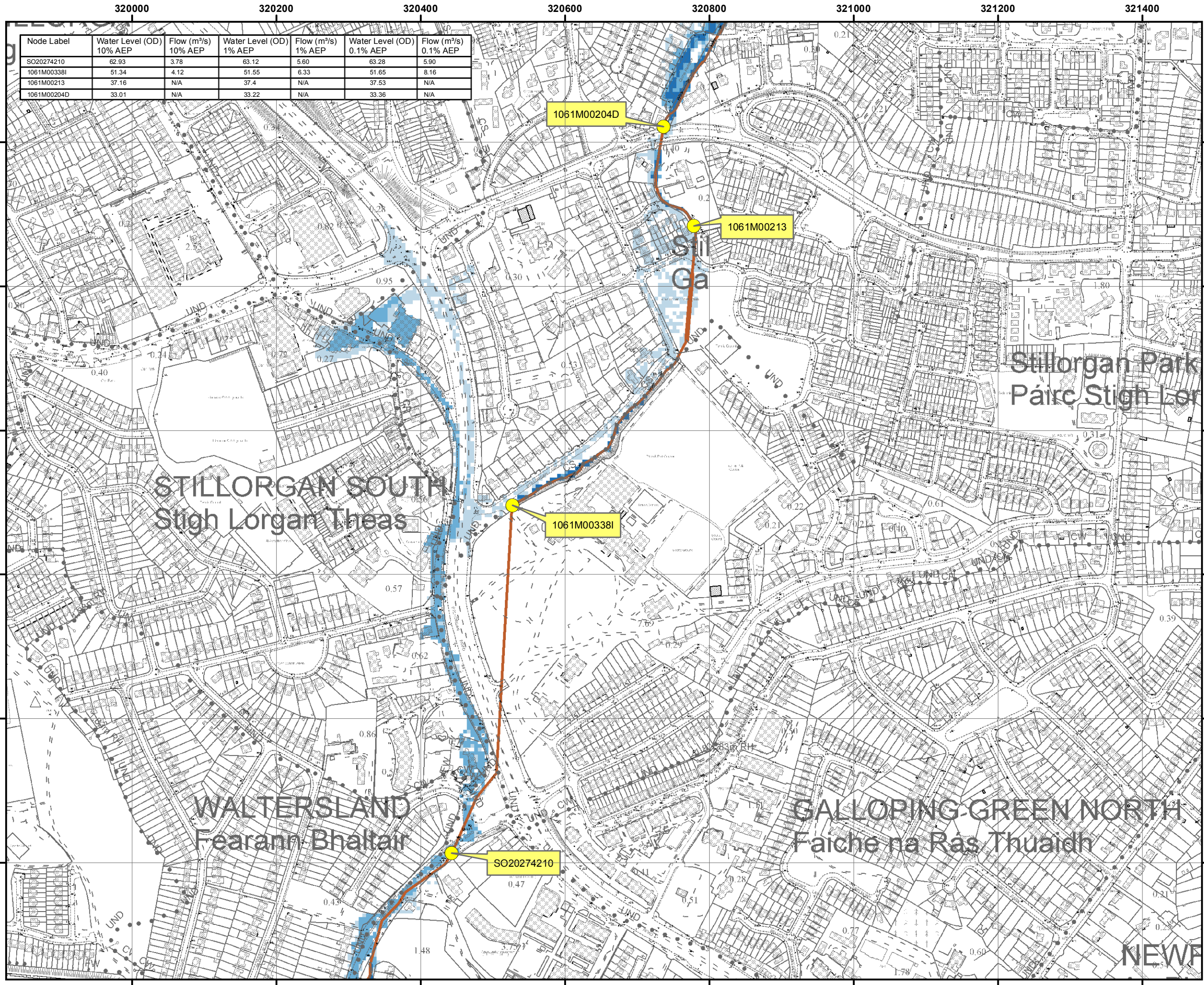
Figure No.:
DR/EXT/UA/CURS/101

Map Series: Page 8 of 12
Drawing Scale: 1 : 5,000 **Plot Scale:** 1:1 @ A3



Node Label	Water Level (mOD) per AEP		
	WL 10%	WL 1%	WL 0.1%
LD1-15297	16.41	16.44	18.95
LD1-15634	15.54	15.60	18.35
LD1-15603	15.61	15.69	18.73
LD1-15875	13.12	13.25	14.61
LD1-15982	12.78	12.96	14.51
LD1-16026	8.87	9.62	11.95
LD1-16193	8.43	9.16	11.64
LD1-16494	7.64	8.30	10.55
LD1-16426	7.67	8.35	10.93
LD1-16634	7.10	7.68	9.96
LD1-16797	6.75	7.37	10.08
LD1-16945	6.34	6.95	9.90

RPS Consulting Engineers
 ELMWOOD HOUSE TEL : 028 9066 7914
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IMPORTANT USER NOTE:
THE VIEWER OF THIS MAP SHOULD REFER TO THE DISCLAIMER, GUIDANCE NOTES AND CONDITIONS OF USE THAT ACCOMPANY THIS MAP.

- Legend**
- 10% Fluvial AEP Event
 - 1% Fluvial AEP Event
 - 0.1% Fluvial AEP Event
 - Modelled River Centreline
 - AFA Extents
 - Embankment
 - Wall
 - Defended Area
 - 1% AEP Standard of Protection of Flood Defence (Walls / Embankments)
 - 0.1% AEP Standard of Protection of Flood Defence (Walls / Embankments)
 - Node Point
 - Node ID Node Label

FINAL

REV:	NOTE:	DATE:
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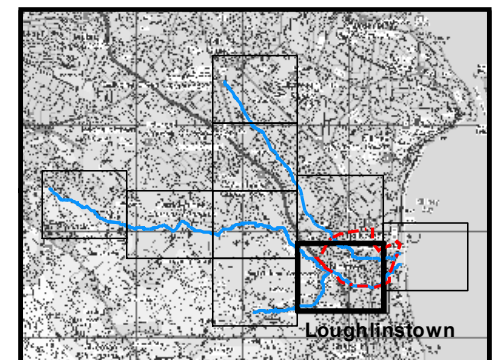
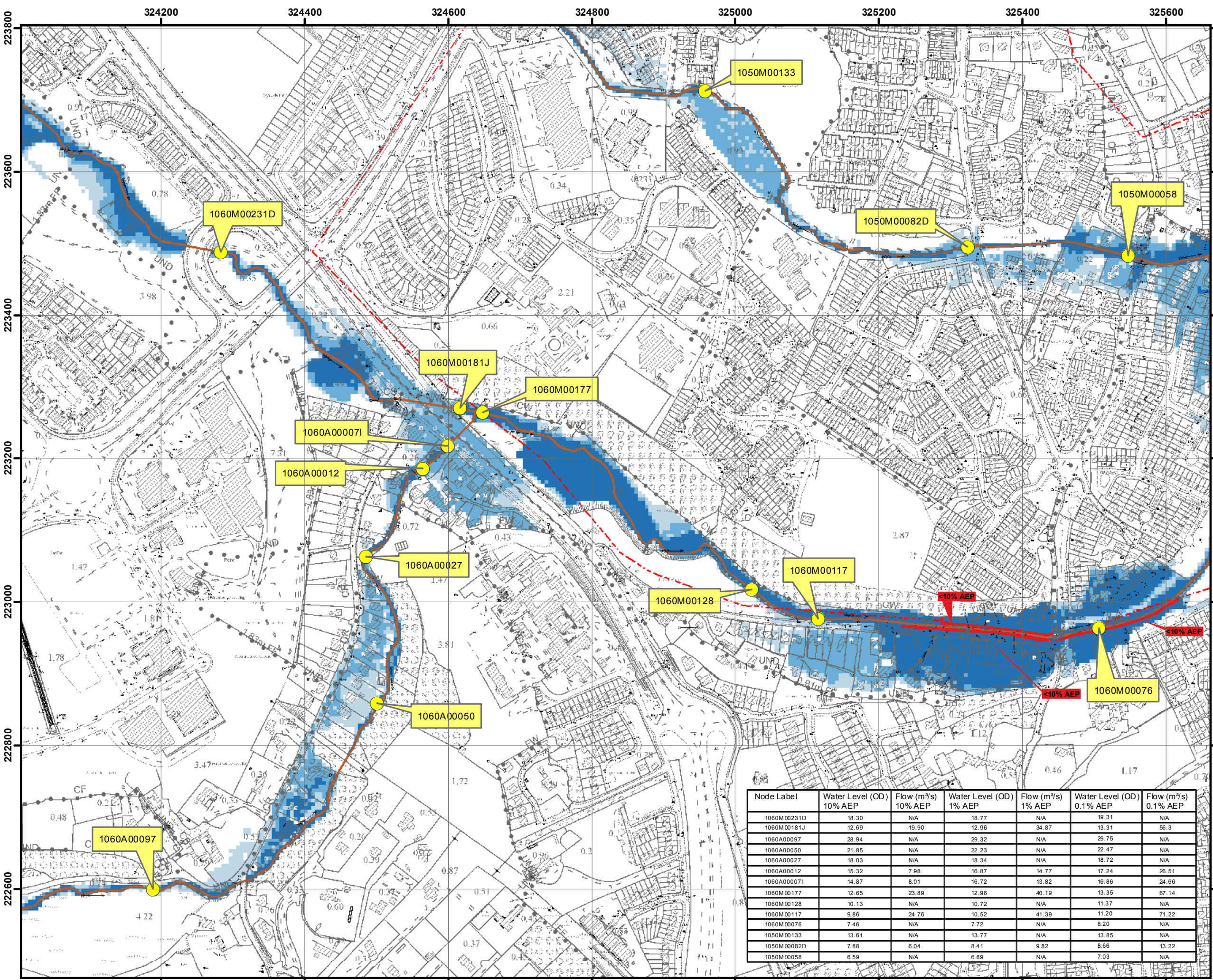
The Office of Public Works
Jonathan Swift Street
Trim
Co Meath

Elmwood House
74 Boucher Road
Belfast
BT12 6RZ

T +44(0) 28 90 667914
F +44(0) 28 90 668286
W www.rpsgroup.com
E ireland@rpsgroup.com

Map: Carysfort Maretimo Fluvial Flood Extents	
Map Type: EXTENT	
Source: FLUVIAL	
Map Area: HPW	
Scenario: CURRENT	
Drawn By: C.C.	Date: 27 October 2017
Checked By: A.S.	Date: 27 October 2017
Approved By: S.P.	Date: 27 October 2017
Drawing No.: E09CAR_EXFCD_F2_06	
Map Series: Page 6 of 7	
Drawing Scale: 1:5,000 @ A3	





IMPORTANT USER NOTE:
THE VIEWER OF THIS MAP SHOULD REFER TO THE DISCLAIMER, GUIDANCE NOTES AND CONDITIONS OF USE THAT ACCOMPANY THIS MAP.

- Legend**
- 10% Fluvial AEP Event
 - 1% Fluvial AEP Event
 - 0.1% Fluvial AEP Event
 - Modelled River Centreline
 - AFA Extents
 - Embankment
 - Wall
 - Defended Area
 - 1% AEP Standard of Protection of Flood Defence (Walls / Embankments)
 - 1% AEP Standard of Protection of Flood Defence (Walls / Embankments)
 - Node Point
 - Node ID Node Label

FINAL

REV: 01	NOTE: Removal of Embankments (Pg 5)	DATE: 03/11/17
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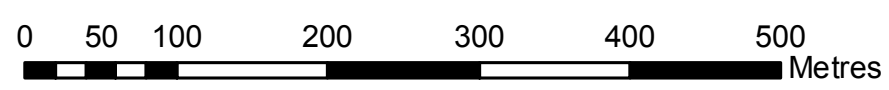


The Office of Public Works
Jonathan Swift Street
Trim
Co Meath

Elmwood House
74 Boucher Road
Belfast
BT12 6RZ

T +44(0) 28 90 667914
F +44(0) 28 90 668286
W www.rpsgroup.com
E ireland@rpsgroup.com

Node Label	10% AEP		1% AEP		0.1% AEP	
	Water Level (OD)	Flow (m³/s)	Water Level (OD)	Flow (m³/s)	Water Level (OD)	Flow (m³/s)
1060M00231D	18.30	N/A	18.77	N/A	19.31	N/A
1060M00181J	12.69	19.90	12.96	34.87	13.31	56.3
1060A00097	28.94	N/A	29.32	N/A	29.75	N/A
1060A00050	21.85	N/A	22.23	N/A	22.47	N/A
1060A00027	18.03	N/A	18.34	N/A	18.72	N/A
1060A00012	15.32	7.98	16.87	14.77	17.24	26.51
1060A00071	14.87	8.01	16.72	13.82	16.86	24.66
1060M00177	12.65	23.89	12.96	40.19	13.35	67.14
1060M00128	10.13	N/A	10.72	N/A	11.37	N/A
1060M00117	9.86	24.76	10.52	41.39	11.20	71.22
1060M00076	7.46	N/A	7.72	N/A	8.20	N/A
1050M00133	13.61	N/A	13.77	N/A	13.85	N/A
1050M00082D	7.88	6.04	8.41	9.82	8.66	13.22
1050M00058	6.59	N/A	6.89	N/A	7.03	N/A



Map: Loughlinstown Fluvial Flood Extents

Map Type: EXTENT

Source: FLUVIAL

Map Area: HPW

Scenario: CURRENT

Drawn By: C.C. **Date:** 3 November 2017

Checked By: A.S. **Date:** 3 November 2017

Approved By: G.G. **Date:** 3 November 2017

Drawing No.: E10LOU_EXFCD_F1_05

Map Series: Page 5 of 9

Drawing Scale: 1:5,000 @A3

Appendix C. Scheme Drawings

Refer to Appendix B for Preliminary Design Drawings

Appendix B2 – General Arrangement

Appendix B11 – Proposed Surface Water Drainage Works