Appendix A13.2
Flood Risk Assessment

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1. Introduction & Background

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 12 key bus corridors.

The proposed development consists of 12 radial core bus corridors, refer to Figure 1.1.

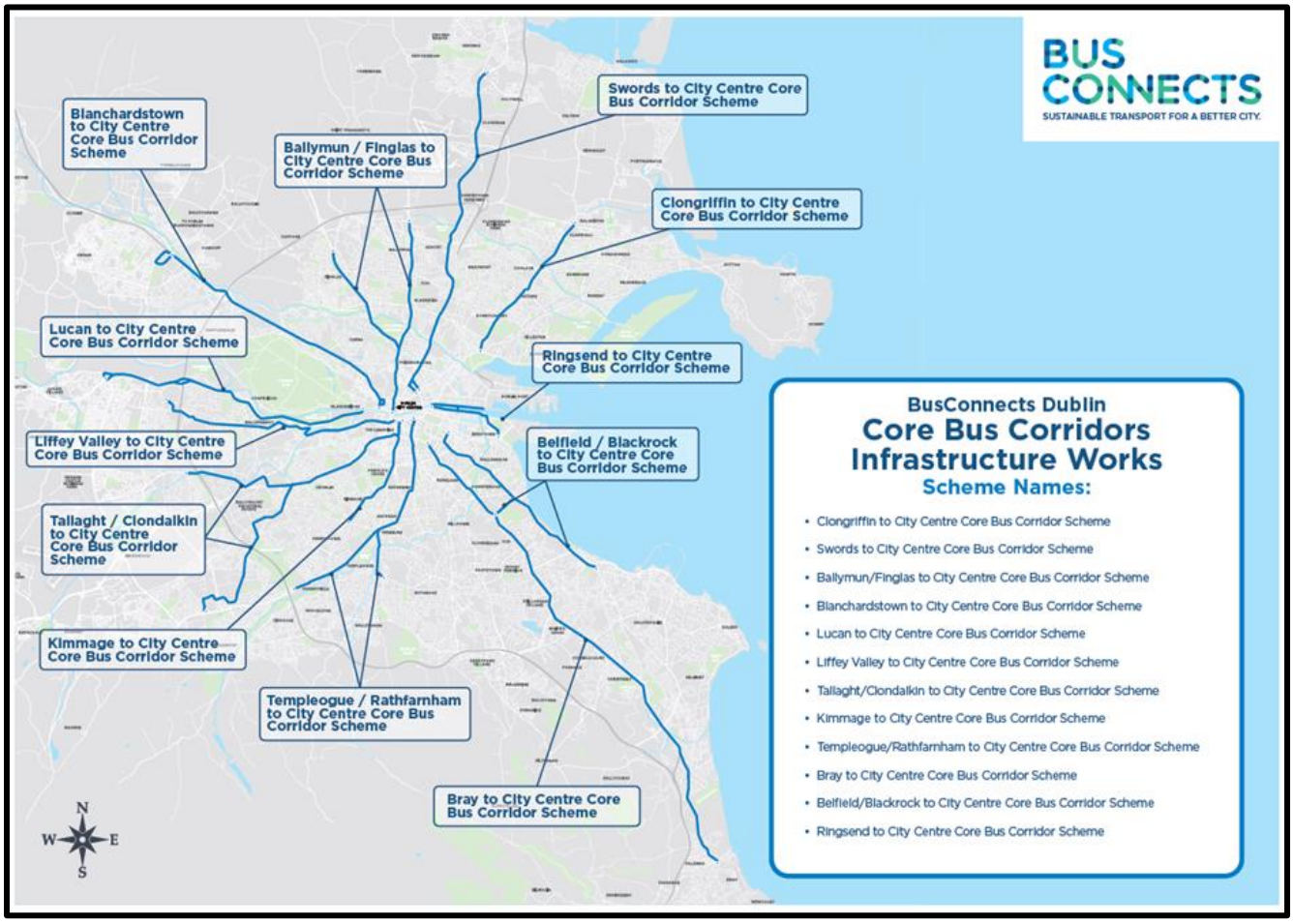


Figure 1.1 Core Bus Corridor Infrastructure

Each bus corridor is subject to an independent flood risk assessment. This flood risk assessment relates specifically to Route No.2 Swords to City Centre.

The objective of this report is to assess the level of flood risk to the proposed development. The assessment complies with the requirements set out in 'The Planning System and Flood Risk Management, Guidelines for Planning Authorities' (Office of Public Works, 2009).

1.2 Works Description

The Swords to City Centre Core Bus Corridor (CBC) scheme (herein after called the Proposed Scheme), refer to Figure 1.2, commences south of Swords at Pinnock Hill Junction and travels in a southerly direction along the R132 Swords Road past Airside Retail Park, Dublin Airport and Santry Park. The route continues on the R132 past Santry Demesne, where the Swords Road joins the R104 at Coolock Lane. The route continues on the R132 in a southerly direction through Santry village. It continues along the Swords Road past Whitehall to Griffith Avenue. The route follows Drumcondra Road Upper past the DCU St Patrick's Campus to the river Tolka. It continues through Drumcondra, on Drumcondra Road Lower to Binns Bridge on the Royal Canal. From there it continues on Dorset Street Lower as far as Eccles Street, from where it continues on Dorset Street Upper to North Frederick Street.

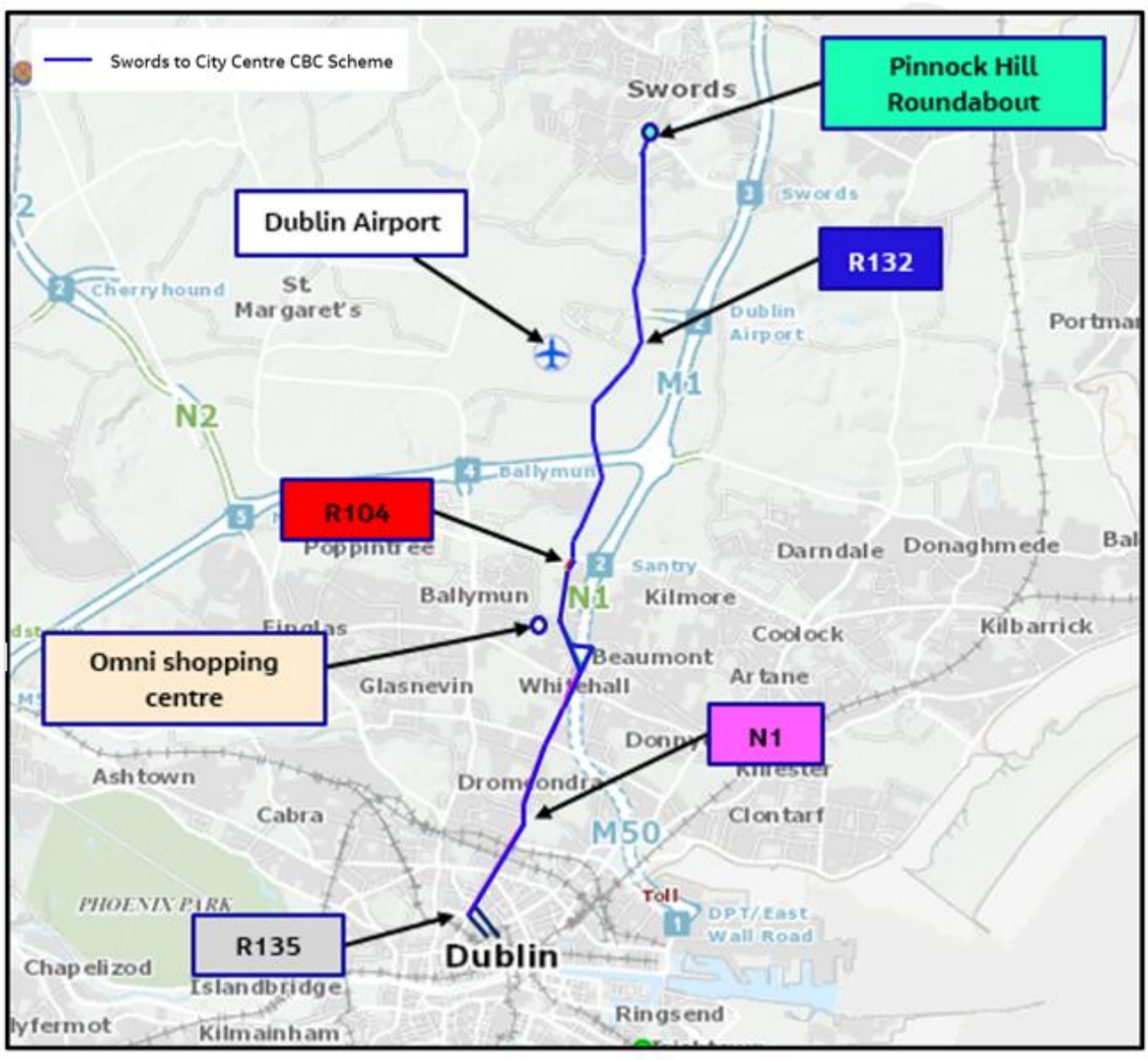


Figure 1.2 Location Map of Route No.2: Swords to City Centre

Inbound buses continue southeast on North Frederick Street and Parnell Square East until the route finishes at Parnell Street. Outbound, the route travels northeast from Parnell Street, past the Rotunda Hospital, along Parnell Square West and Granby Row until it joins with Dorset Street Upper.

The Proposed Scheme is described in greater detail below, split into five discrete sections to align with the previous Options and Feasibility Report and the Preferred Route Options Report. Refer to Figure 1.3.

- Section 1: Pinnock Hill to Airside Junction
- Section 2: Airside junction to Northwood Avenue
- Section 3: Northwood Avenue to Shantalla Road
- Section 4: Shantalla Road to Botanic Avenue
- Section 5: Botanic Avenue to Granby Row

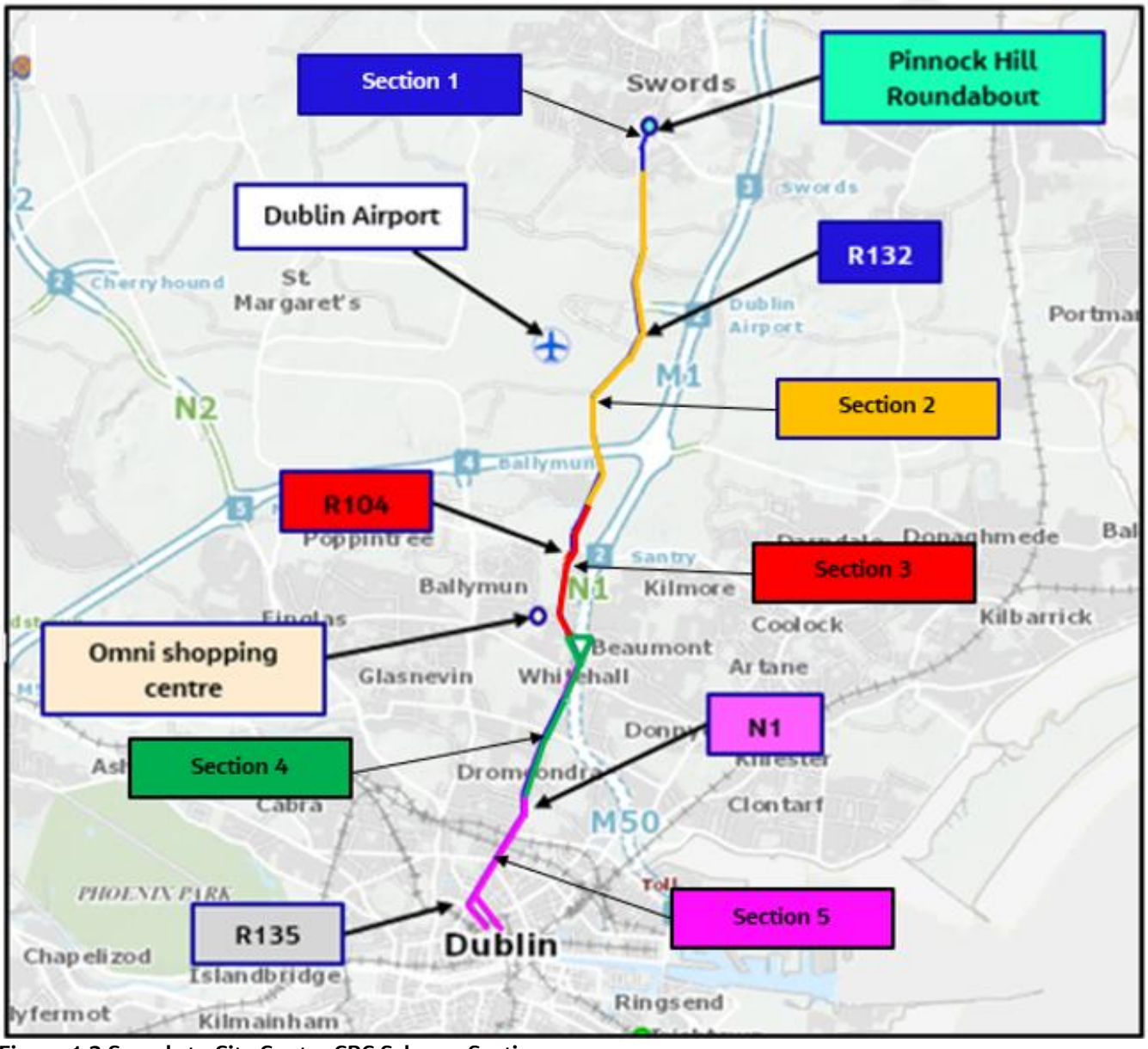


Figure 1.3 Swords to City Centre CBC Scheme Sections

1.2.1 Section 1 - Pinnock Hill Roundabout to Airside Junction

The Proposed Scheme commences south of Swords on the R132 Swords Road at Pinnock Hill. The existing roundabout at Pinnock Hill will be modified to a fully signalised junction with pedestrian and cyclist facilities. Between the Pinnock Hill and Airside junctions, the existing bus lanes will be maintained, the existing footpath will be upgraded, and segregated cycle lanes provided.

1.2.2 Section 2 - Airside Junction to Northwood Avenue

Between the Airside and Cloghran junctions, the existing bus lanes will be maintained, the existing footpaths will be upgraded and extended, and segregated cycle lanes provided. The existing Cloghran roundabout will be modified to a fully signalised junction with pedestrian and cyclist facilities.

South of the Cloghran junction, current provision for cars and buses northbound will remain and a new bus lane provided southbound. Segregated one-way cycle facilities are provided on both sides of the R132. Southbound cyclists cross the R132 at the Coachman's Inn to a two-way cycle track on the western side of the R132.

It is proposed to maintain the Airport Roundabout as a signalised junction with some amendments. To provide bus priority southbound through the Airport junction, it is proposed to provide a new signal-controlled priority on the northern approach to the roundabout. The cycle facilities through the Airport junction will be upgraded and cyclists will be accommodated in a two-way cycle track on the western side of the junction, crossing the airport access road via a signalised toucan crossing.

South of the Airport Roundabout the existing northbound shared cycle lane and pedestrian lane is converted to a dedicated footpath and two-way cycle track as far as the South Corballis Road and from this point the cyclists will cross the R132 to return to the eastern side of the road.

Between Collinstown Cross Industrial Estate and Northwood Avenue, improved cycle facilities will be provided. New bus stop facilities will be provided outside Whitehall Colmcille GAA Club.

1.2.3 Section 3 – Northwood Avenue to Shantalla Road

Signal Controlled Bus Priority will be provided between Northwood Avenue and Coolock Lane to avoid impact on properties and Santry Demesne. New bus stop facilities will be provided between Santry Close and Coolock Lane.

Between Coolock Lane and the entrance to Omni Park Shopping Centre, it is proposed to extend continuous bus lanes and cycle tracks in both directions. This will require some limited land take from adjacent properties on both sides of the existing road and the removal of existing on-street car parking.

Between the Omni Park Shopping Centre entrance and the Shantalla Road junction it is proposed to maintain the two-way general traffic lanes and introduce continuous bus lanes in both directions. A segregated footpath will be maintained on either side. This will require some land take from adjacent properties on both sides of the existing road in Santry village and the removal of existing on-street car parking.

It is proposed to redirect cyclists through Lorcan Road and Shanrath Road as a quiet street. This cycle route commences at the junction with Omni Park Shopping Centre and connects with the Swords Road at the junction with Shantalla Road. A two-way cycle track is proposed to connect the quiet street from Shanrath Road through the Shanrath junction, connecting to the existing quiet street west of the off-slip.

A dedicated bus lane is proposed inbound along the Shantalla Road Bridge and a general traffic lane is maintained in both directions. The Shantalla Road junction will be upgraded to accommodate the bus lane and cycle and pedestrian movements.

1.2.4 Section 4 – Shantalla Road to Botanic Avenue

From Shantalla Road to the Botanic Avenue, a continuous bus lane will be provided in both directions. It is proposed to retain the existing bus lanes and provide a segregated cycle track and footpath between these Shantalla Road and Milmount Avenue in both directions. In Drumcondra, an independent pedestrian and cycle bridge over the River Tolka will be required to allow the proposed bus lanes to be accommodated over the existing bridge.

As part of the scheme, it is proposed to provide on-street parking at the following locations:

- 96 to 112 Upper Drumcondra Road, and;
- 4 to 12 Upper Drumcondra Road.

The following junctions will be upgraded with improved pedestrian, cycle and bus priority facilities:

- Collins Avenue;
- Griffith Avenue;
- Home Farm Road and
- Richmond Road.

It is proposed to upgrade the Collins Avenue junction to better facilitate bus priority and provide dedicated, segregated bus lanes to the stop lines with signal-controlled priority. The other key junctions will be upgraded to improve cyclist provision and bring bus lanes closer to the stop lines.

1.2.5 Section 5 – Botanic Avenue to Granby Row

To facilitate bus lanes and cycle tracks in each direction it is necessary to remove one inbound and one outbound traffic lane between Clonliffe Road and Eccles Street. In addition, the landscaped central reserve will be removed between Portland Avenue and Belvedere Road to facilitate the required cross-section. South of Belvidere Road, the existing landscaped median will be maintained.

South of Eccles Street, some minor kerb realignments are proposed to provide bus, cycle and a single traffic lane in each direction. The painted central median will be removed to facilitate this.

As part of the scheme, it is proposed to provide on-street parking at the following locations:

- 45 to 55 and 14 to 20 Lower Drumcondra Road; and
- Between Clonliffe Road and Whitworth Road.

On this section of route, a few loading bays will be affected by the proposed works while most of the loading bays have been realigned and retained.

It is proposed to provide new turning restrictions at the following junctions:

- Left turn ban from Dorset Street to Synott Place; and
- Left turn ban from Dorset Street to Hardwicke Place.

On North Frederick Street, the existing bans on left turning traffic from Dorset Street Lower and straight through traffic from Blessington Street will be maintained. North Frederick Street is restricted to one southbound bus lane and one northbound traffic lane from the junction of Dorset Street with Gardiner Row.

South of Gardiner Row the existing southbound traffic lane and bus lane will be maintained. Two-way cycle facilities will be provided on the west side of Parnell Square East. On street parking will be removed. Improved bus stop facilities are proposed for this section of scheme. This section of the scheme ties into the existing street layout at Parnell Street.

Outbound buses will use Parnell Street, Parnell Square West and Granby Row to access Dorset Street Upper. A bus lane will be provided along these roads to facilitate outbound buses.

The following junctions will be upgraded with improved pedestrian, cycle and bus priority facilities:

- Botanic Avenue;
- Clonliffe Road;
- Whitworth Road;
- North Frederick Street;
- Gardiner Street Upper; and
- The junction of Parnell Square North and North Frederick Street.

As part of the scheme, it is proposed to provide on-street parking at the following locations:

- Between Belvedere Road and North Circular Road.

1.3 Report Structure

The flood risk assessment is structured as follows:

- Chapter 2 sets out the Plan 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 presents the findings of the Stage 3 flood risk assessment of the proposed new bridge crossing upstream of Frank Flood Bridge.
- Chapter 8 assesses the proposed works in accordance with the Justification Test.
- Chapter 9 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 Scheme is within or proximate to these sites, further detail is provided within this report.

The Proposed Scheme will need to demonstrate compliance with the overarching objectives and recommendations of the SFRA stated in Table 2.1.

Table 2.1 Objectives and recommendations of the SFRA

Dublin City Development Plan SFRA Objective	Proposed Scheme Approach to Compliance
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.	The Proposed Scheme comprises extension to and/or modification of the existing highway to accommodate improved bus, cycle and pedestrian routes. Extension of the road onto adjacent greenfield land is only undertaken where the works cannot be accommodated within the existing highway extent or for the provision of Sustainable Drainage Measures. **The Proposed Scheme therefore meets this objective**
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."	Apart from the Tolka River, no works are proposed to change the width or level of the highway at any watercourse crossing. There will therefore be no loss of functional floodplain or impact on flood risk. The span arrangement of the new bridge proposed over Tolka River, immediately upstream of the existing Frank Flood Bridge has been designed to maintain the adjacent floodplain on the south side of the river for flood storage. **The Proposed Scheme therefore meets this objective**
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."	The impacts to and arising from the Proposed Scheme are assessed against the medium range future scenario for climate change. The proposed new crossing of the Tolka River also allows for the effects of future climate change. All new drainage is also designed to accommodate the effects of the medium range future climate change scenario. **The Proposed Scheme therefore meets this objective**

2.3 Fingal County Council Development Plan – Strategic Flood Risk Assessment (2017-2023)

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 18 sites within flood zones A and B and covers acceptable grounds for justification tests for development plans within each site. Where the Proposed Scheme is within or proximate to these sites, further detail is provided within this report.

The Proposed Scheme will need to demonstrate compliance with the objective set out in section 4.4.3 of the SFRA. FCC states that no proposals for highly vulnerable developments should be considered in flood risk areas. Any applications should be supplemented by an appropriately detailed FRA and meets the criteria of the Development Management Justification Test.

The Proposed Scheme will need to demonstrate compliance with the overarching objectives and recommendations of the SFRA stated in Table 2.2.

Table 2.2 Objectives and recommendations of the SFRA

Fingal County Development Plan SFRA Objective	Proposed Scheme Approach to Compliance
Section 4.4.3 of the SFRA covers highly vulnerable development in Flood Zone A and B. It states that "Compensatory storage for development that results in a loss of floodplain within Flood Zone A must be provided on a level for level basis."	No works are proposed to change the width or level of the highway at any watercourse crossing. There will therefore be no loss of functional floodplain or impact on flood risk. **The Proposed Scheme therefore meets this objective**
Section 5.8.2 of the SFRA covers climate change. It states that "For most development…the medium-range future scenario (20% increase in flows and/or 0.35 m increase in sea level and 100% increase in urbanisation) is an appropriate consideration."	The impacts to and arising from the Proposed Scheme are assessed against the medium range future scenario for climate change. All new drainage is designed to accommodate the effects of the medium range future climate change scenario. **The Proposed Scheme therefore meets this objective**

2.4 Greater Dublin Strategic Drainage Study (April 2005)

The Greater Dublin Strategic Drainage Study (GDSDS) was commissioned in 2001 to analyse 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. With respect to the Proposed Scheme the applicable objectives of the study can be summarised as follow:

- 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.

An overarching Drainage Strategy was developed for the overall BusConnects project which was applied to the design of the Proposed Scheme. This incorporated the recommendations of the GDSDS specifically in relation to the design of sustainable drainage measures and minimum drainage design standards.

3. Flood Risk Assessment Methodology

The document *Planning System and Flood Risk Management: Guidelines for Planning Authorities* published by the OPW (referred to hereafter as the FRM Guidelines) outlines the key principles that should be used for assessing flood risk to proposed development sites. It recommends that a staged approach should be adopted. The stages of appraisal and assessment are as follows:

- **Stage 1: Flood risk identification** – This stage identifies any issues (flooding or surface water management) related to the Proposed Scheme.

- **Stage 2: Initial flood risk assessment** – This stage seeks to confirm the sources of flooding identified in Stage 1. All existing information is reviewed in detail and extent of the flood risk associated with the Proposed Scheme established.

- **Stage 3: Detailed flood risk assessment** – Where required, 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.

  A Stage 3 assessment was completed for the proposed new bridge crossing of the Tolka River.

3.1 Flood Zones

The FRM Guidelines define the following three flood zones:

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

These flood zones are used to assess the suitability of the location for a proposed development with respect to its vulnerability to flooding.

3.2 Vulnerability of BusConnects Route No.2 Corridor

In summary, the Proposed Scheme development comprises extension and/or realignment of the existing highway to accommodate improved bus, cycle and pedestrian infrastructure. Junction upgrades, new bus stops, and street furniture will also be provided.

With reference to Table 3.1 of the Planning System and Flood Risk Management Guidelines for Planning Authorities, the Proposed Scheme works are assessed as "essential infrastructure such as primary transport" and therefore classed as a "highly vulnerable development". Whilst the Proposed Scheme will principally serve areas in Fingal CC and Dublin CC; its strategic importance and potential catchment area are assessed to elevate it above the criteria of local transport infrastructure.

The FRM Guidelines require that a Justification Test should be completed for any highly vulnerable developments that are located within Flood Zone A or Flood Zone B.

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 is required.

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 ensure a commensurate assessment of the risk of flooding.

4. Stage 1 Flood Risk Identification

4.1 General

The Stage 1 Flood Risk Assessment assesses the existing flood risk to the Proposed Scheme. This is carried out as a desktop study using existing information from a number of sources. The objective is to identify whether there are potential flooding or surface water management issues for the site that require further investigation.

4.2 OPW Preliminary Flood Risk Assessment Mapping

The OPW Preliminary Flood Risk Assessment (PFRA) Maps were prepared for the purpose of initial flood risk assessment at a national level. The mapping is not considered to be suitable for assessment of flood risk to the Proposed Scheme and particularly where they have been superseded by the Catchment Flood Risk Assessment and Management ('CFRAM') Studies (see section 4.4). PFRA mapping is therefore not used in this assessment.

4.3 Historic Flood Events

The OPW National Flood Hazard Mapping website (www.floodinfo.ie) was used to identify historical flooding along the Proposed Scheme, refer to Figure 4.1.

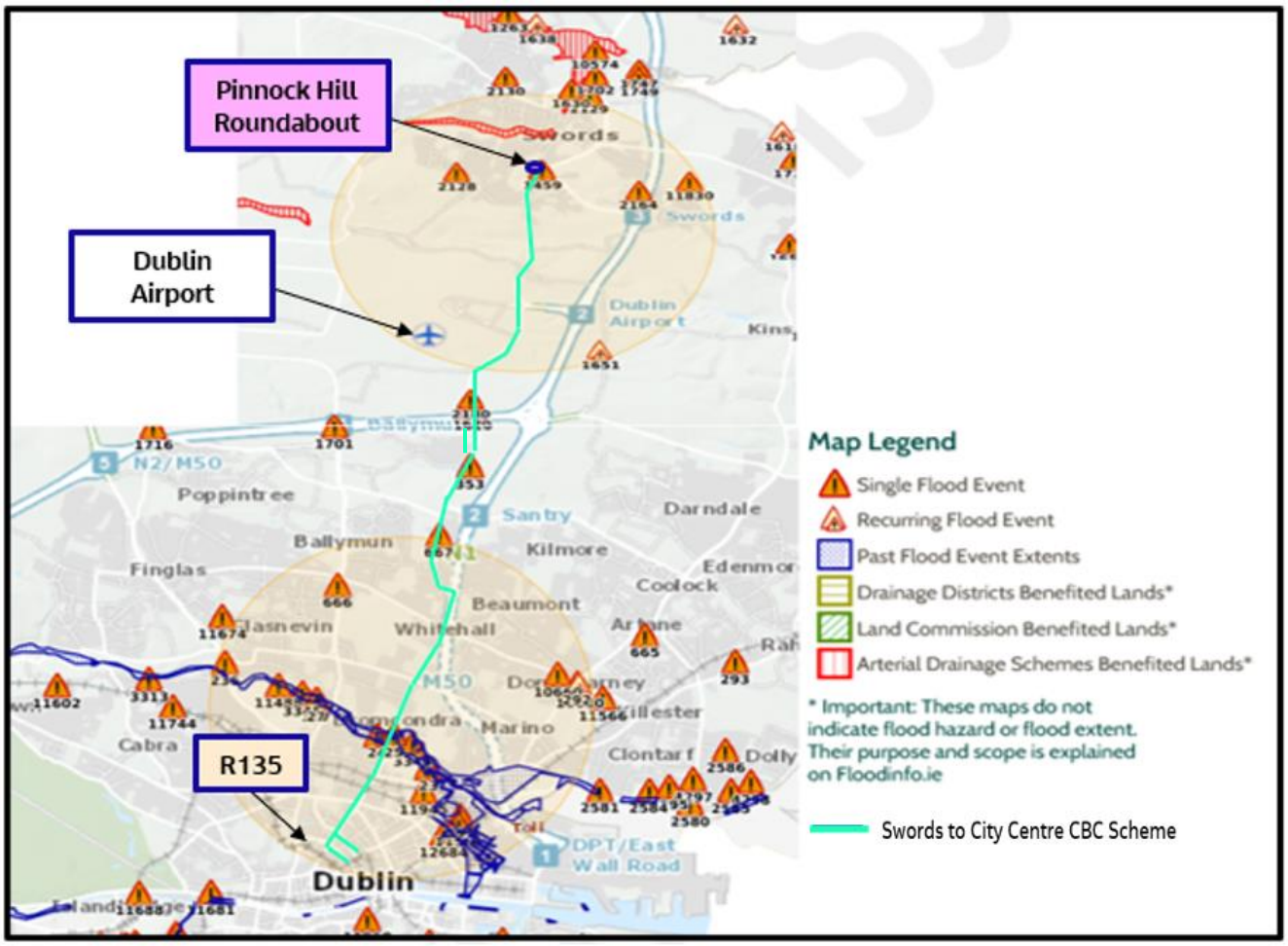


Figure 4.1 Past flood events in close proximity to the Proposed Scheme

Five flood events were identified on or immediately adjacent to the Proposed Scheme. Further details of these flood events are provided in **Table 4.1** below.

Table 4.1 Flood events identified on or immediately adjacent to the Proposed Scheme

Location	Type	Date	Description
Pinnock Hill	Pluvial	2004	Refer to Figure 4.2. Flooding of N1 near 'Little Chef' restaurant (at the Travelodge hotel) as the current surface water pipe system is under capacity. A stream flows through a property opposite the restaurant ("Milton Fields"). In times of very heavy rainfall the screen overflows and results in the flooding of the Little Chef restaurant. To prevent this occurring Council staff and emergency services divert the flow prior to the screen onto the N1, this in turn floods the Pinnock Hill roundabout. It should be noted that there have been upgrades completed to the drainage system in this location including the provision of a new 900mm pipe to divert storm flows into the Broadmeadow River. There are no reported incidents of flooding since the upgraded drainage network was installed.
North of M50 (N1 road). Old Airport Road	River – Mayne River	November 2002 / Recurring	Refer to Figure 4.3. This road flooded at two locations within 300 metres of the M50 in 2000. The first location, close to the M50, is the section of culvert underneath the Old Airport Road whereas the second section contains a 300 mm diameter culvert which requires regular maintenance.
Santry Close	River – Santry River	November 2002	Refer to Figure 4.3. The culvert on the Santry River at the Old Swords Road was unable to take the quantity of water in the river and overflowed on Thursday 14th November 2002. It flowed from the Old Swords Road into Santry Close, which was under one and a half feet of water.
Swords Road (R132)	River – Wad River	January 1965	Refer to Figure 4.3. The cause of flooding on the roadway at Santry arose because the water, being unable to enter the culvert, re-routed itself overground and flowed to the lowest part on the roadway and was impounded there. The gullies on the roadway could be expected to deal with road drainage and were overpowered by this excess flow. There were seven gullies in the vicinity of the hollow, and it is probable that some of these choked during the flood as considerable silt and papers would be carried to them.
Drumcondra Road Lower (N1)	River – Tolka River	December 1954 /Recurring	Refer to Figure 4.4. The lands adjacent to the river have been flooded on a number of occasions during the last century, the most serious example occurring on the 8th December 1954. Major flooding has been confined to the period between late August and December. Due to the flatness of the catchment and its retentive vegetation spring and summer storms have seldom produced flows of any significance.

Location	Type	Date	Description
			It should be noted a flood defence scheme was completed along the Tolka in 2004 and is thought to provide a 1% AEP standard of protection.

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

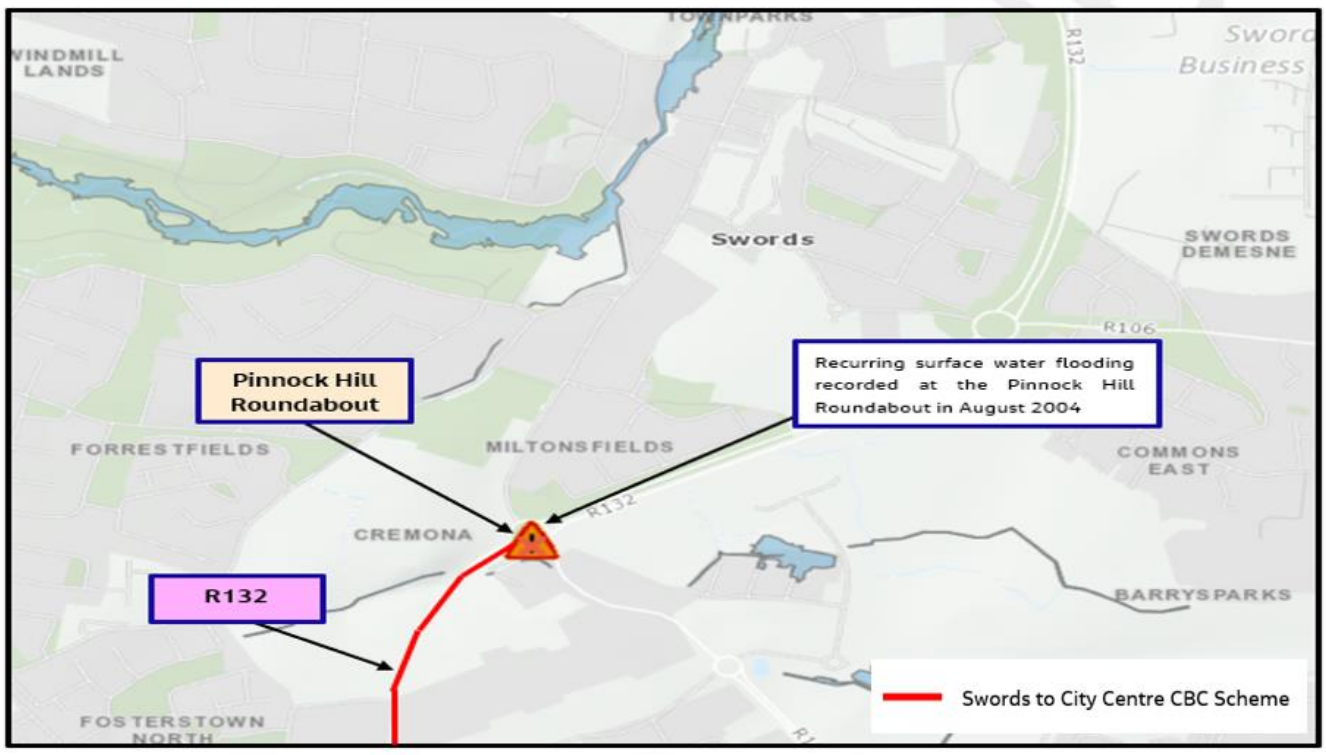


Figure 4.2 Historic flooding at Pinnock Hill Roundabout

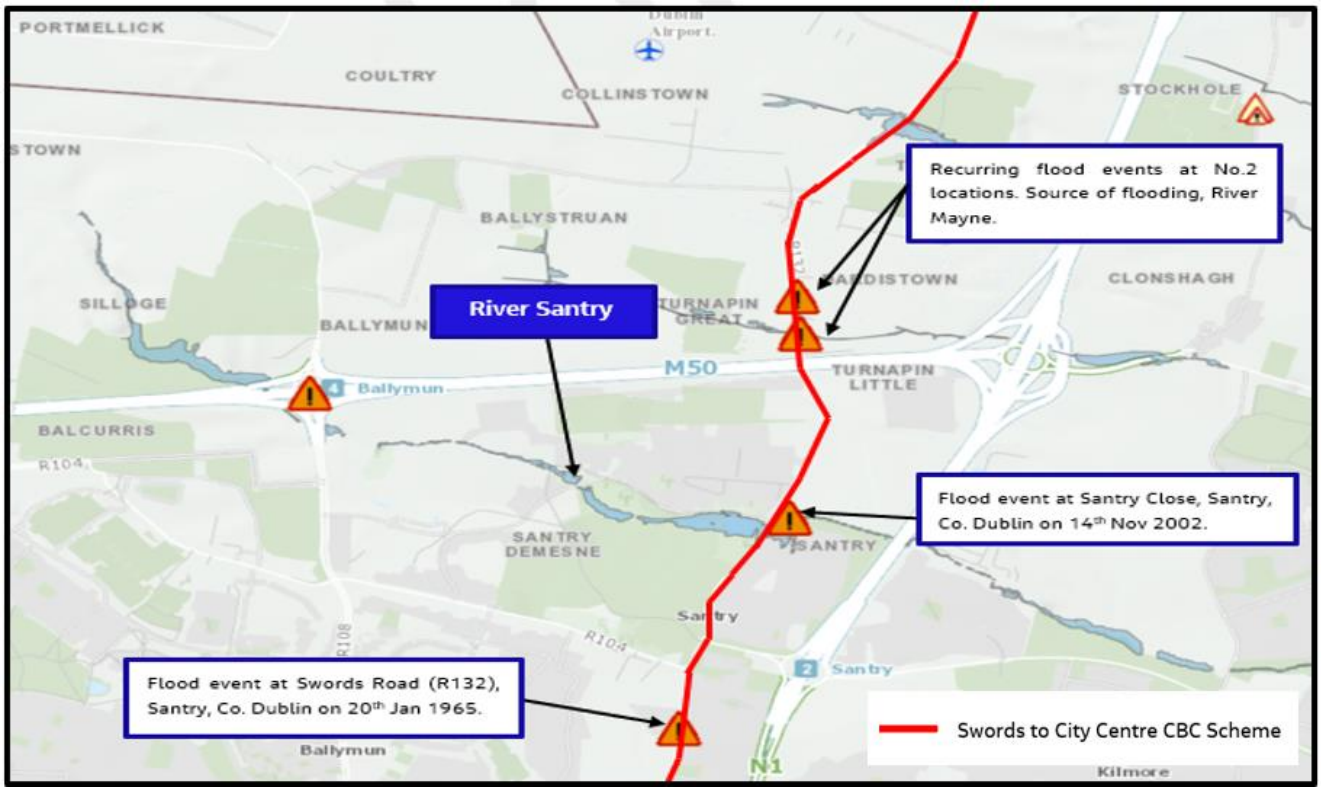


Figure 4.3 Locations of historic flooding near Dublin Airport and across Santry

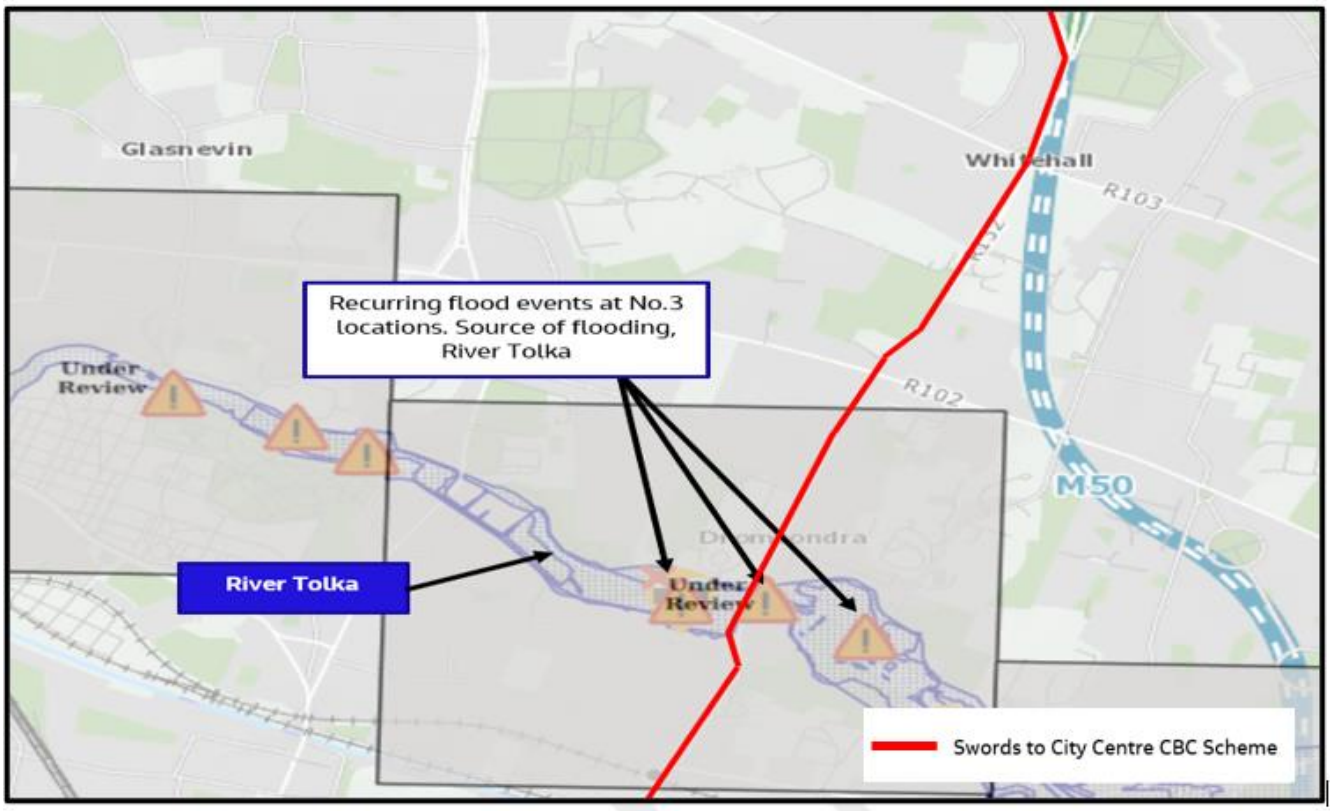


Figure 4.4 Locations of historic flooding near Tolka River across Drumcondra

4.4 OPW CFRAM Study Mapping

Flood risk along Proposed Scheme was assessed as part of the OPW Eastern Catchment Flood Risk Assessment and Management (CFRAM) Study. The predicted flood extents for Gaybrook watercourse, Sluice River, Cuckoo Stream, Mayne River, Santry River and Tolka River from the CFRAM study are presented in full in Appendix B, with extracts showing the predicted fluvial flood extents in Figure 4.5, Figure 4.6, Figure 4.7, Figure 4.8 and Figure 4.9.

These figures show that the proposed route is not at risk of coastal flooding however, it is at risk of fluvial flooding in the 0.1%, 1% and 10% AEP floods.

The results of the fluvial flood extents of Tolka River are currently under review at the crossing with the Proposed Scheme by the OPW, refer to Figure 4.10.

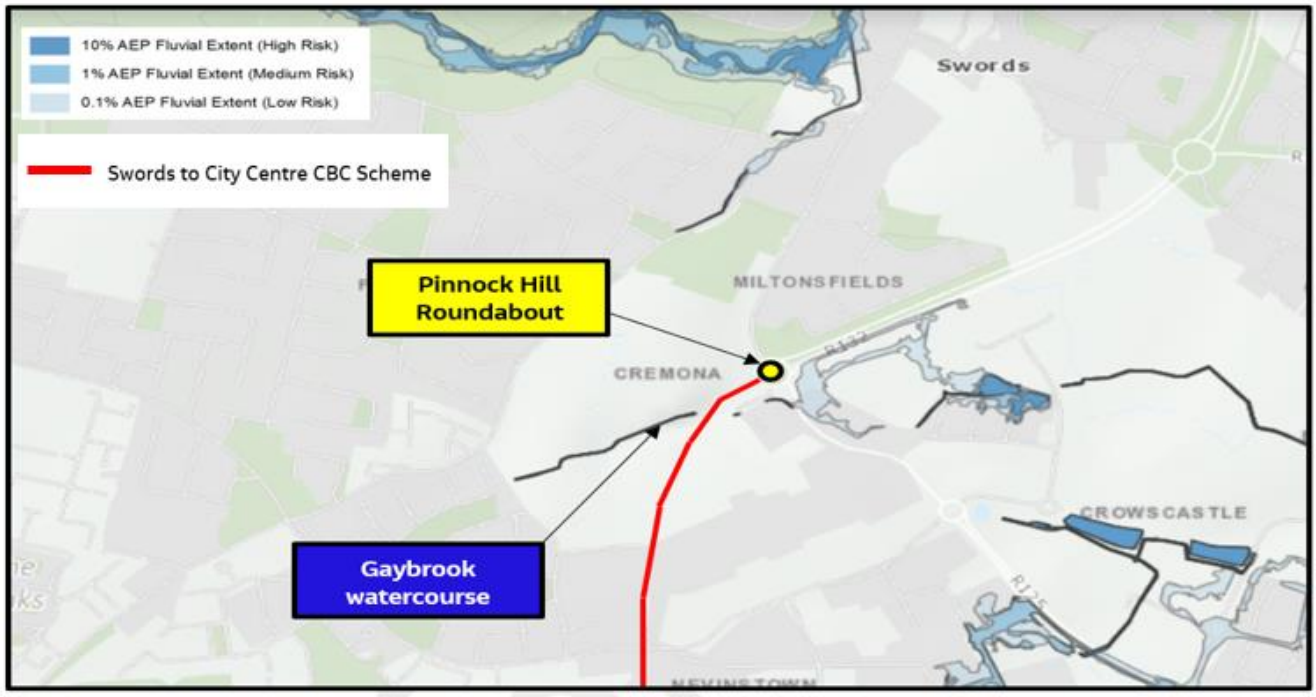


Figure 4.5 Extract of Fluvial flood mapping from Eastern CFRAM study for the Scheme 2 at the crossing with Gaybrook watercourse.

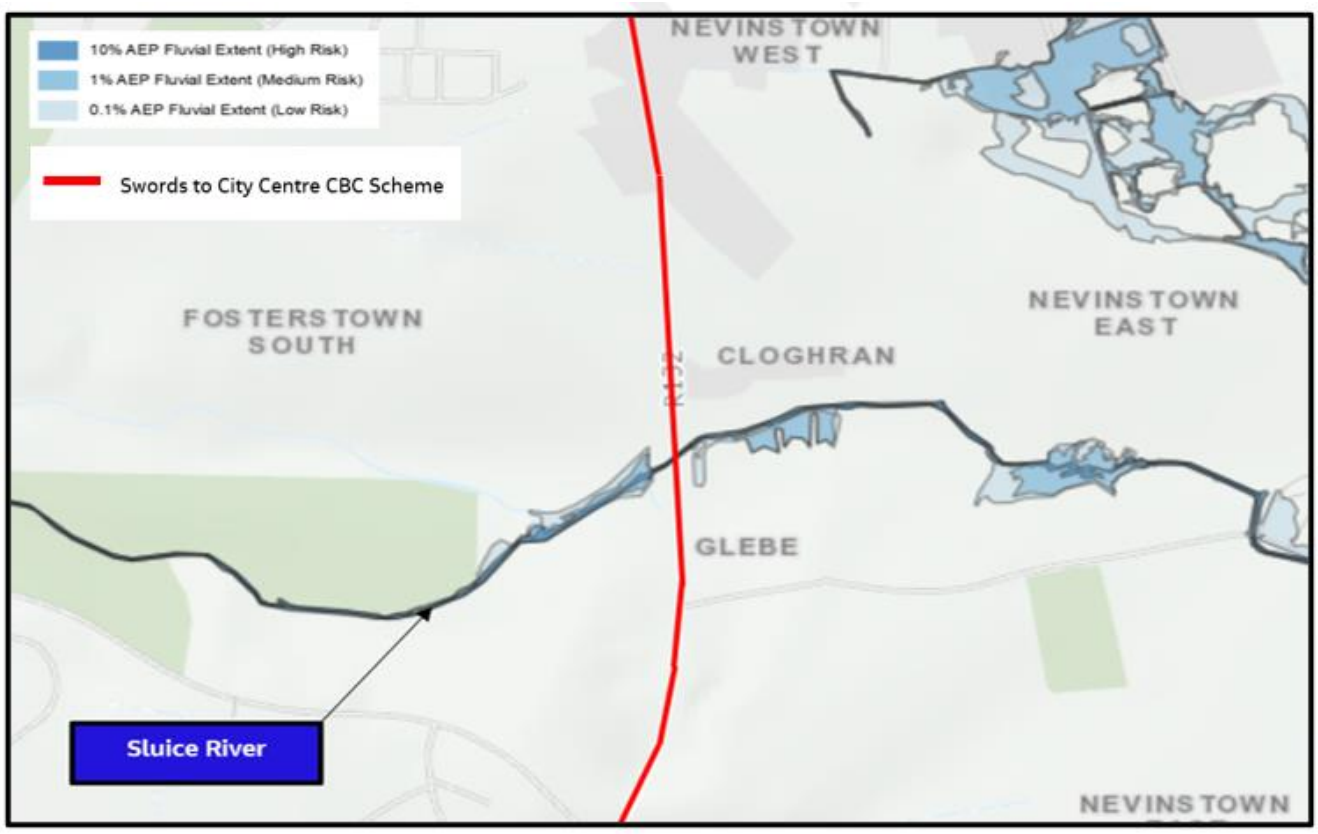


Figure 4.6 Extract of Fluvial flood mapping from Eastern CFRAM study for the Scheme 2 at the crossing with Sluice River.

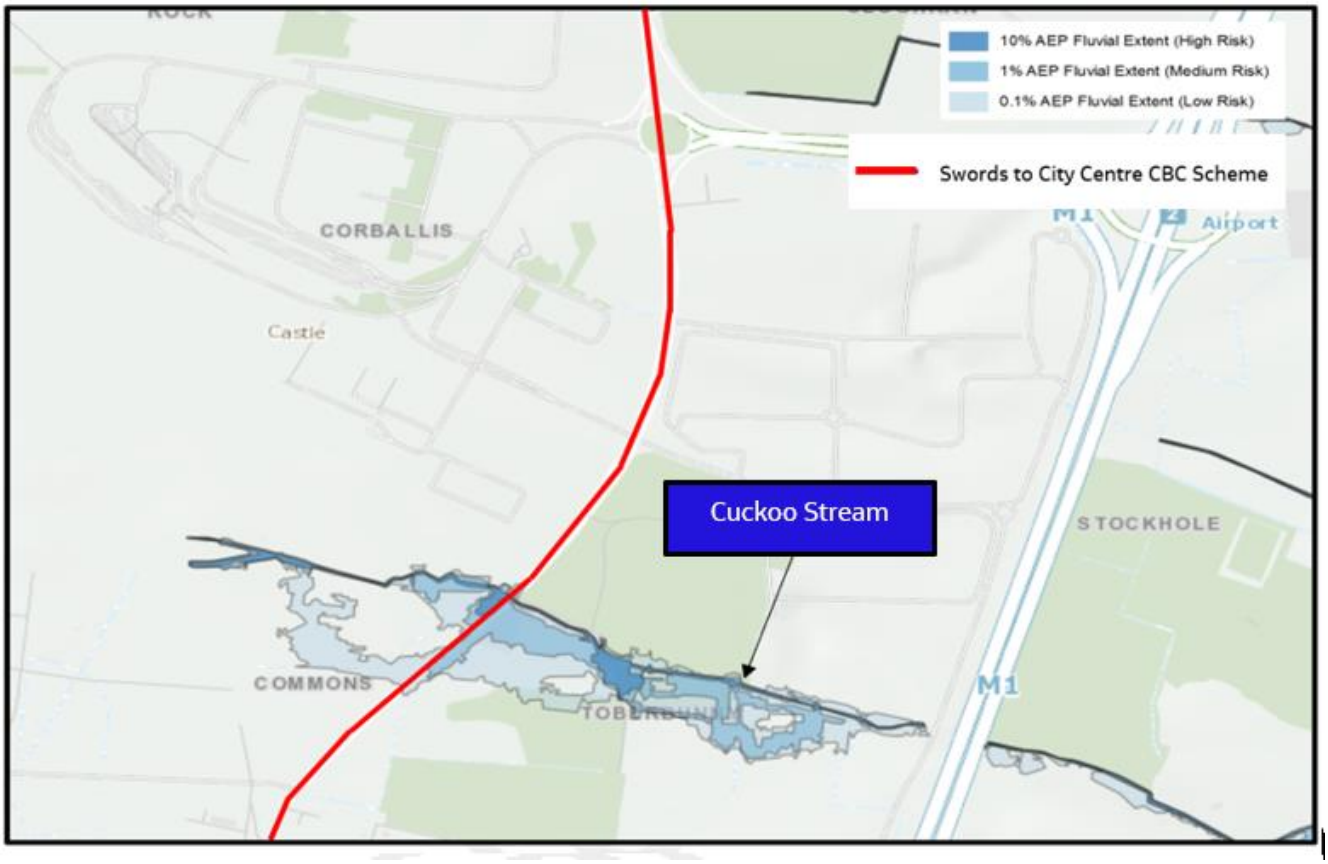


Figure 4.7 Extract of Fluvial flood mapping from Eastern CFRAM study for the Scheme 2 at the crossing with Cuckoo Stream.

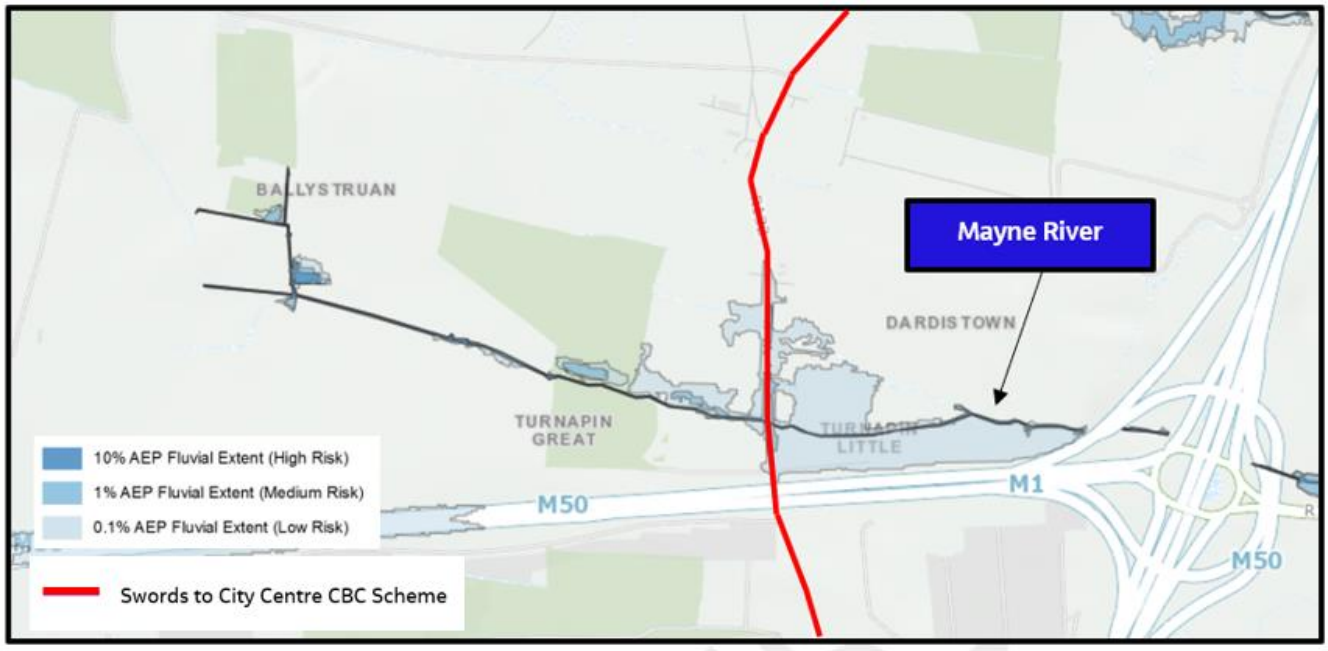


Figure 4.8 Extract of Fluvial flood mapping from Eastern CFRAM study for the Scheme 2 at the crossing with Mayne River.

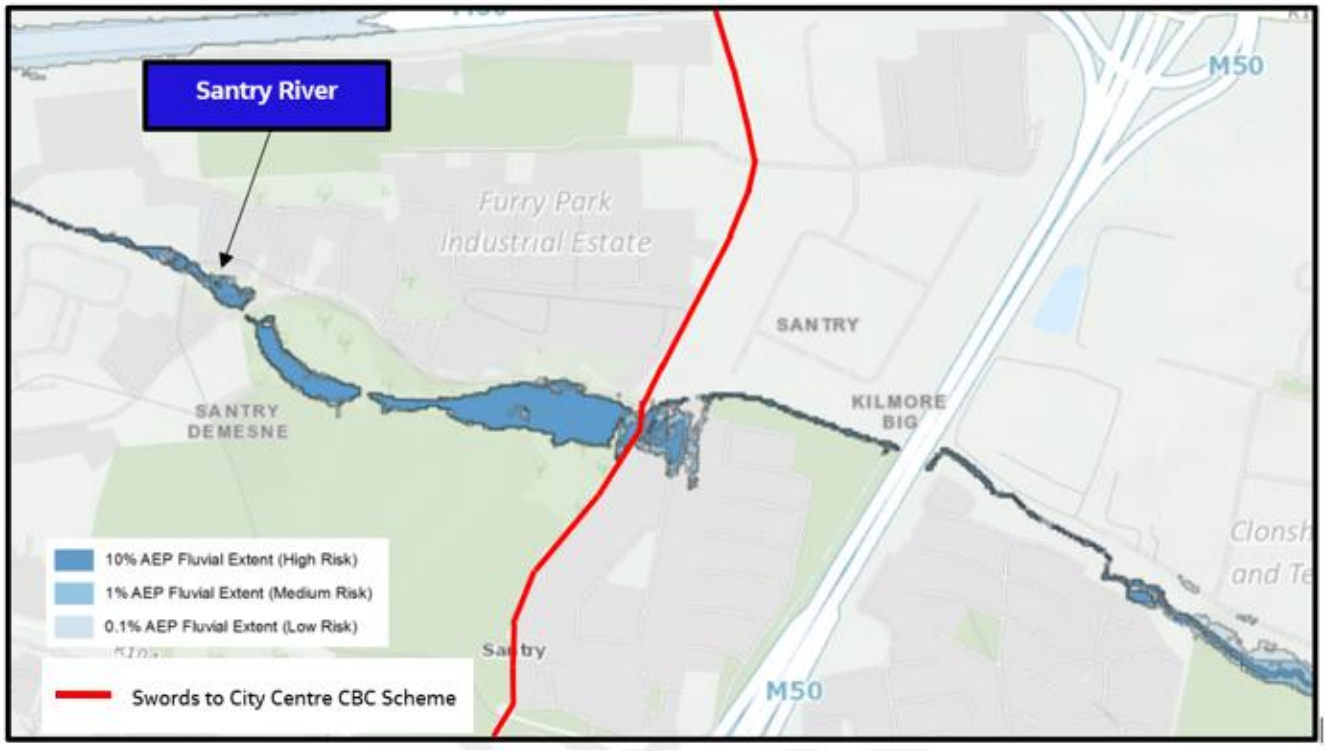


Figure 4.9 Extract of Fluvial flood mapping from Eastern CFRAM study for the Scheme 2 at the crossing with Santry River.

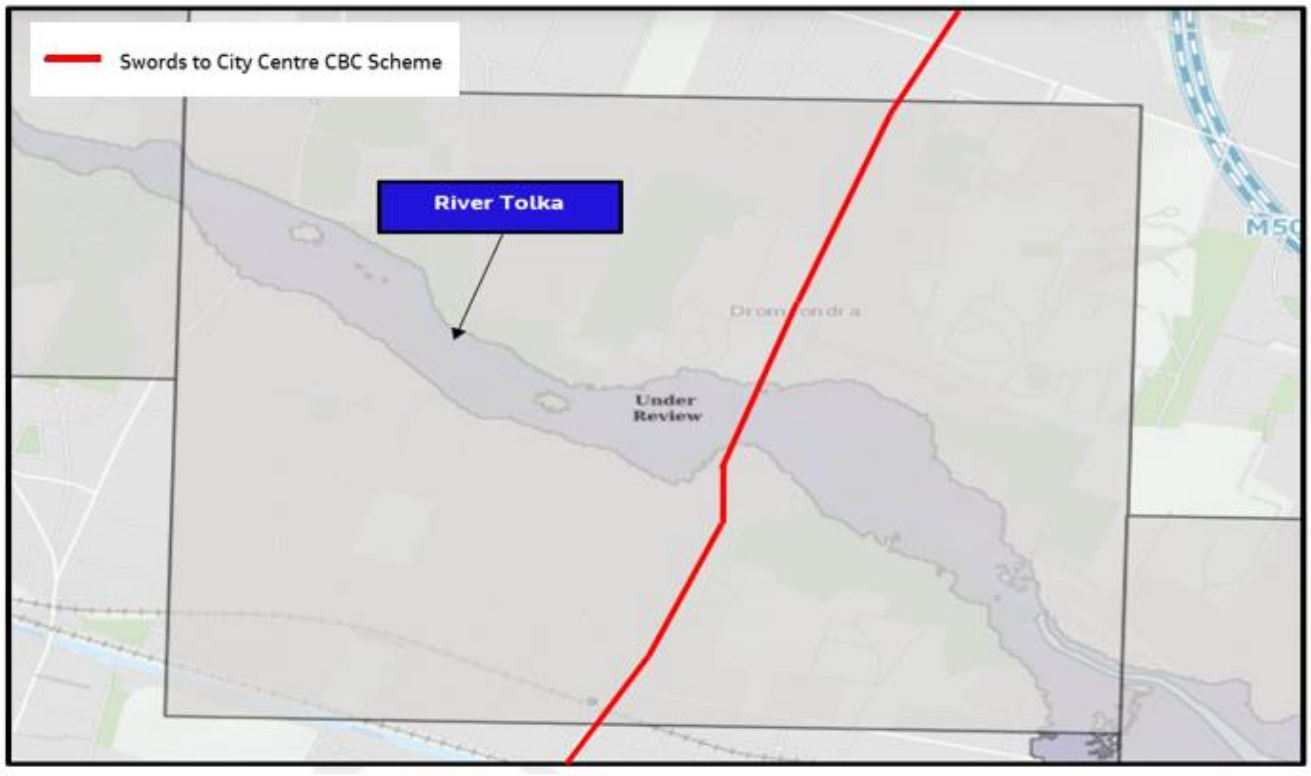


Figure 4.10 Extract of Fluvial flood mapping from Eastern CFRAM study for the Scheme 2 at the crossing with Tolka River.

4.4.1 River Flood Extents

Six locations have been identified where the Swords Scheme 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 Swords Scheme Watercourse Crossings

Watercourse	Chainage	Crossing Detail
Gaybrook watercourse	A00 +250	Existing culvert/bridge crossings retained and not modified, no change to highway width or level.
Sluice River	A01 + 450	
Cuckoo Stream	A03 + 600	
Mayne River	A04 + 775	
Santry River	A05 + 700	
Tolka River	A09 + 950	Existing Frank Flood Bridge retained and not modified. Proposed new bridge upstream of the existing 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 have been identified:

- Gaybrook watercourse south to Pinnock Hill Roundabout (R132), around Ch. A00 +250.
- Sluice River on Dublin Road (R132), around Ch. A01 + 450.
- Cuckoo Stream on Swords Road (R132), Ch. A03 + 400 – Ch. A03 + 825.
- Mayne River on Swords Road (R132), Ch. A04 + 450 – A04 + 900.
- Santry River on Swords Road (R132), Ch. A05 + 700 – A05 + 800.
- Tolka River on Drumcondra Rd Lower (N1), Ch. A09 + 800 – 10 +150.

4.4.1.1 Gaybrook watercourse south to Pinnock Hill Roundabout (R132), crossing at Ch. A00 +250.

The Proposed Scheme follows R132 south to Pinnock Hill roundabout, refer to Figure 4.11. Gaybrook Stream runs underneath the works via an existing culvert. The proposed works are entirely confined to the existing highway extent at this location with no amendment proposed to the existing watercourse crossing.

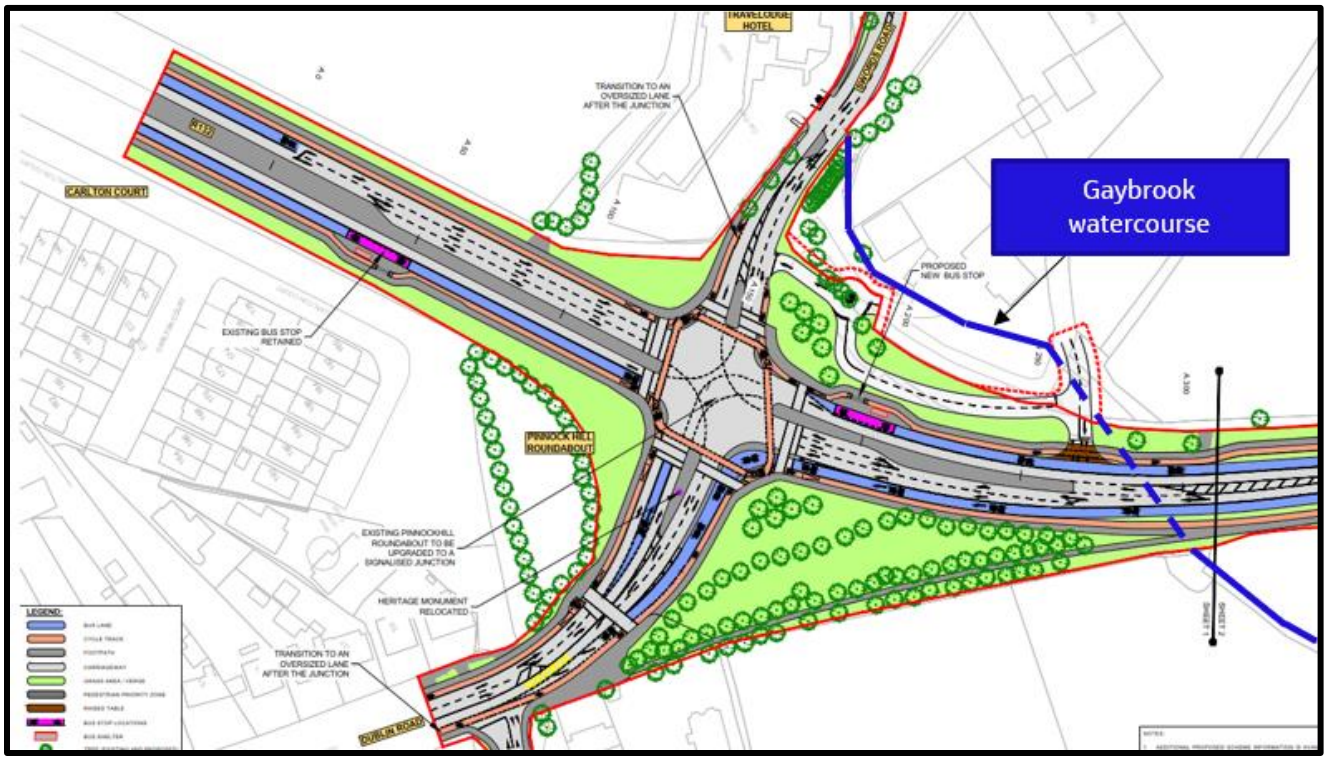


Figure 4.11 Proposed works at Pinnock Hill Roundabout and R132 (around Ch. A00 +250)

Figure 4.12 shows that the route is adjacent to lands at risk of fluvial flooding in the 0.1% AEP flood where it crosses the Gaybrook watercourse.

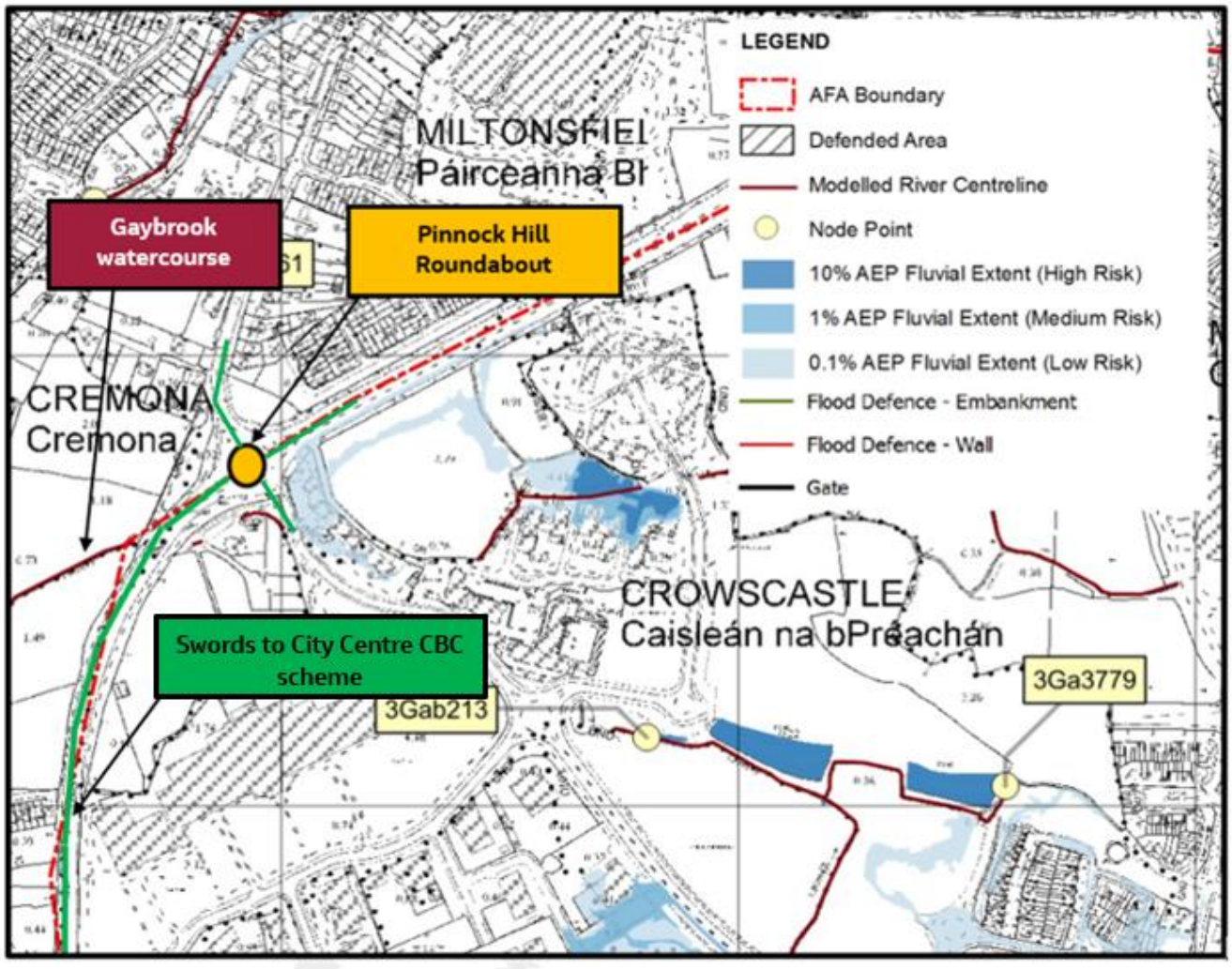


Figure 4.12 Extract of fluvial flood mapping from CFRAM study around the Gaybrook Watercourse crossing (around Ch. A00 + 250).

However, from site investigation, it is considered that the CFRAM model results are not accurate. The CFRAM model assumes all flow for the Gaybrook watercourse passes under the R132 road and continues along the mapped route. However, further analysis has found that a 900mm culvert intercepts the stream west of the R132 and diverts the water to the Ward River catchment. Further details are presented in Figure 4.13.

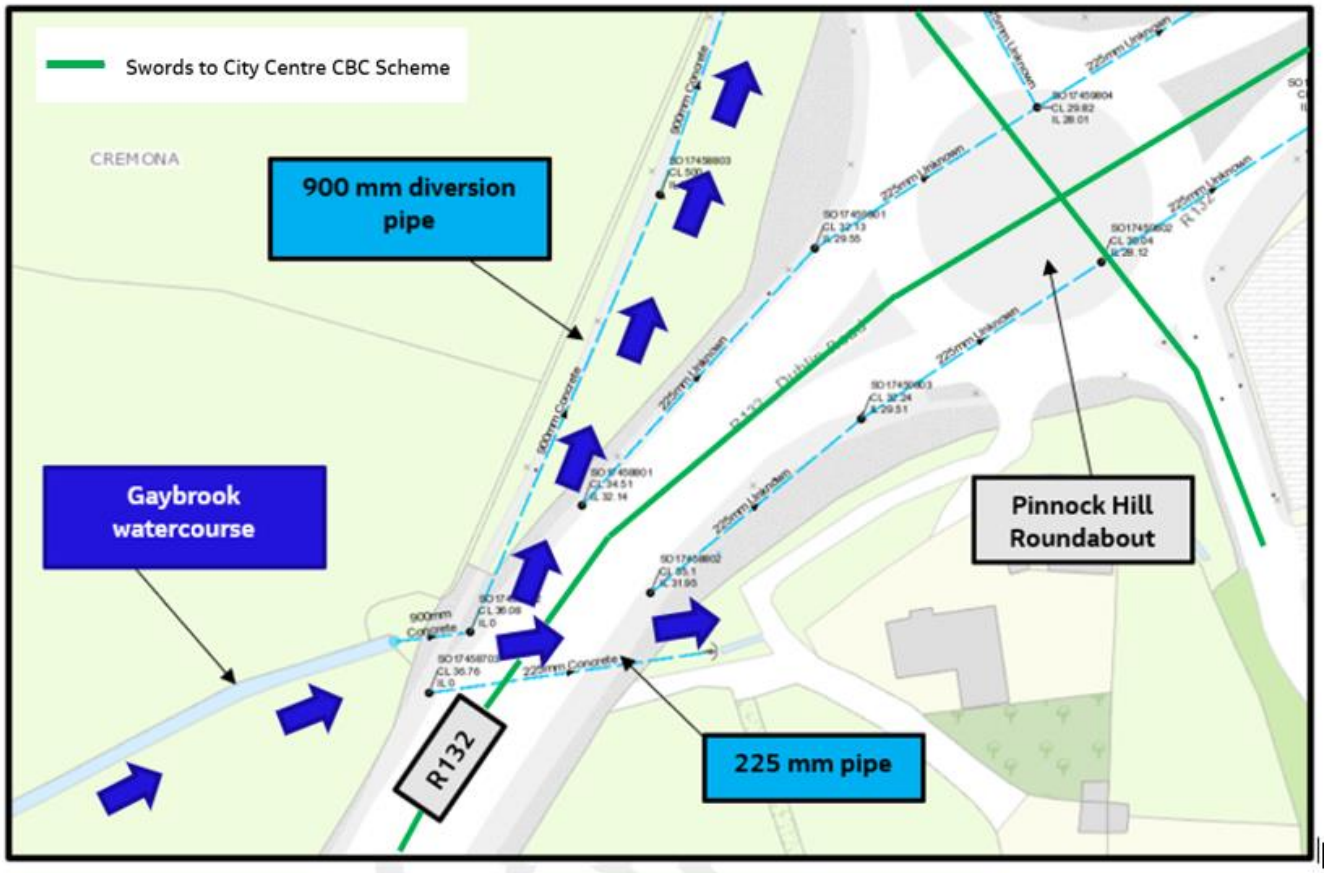


Figure 4.13 Gaybrook watercourse diversion

Based on the visual inspection, it is estimated that 95% of the Gaybrook flow is diverted to the new 900mm pipe, with a small sweetening flow carried under the R132 road in a 225mm diameter pipe.

Existing flood mapping is therefore considered to overestimate the potential flood risk from the Gaybrook as it does not allow for the full hydraulic capacity of the existing watercourse and the culverted diversion. The proposed works are therefore not considered to be at risk from flooding around Ch. A00 +250.

4.4.1.2 Sluice River on Dublin Road (R132), crossing at Ch. A01 + 450.

The Proposed Scheme follows R132 along Dublin Road, refer to Figure 4.14. The Sluice River runs underneath the works in an existing culvert. The proposed works are entirely confined to the existing highway extent at this location with no amendment proposed to the existing watercourse culvert or change in the level of the highway.

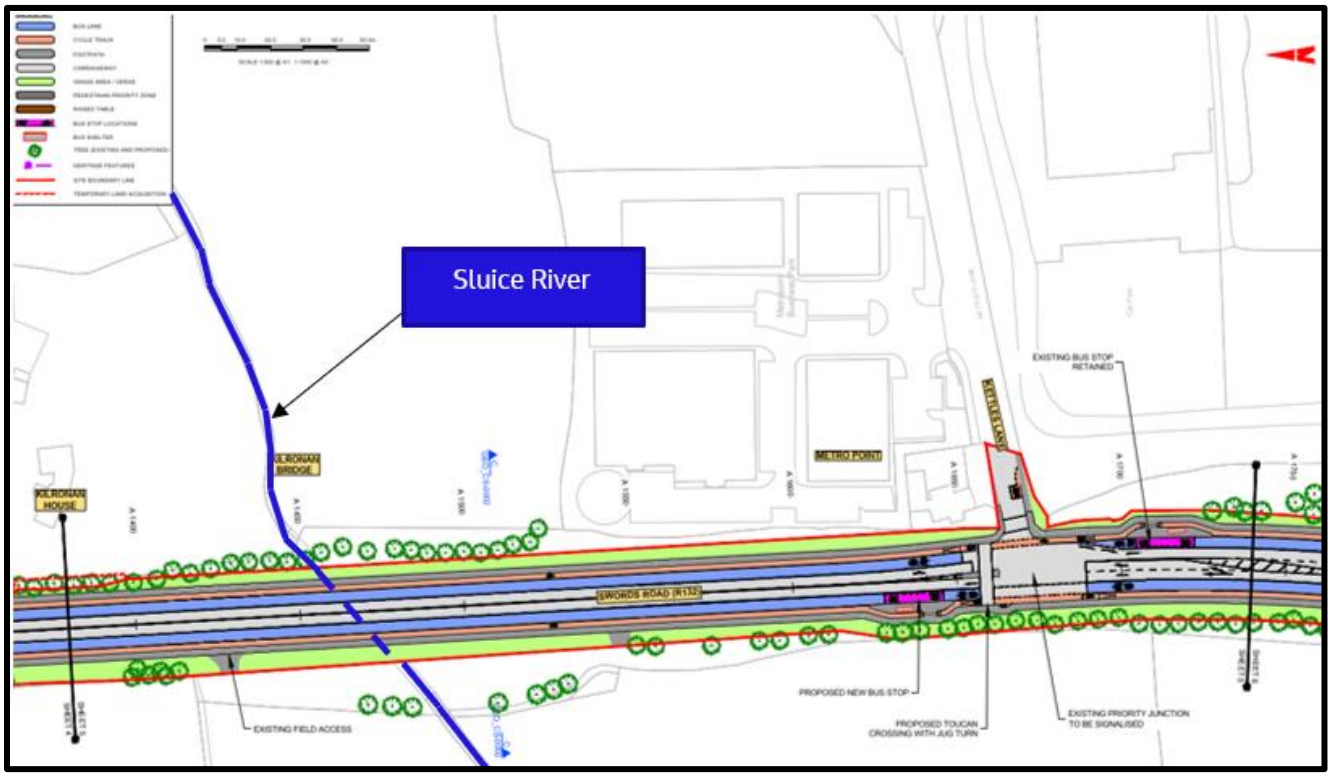


Figure 4.14 Proposed works around the crossing with Sluice River on R132 (around Ch. A01 + 450)

Figure 4.15 shows that the route is not at risk from fluvial flooding from the Sluice River. Further analysis of the CFRAM records found that the 0.1% AEP flood level is 39.66mOD which compares to a minimum road level of 41.8mOD i.e. a difference 2.14m.

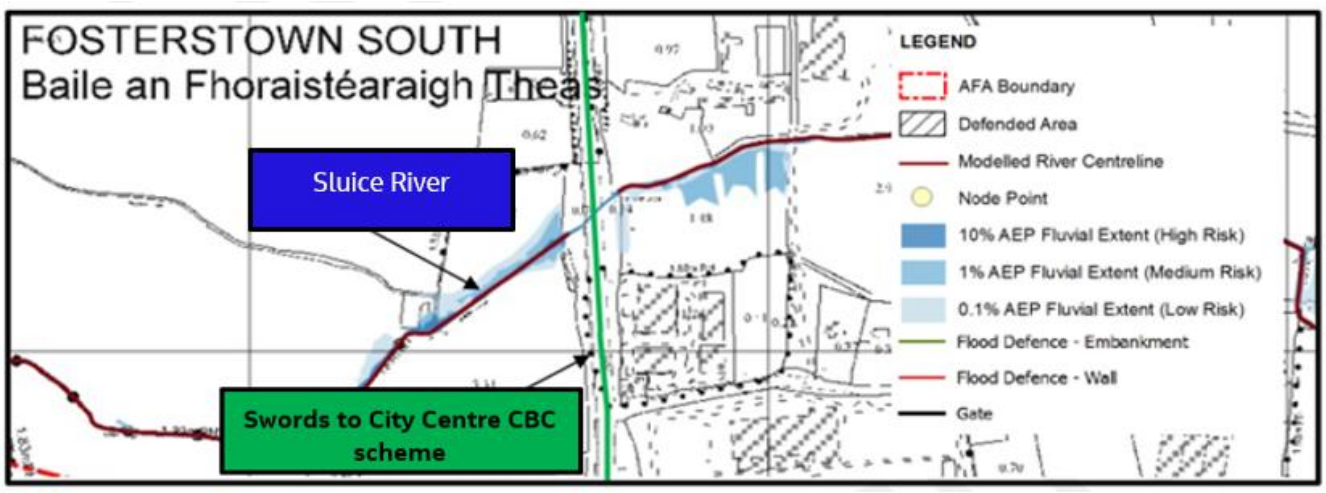


Figure 4.15 Extract of fluvial flood mapping from CFRAM study around the Sluice River crossing (around Ch. A01 + 450).

4.4.1.3 Cuckoo Stream on Swords Road (R132), Ch. A03 + 400 – Ch. A03 + 825.

The Proposed Scheme follows R132 along Swords Road, refer to Figure 4.15. The Cuckoo Stream runs underneath the works in an existing culvert. The proposed works are entirely confined to the existing highway extent at this location with no amendment proposed to the existing culvert or change in the level of the highway.

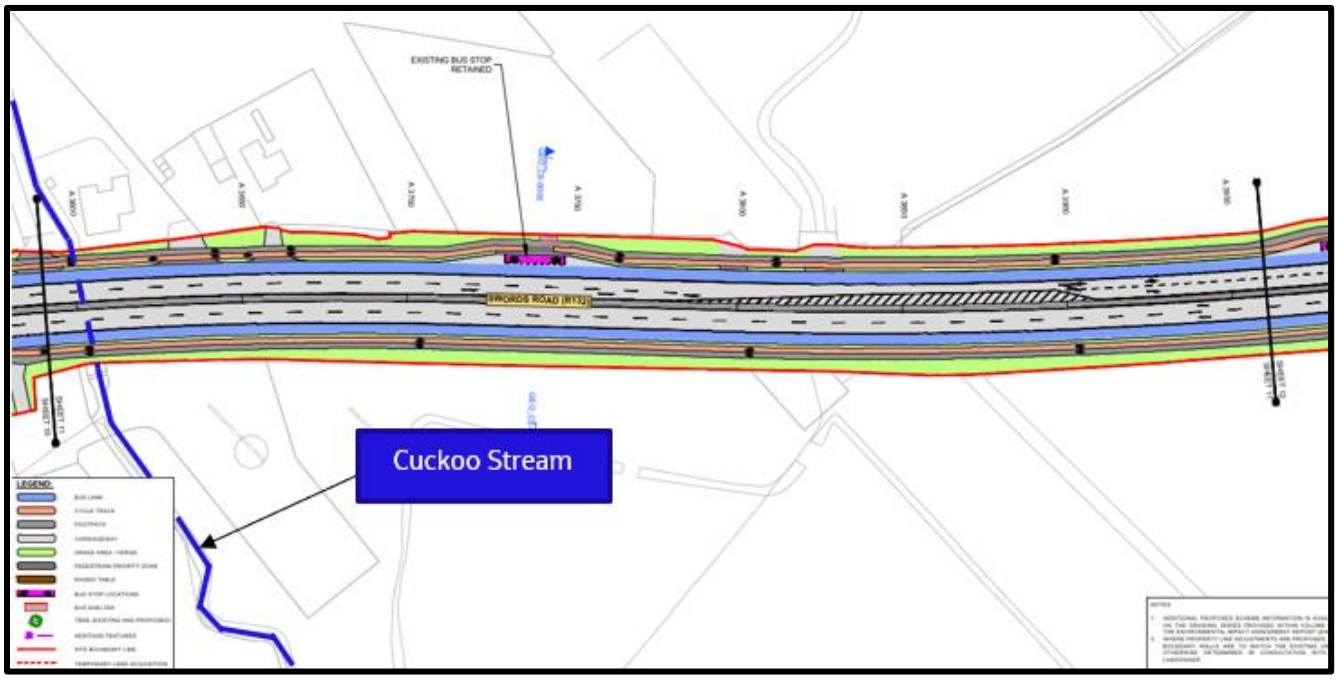


Figure 4.15 Proposed works around the crossing with Cuckoo Stream on R132 (around Ch. A03 + 600)

Figure 4.16 shows that the route is at risk of fluvial flooding in the 1% and 0.1% AEP floods around the crossing with the Cuckoo Stream.

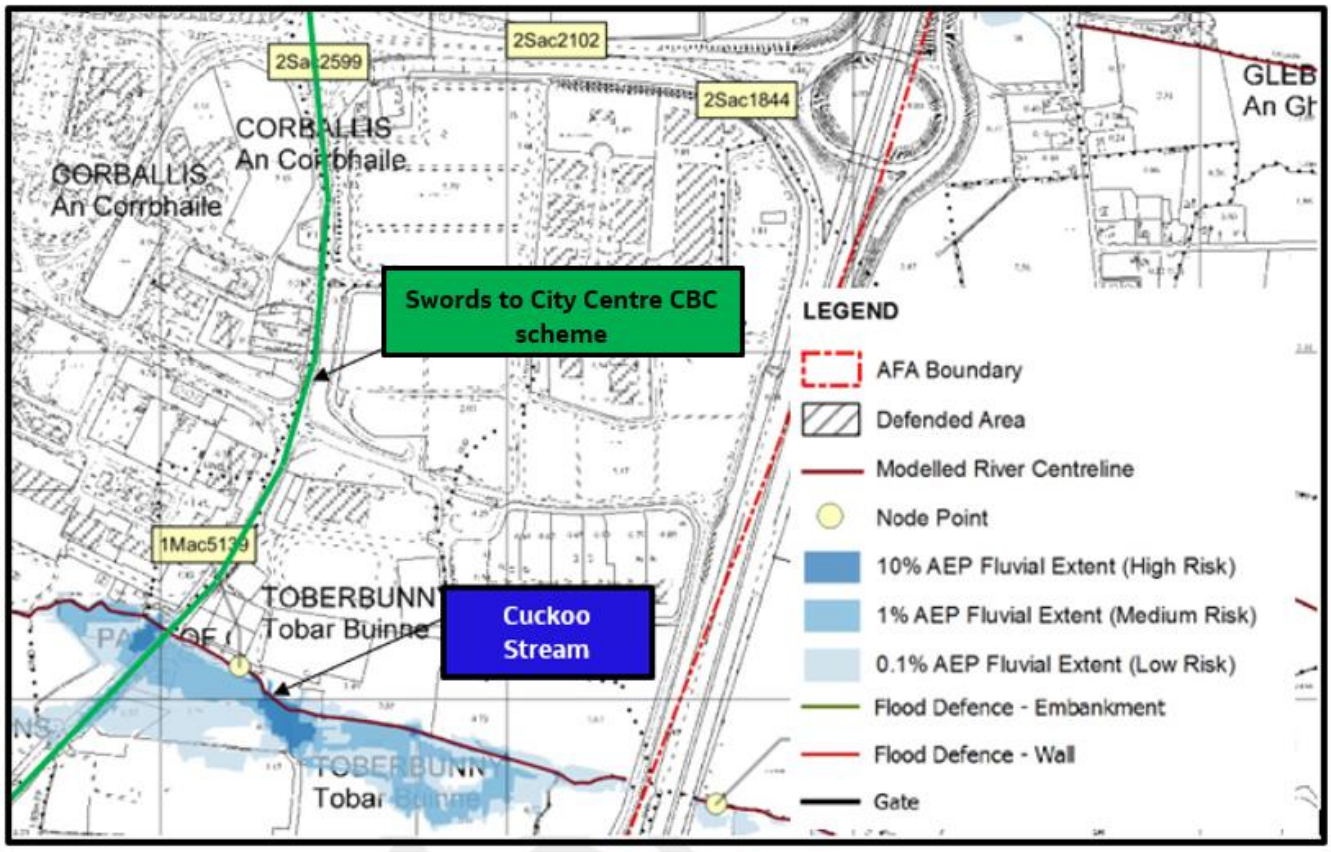


Figure 4.16 Extract of fluvial flood mapping from CFRAM study around the Cuckoo Stream crossing (Ch. A03 + 400 – Ch. A03 + 825).

4.4.1.4 Mayne River on Swords Road (R132), Ch. A04 + 450 – A04 + 900.

The proposed bus corridor follows R132 along Swords Road, refer to Figure 4.17. The Mayne River runs underneath the works via an existing culvert. The proposed works are entirely confined to the existing highway

extent at this location with no amendment proposed to the existing watercourse culvert or change in the level of the highway.

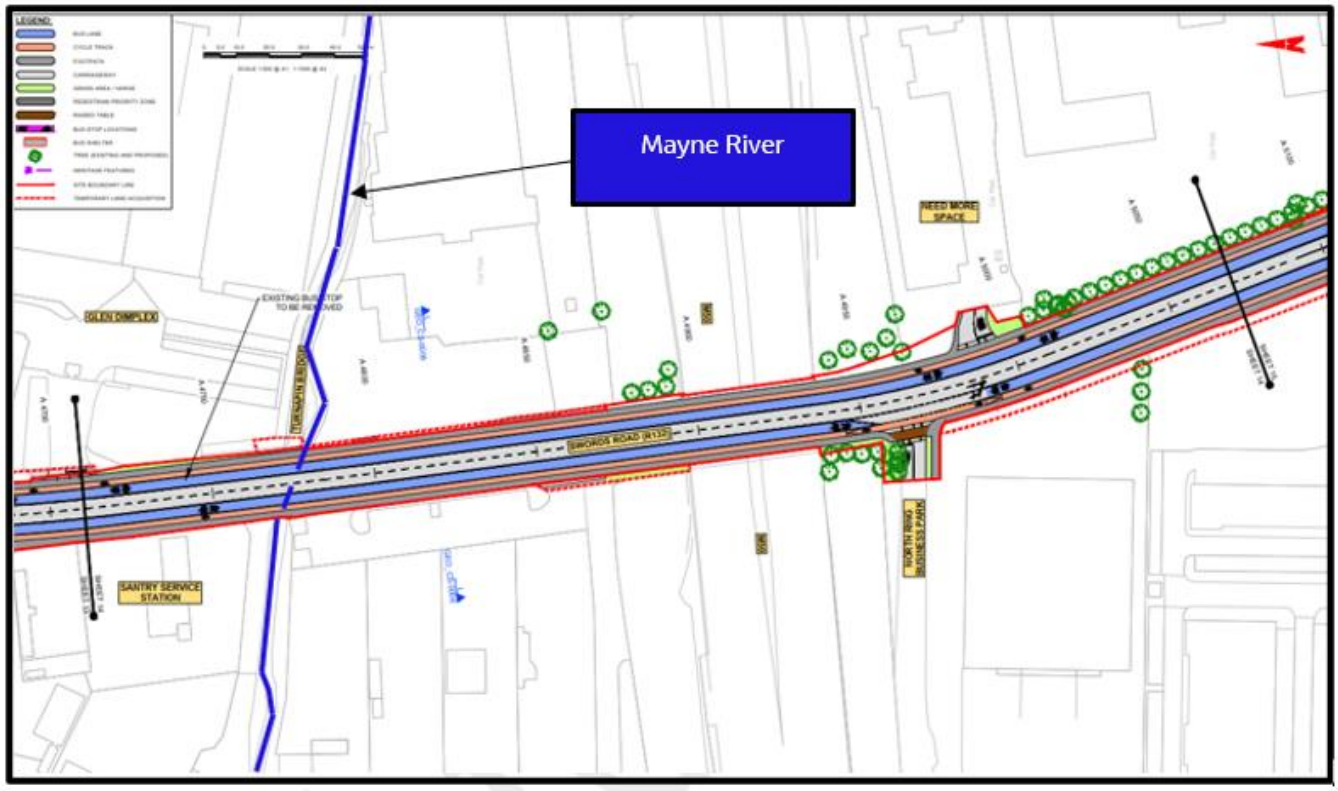


Figure 4.17 Proposed works around the crossing with Mayne River on R132 (around Ch. A04 + 775)

Figure 4.19 shows that the route is at risk of fluvial flooding in the 0.1% AEP flood around the crossing with the Mayne River.

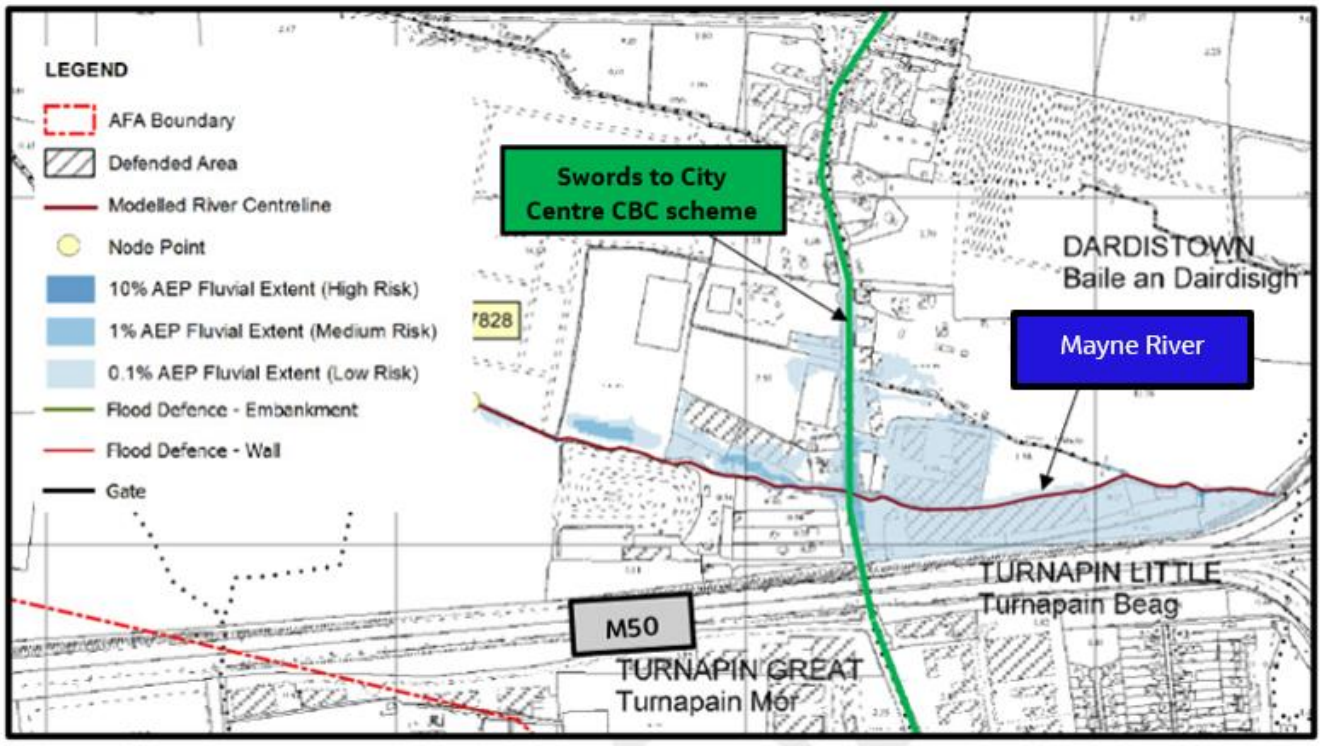


Figure 4.18 Extract of fluvial flood mapping from CFRAM study around the Mayne River crossing (Ch. A04 + 450 – A04 + 900).

4.4.1.5 Santry River on Swords Road (R132), Ch. A05 + 700 – A05 + 850.

The proposed bus corridor follows R132 along Dublin Road, refer to Figure 4.19. Santry River runs underneath the works via an existing culvert. The proposed works are entirely confined to the existing highway extent at this location with no amendment proposed to the existing watercourse culvert or change in the level of the highway.

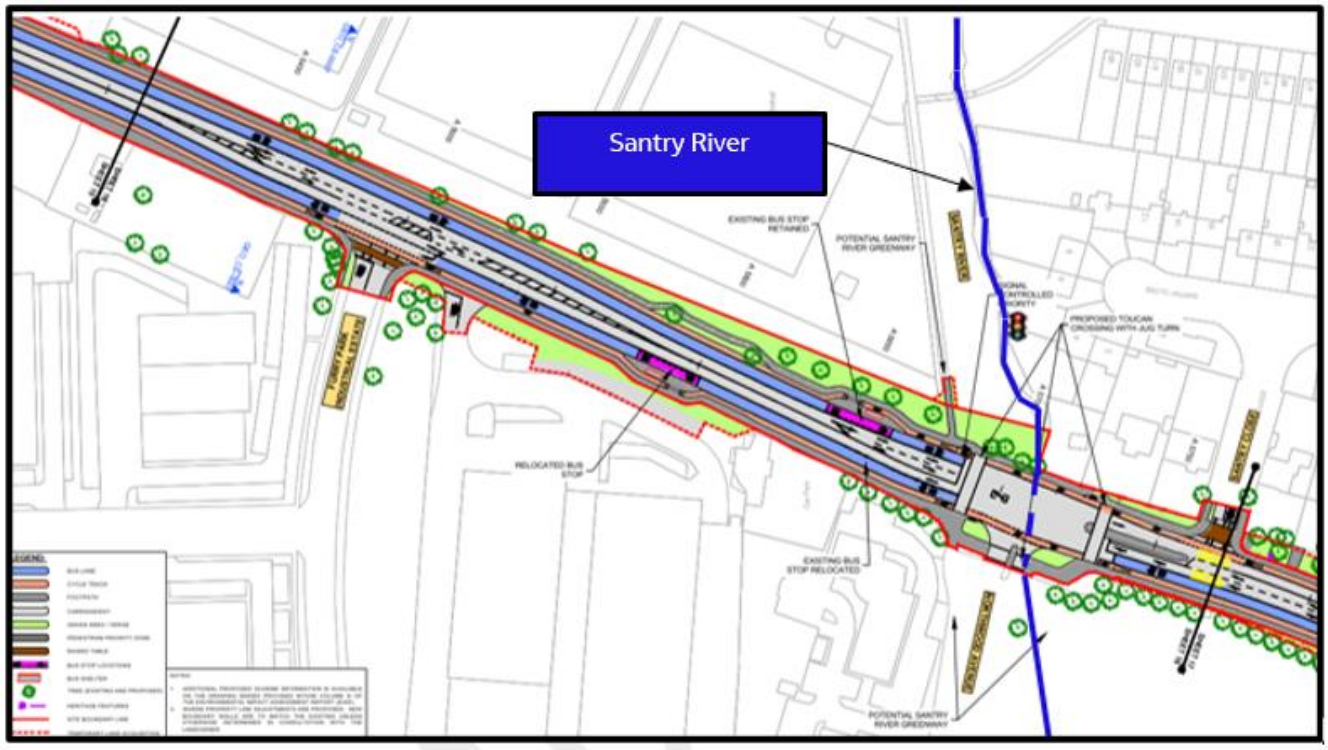


Figure 4.19 Proposed works around the crossing with Santry River on R132 (around Ch. A05 + 700)

Figure 4.20 shows that the route is at risk of fluvial flooding in the 10%, 1% and 0.1% AEP floods around the crossing with the Santry River.

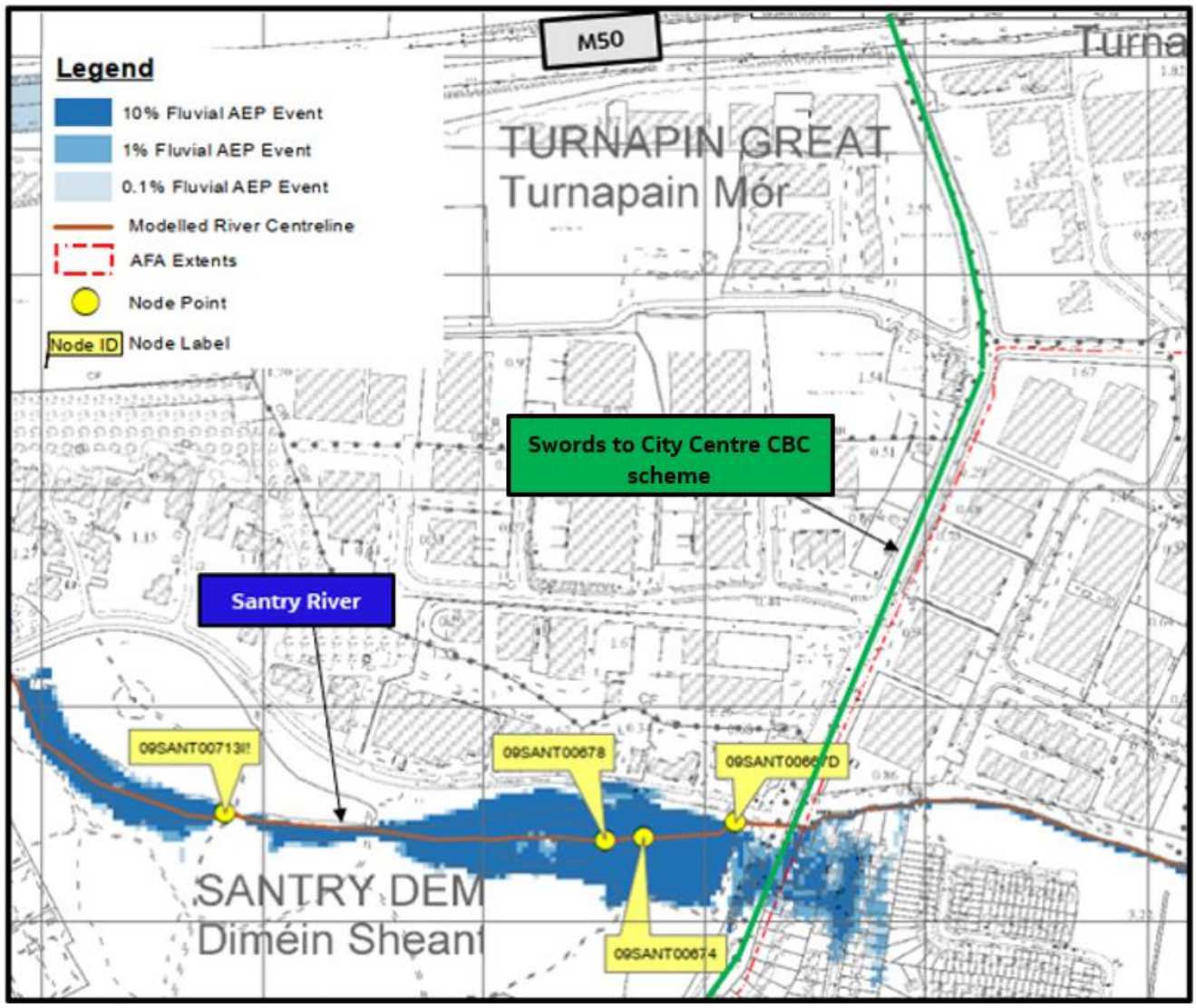


Figure 4.20 Extract of fluvial flood mapping from CFRAM study around the Santry River crossing (around Ch. A05 + 700 – A05 + 850).

4.4.1.6 Tolka River on Drumcondra Rd Lower (N1), Ch. A09 + 800 – 10 +150.

The proposed bus corridor follows R132 along Drumcondra Rd Lower, refer to Figure 4.21. The proposed works comprise construction of a two-opening bridge located 3m upstream of the existing Frank Flood Bridge crossing

over Tolka River. A hydraulic analysis was completed for the proposed bridge to demonstrate that there is no increase in the risk of flooding.

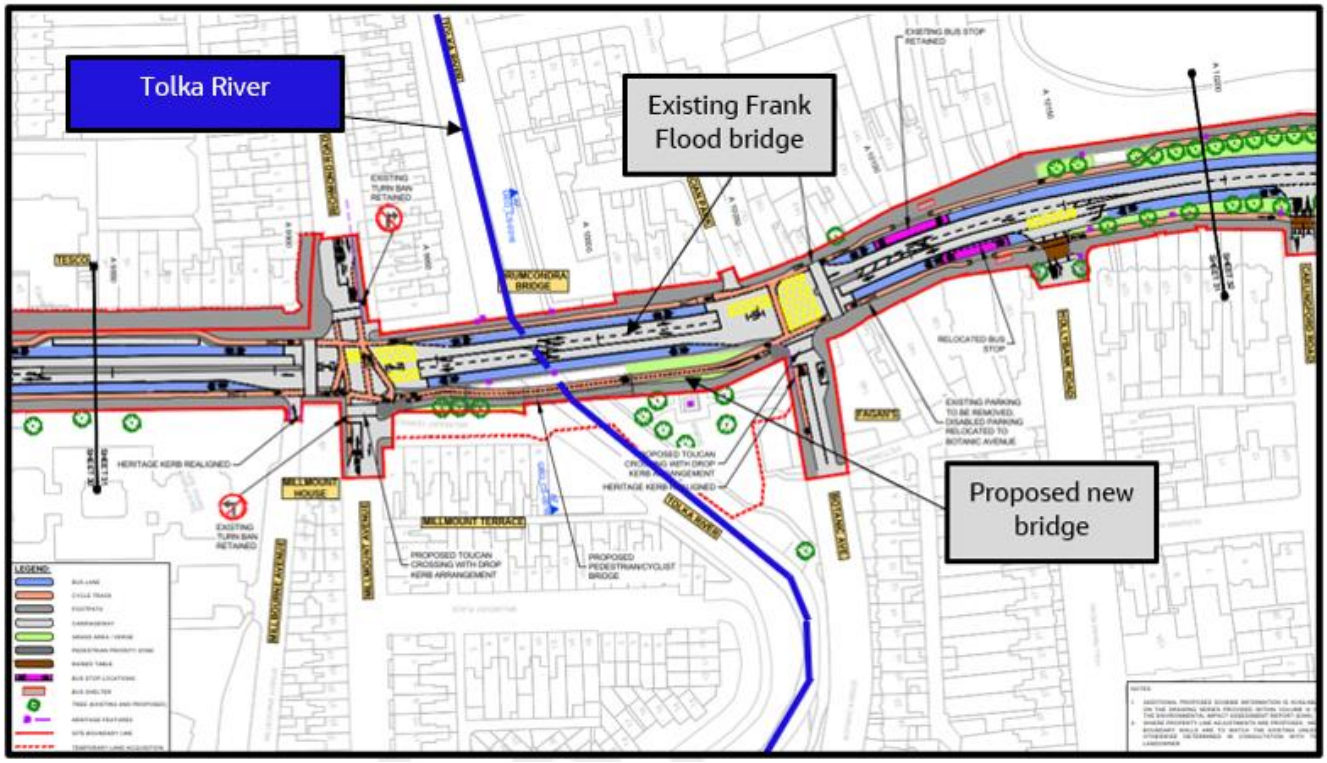


Figure 4.21 Proposed works around the crossing with Tolka River on N1 (around Ch. A09 + 950)

The OPW CFRAM Study Maps at the area of interest are currently under review hence, an extract of the Dublin City Council Composite Flood Map was used to assess risk of flooding in this area, refer to Figure 4.23. The map shows that the route is within Flood Zone A at the river crossing. It should be noted however that OPW records indicate that the lands either side of the Frank Flood Bridge are located within the benefitting area from the River Tolka Flood Relief Scheme. The OPW state that the scheme provides a 1% AEP standard of flood protection.

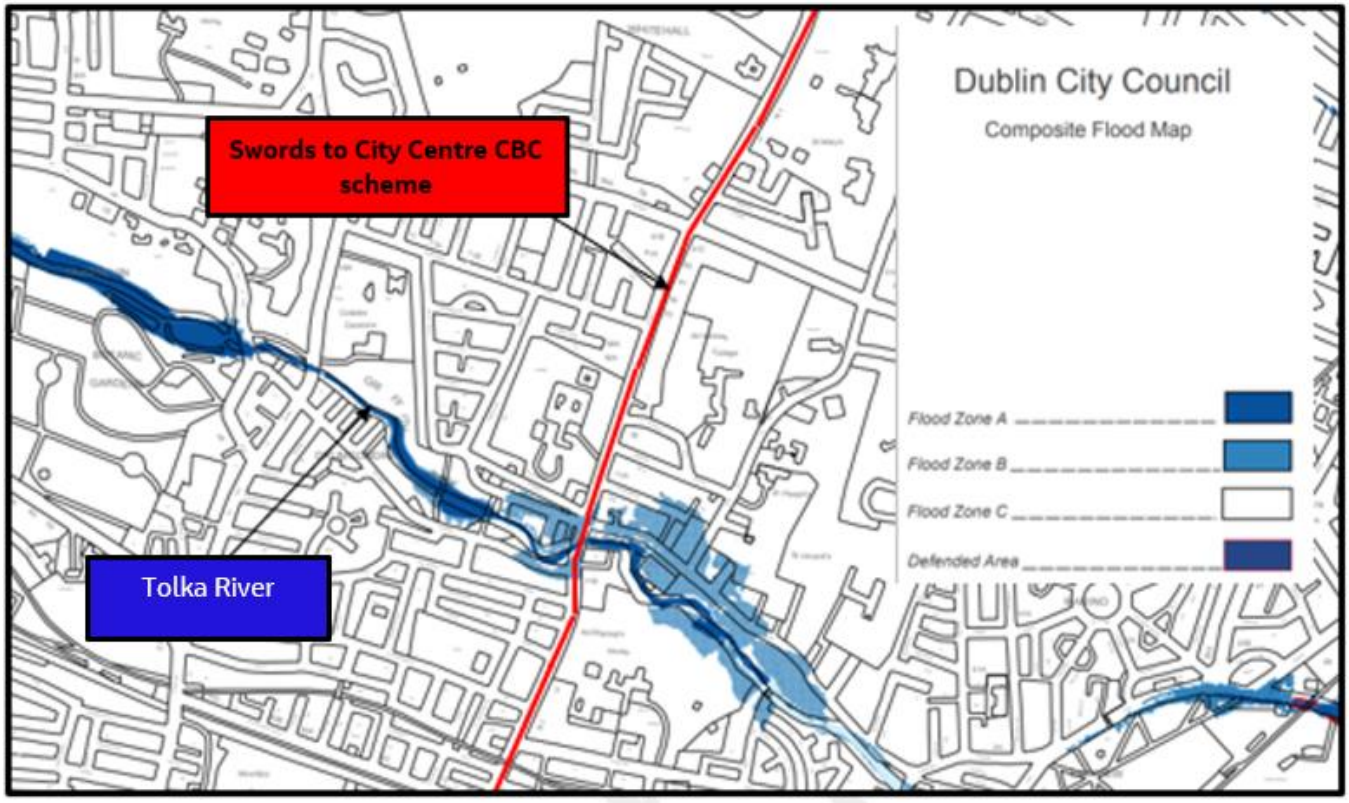


Figure 4.23 Extract of Dublin City Council Composite Flood Map at the area of interest (Ch.A09 + 800 – 10 + 150)

4.4.2 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 flood risk was identified along this route, refer to Figure 4.24.

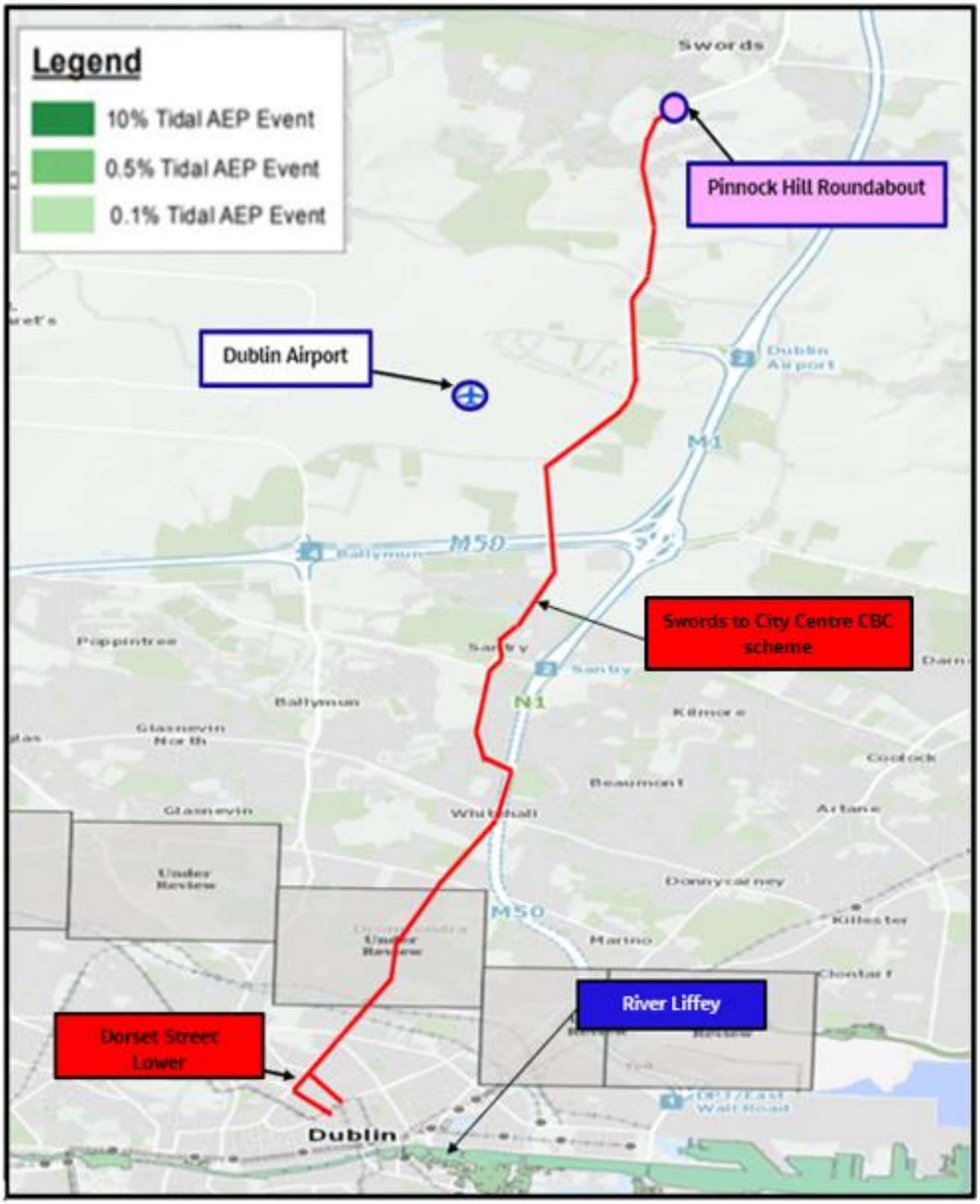


Figure 4.24 Extract of coastal flood mapping from Eastern CFRAM study

4.5 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 parts of Dublin and provide an indication of the level of risk. Pluvial mapping extends from the City Centre as far as the M50 overpass. The flood mapping considered flood risk in the 10%, 1% and 0.5% AEP rainfall events. The pluvial flood extents along the Proposed Scheme were reviewed using the OPW flood info website (available at www.floodinfo.ie) and the 10% pluvial flood extents are illustrated in Figure 4.25 and Figure 4.26.

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 the M50 overpass and Pinnock Hill Roundabout) is exposed to a similar level of flood risk.

Figure 4.25 Extract of pluvial flood mapping on the Proposed Scheme from the M50 overpass down to Whitehall.

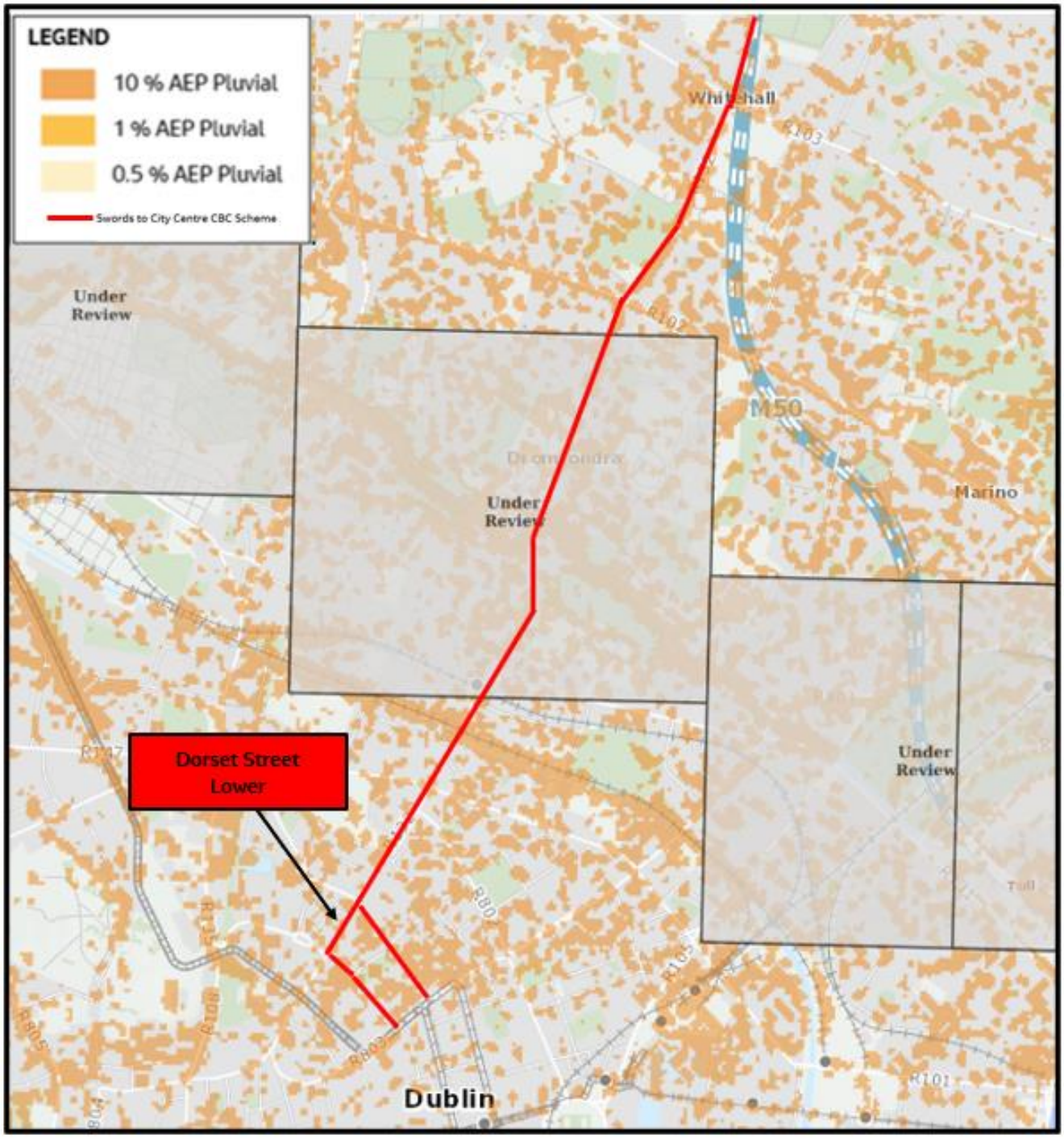


Figure 4.26 Extract of pluvial flood mapping on the Proposed Scheme from Whitehall down to City Centre.

The level of risk identified is a function of the limited capacity of the surface water drainage network that is present across much of the city. It is beyond the scope of the Proposed Scheme to undertake wholesale improvements to the capacity of the city's drainage network.

4.6 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 4.27.

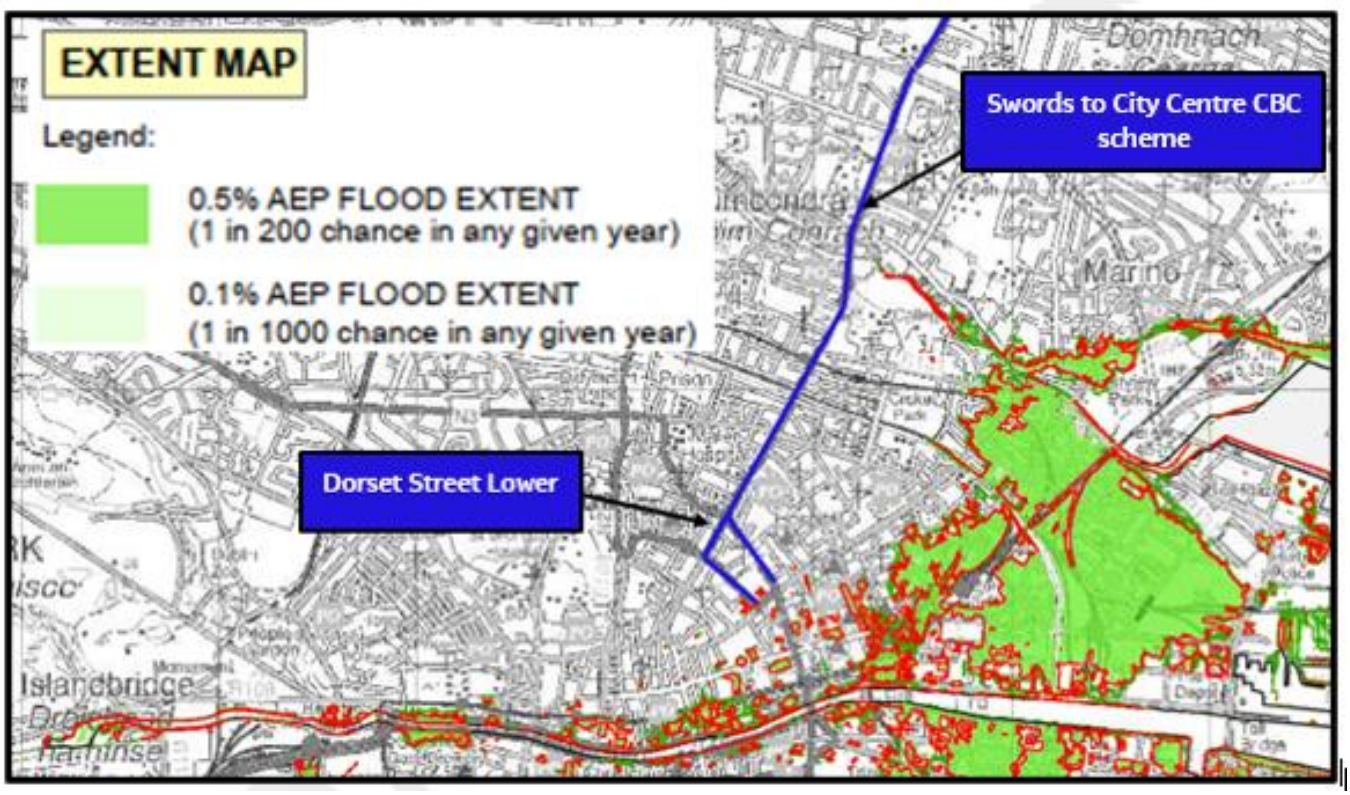


Figure 4.27 ICPSS coastal mapping. City Centre

ICPSS flood mapping show that the junction between Gardiner Street Lower and Beresford Place is potentially at risk of coastal flooding in a 0.1% Tidal AEP event.

There are several flood defence schemes in place to mitigate against this risk. Quay walls on both sides of the River Liffey from East Wall Road Bridge to the Sean Heuston Bridge protect the majority of Dublin City Centre from coastal flooding. There are also ongoing works at South Campshires area from Butt Bridge to Cardiff Lane that will protect the area from an estimated 200-year flood event plus climate change.

As part of the Dublin Coastal Flooding Protection Project, a review of the capacity of existing coastal flood defence schemes was carried out. The report, published in 2005, identified a number of locations in where the current level of flood defences was below that required for current and future predicted sea levels. The quay wall located at Custom House Quay was not present on this list, therefore it can be concluded that the wall should provide adequate protection against current and future coastal flood risks.

Due to the high elevation of this location above flood levels and the flood alleviation measures, the risk of coastal flooding along the Proposed Scheme is considered to be low.

4.7 Royal Canal. Crossing at Ch A10+800

The proposed bus corridor follows Phibsborough Road (R108), refer to Figure 4.28. Royal Canal runs underneath the works via an existing bridge (Binn's Bridge). The proposed works are entirely confined to the existing highway extent at this location with no amendment proposed to the existing watercourse crossing.

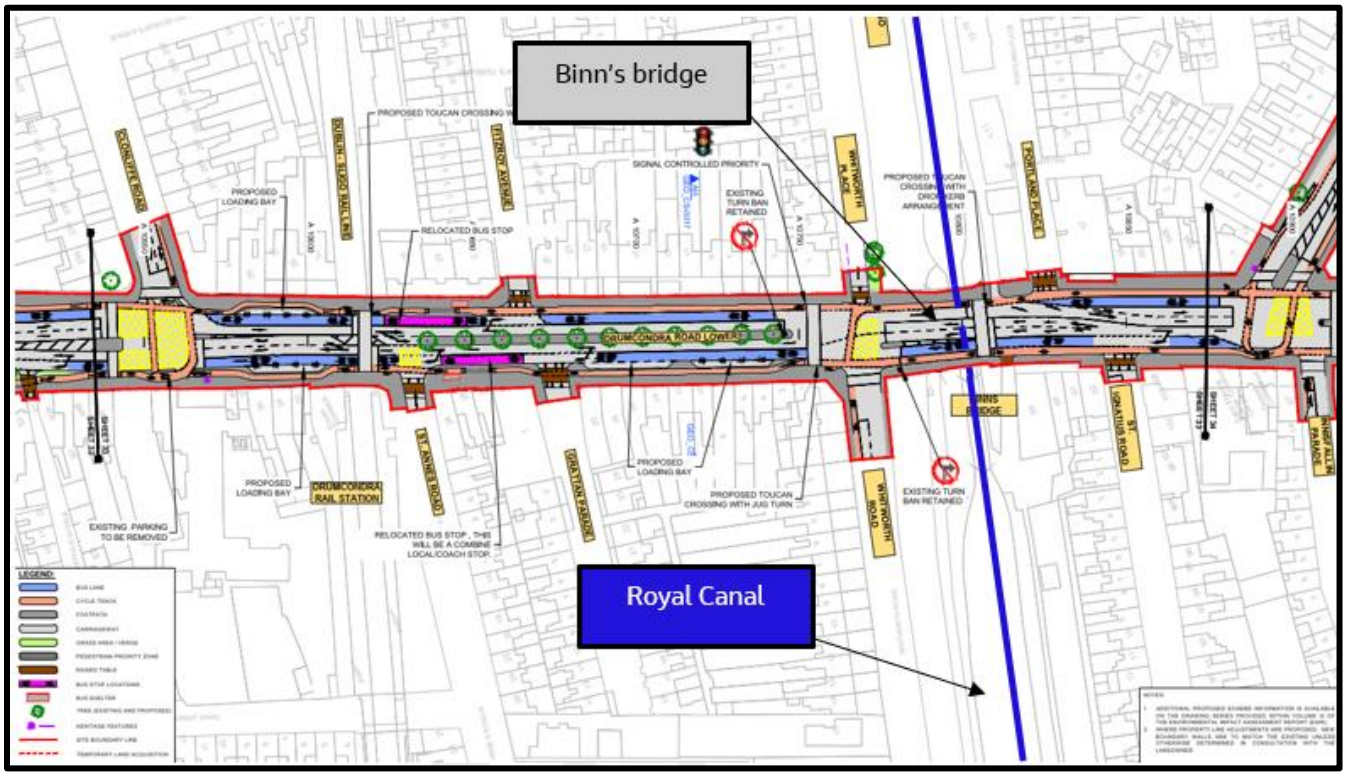


Figure 4.28 Proposed works around the crossing with Royal Canal on Phibsborough Rd (R108) (around Ch. A10 + 800)

Water levels along the canal are regulated by a series of lock gates and waste-weirs. There are insufficient flows in the canal to pose a flood risk to the Proposed Scheme.

4.8 Strategic Flood Risk Assessments (SFRA)

4.8.1 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 proposed works along Drumcondra Road Lower are located within Flood Zones A and B (associated with the Tolka River), refer to Figure 4.29.

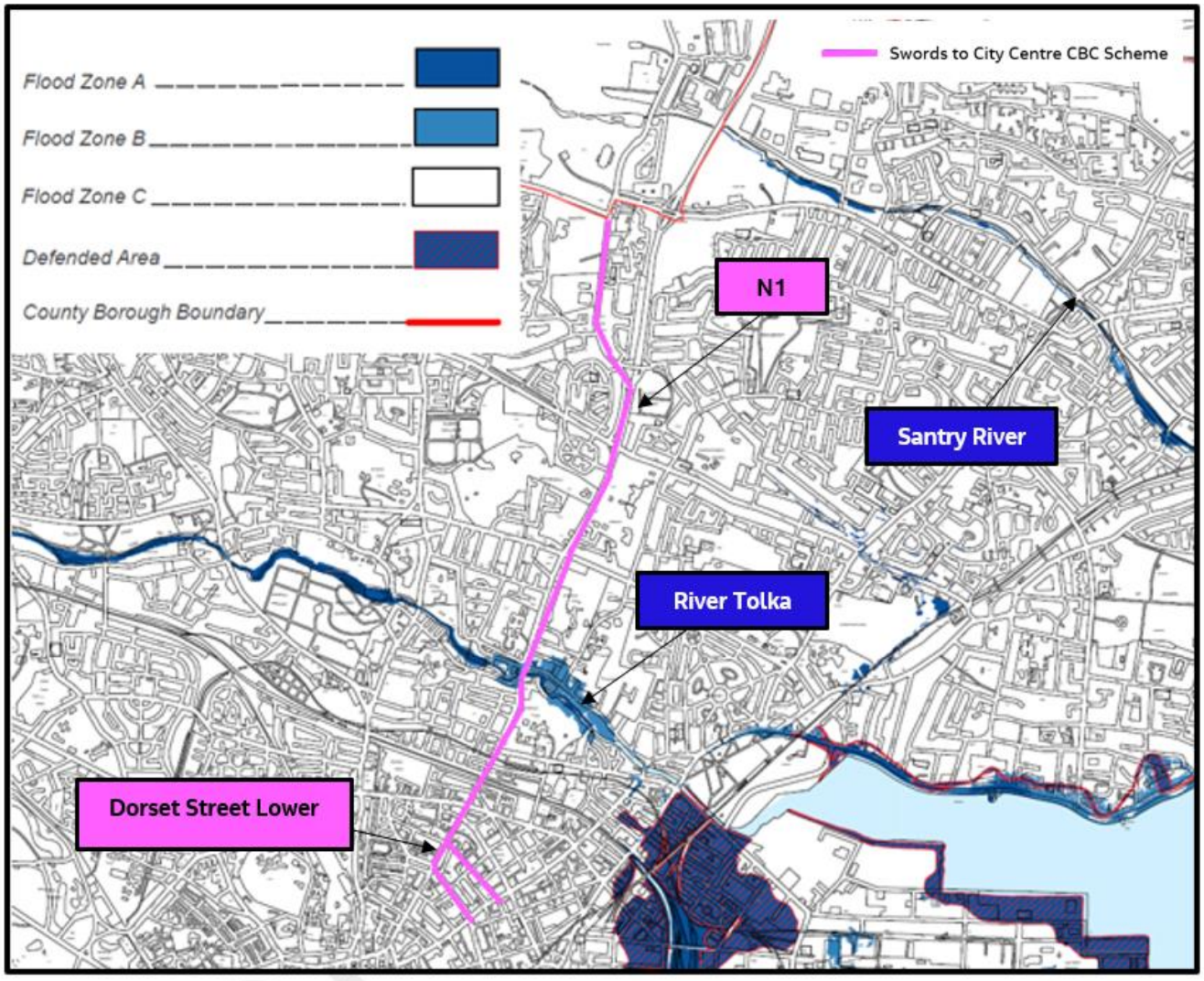


Figure 4.29 Dublin City Council Composite Flood Map.

A moderate risk of pluvial risk has been reported along much of the Proposed Scheme. 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), refer to Figure 4.30.

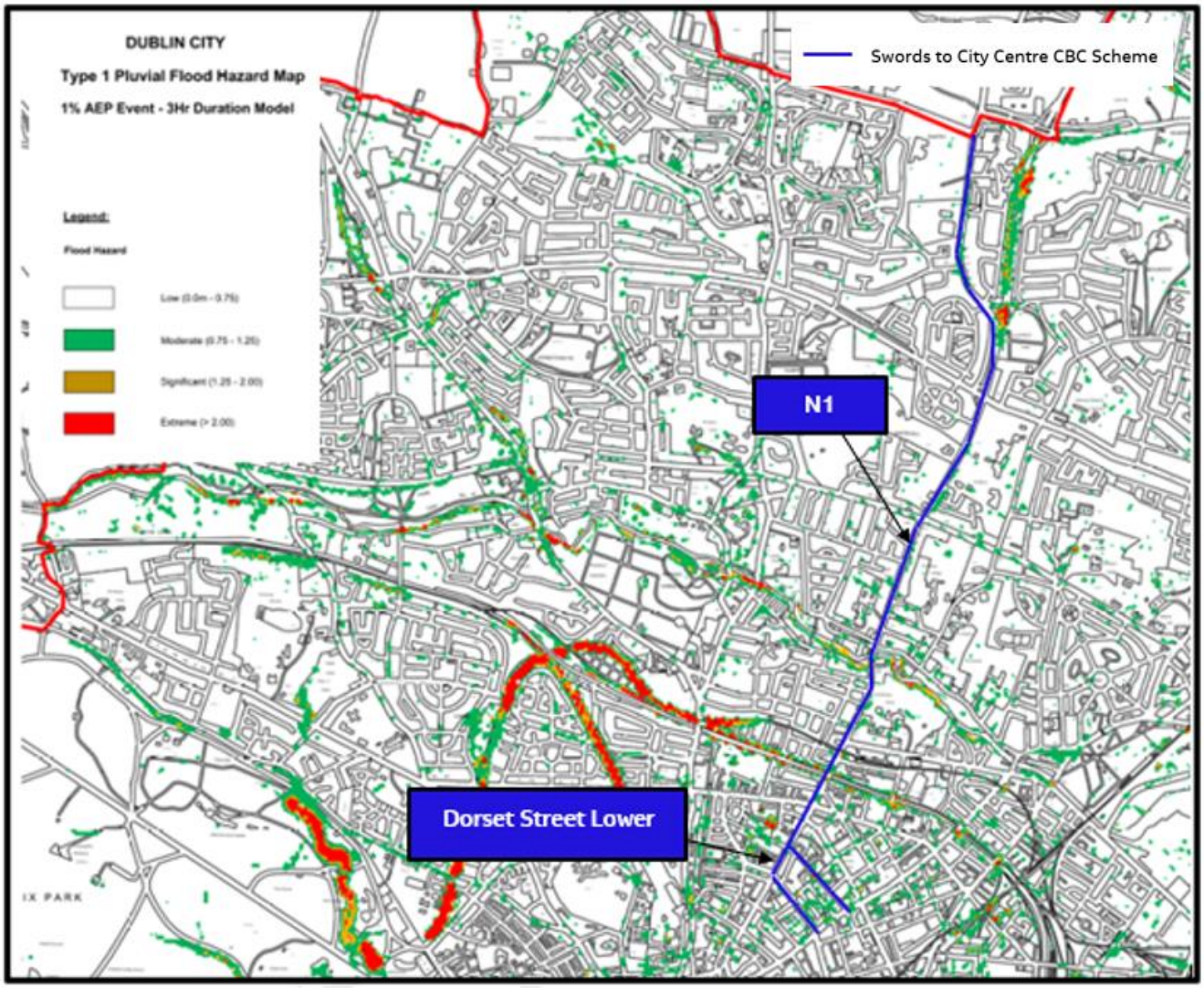


Figure 4.30 Dublin City Council Pluvial Flood Hazard Map.

4.8.2 Fingal County Council Development Plan

A Strategic Flood Risk Assessment and Management Plan was prepared as part of the Fingal County Council Development Plan 2017-2023. This document states that the proposed works along Swords Road (R132) are located within Flood Zones A and B, refer to Figure 4.31 and Figure 4.32.

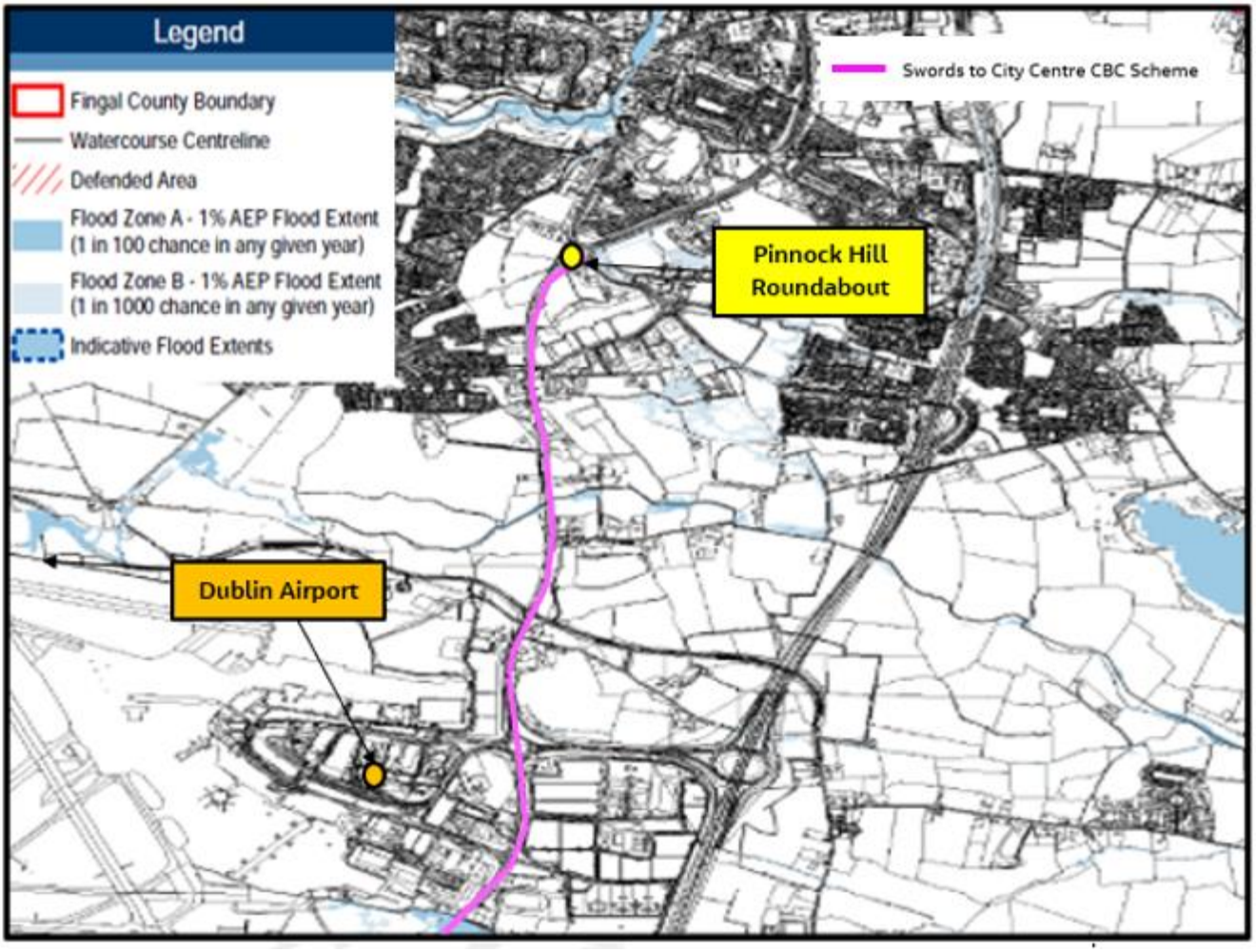


Figure 4.31 Fingal County Council Composite Flood Map. Pinnock Hill Roundabout to Dublin Airport.

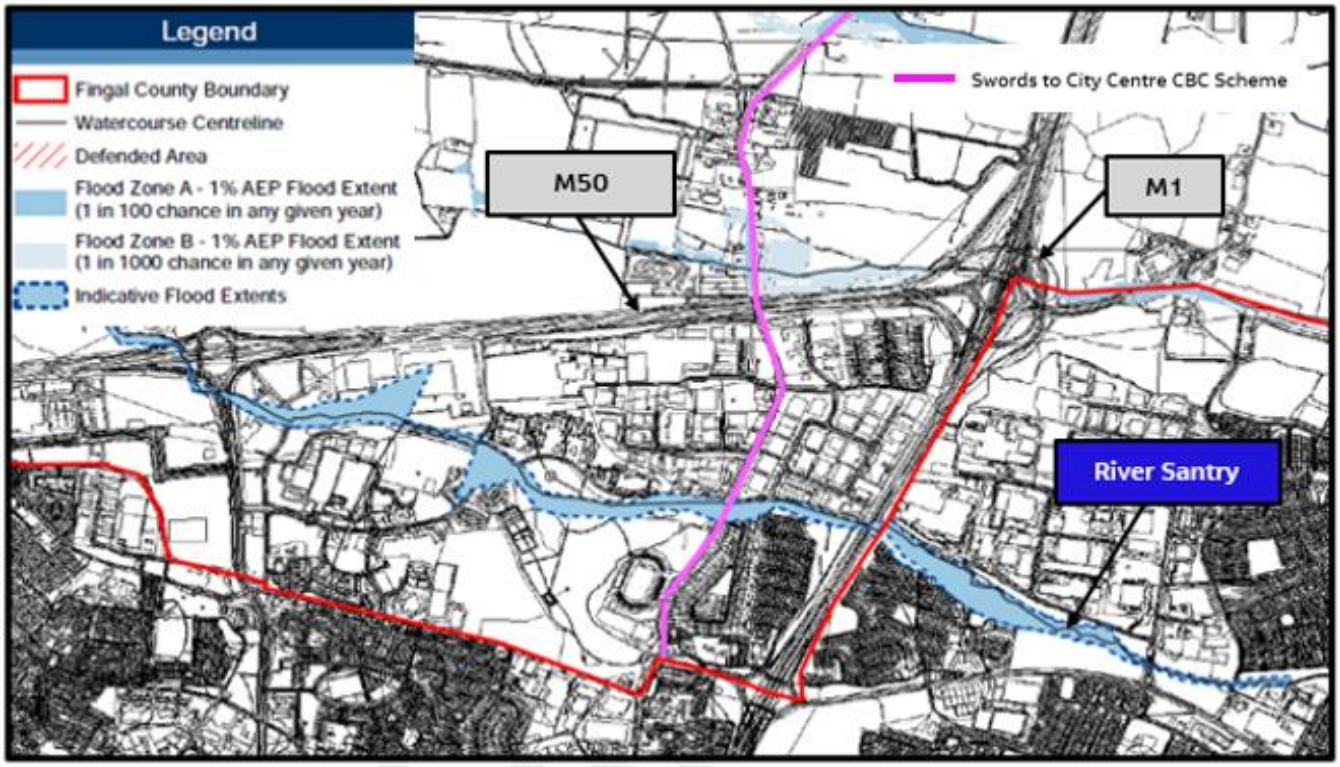


Figure 4.32 Fingal County Council Composite Flood Map. Dublin Airport to Santry

A pluvial hydraulic assessment was undertaken for the AFAs in the FEMFRAM (Fingal East Meath Flood Risk Assessment and Management) study for specific design events and future scenarios. For the SFRA, the results of the FEMFRAM pluvial assessment were reviewed against historical records and the OPW Pluvial Flooding Risk Assessment (PFRA) study. The OPW PFRA study provides a national level pluvial screening of areas that are at potential risk of pluvial flooding.

Results of the study indicate that the Swords area is prone to historic flooding at Pinnock Hill indicative of a 1% AEP risk on the PFRA mapping. The FEMFRAM shows flooding around Mayne/M50 flyover on the Old Airport and north of M50 Dardistown area. Extensive flooding was also found at the south-east corner of Dublin Airport; at upstream of M1 crossing by the Cuckoo Stream. These areas are also indicative of a 1% AEP risk on the PRFA.

5. Stage 2 Initial Flood Risk Assessment

This section assesses the risk of flooding to the Proposed Scheme 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 Scheme.

5.1 Potential Sources of Flooding

Further to the Stage 1 assessment, there is no identified risk of coastal, estuarine or groundwater flooding to the Proposed Scheme. The potential sources of flooding are listed below:

- **Fluvial** – Four locations across the scheme are at risk from fluvial flooding:
    - Swords Rd (R132) from the Cuckoo Stream (Ch A03 + 400 – A03 + 825) in the 1% and 0.1% AEP floods.
    - Swords Rd (R132) from the Mayne River (Ch A04 + 450 – A04 + 900) in the 0.1% AEP flood.
    - Swords Rd (R132) from the Santry River (Ch A05 +700 – A05 + 800) in the 10% and 1% AEP floods.
    - Drumcondra Road Lower (Frank Flood Bridge) is located in Flood Zone A from the River Tolka. OPW records also however show that the area is defended to a 1% AEP standard by the River Tolka Flood Relief Scheme.
- **Pluvial** – OPW records show the risk of pluvial flooding along the route between the city centre and the M50 overpass in the 10% AEP flood. It is reasonable to assume that the remainder of the Proposed Scheme (between Pinnock Hill Roundabout and the M50 overpass) is exposed to a similar level of flood risk.

5.2 Initial Fluvial Flood Risk Assessment

The Four fluvial flood risk areas identified for the Proposed Scheme are:

- Swords Road (R132), Ch A03 + 400 – A03 + 825, associated with the Cuckoo Stream.
- Swords Road (R132), Ch A04 + 450 – A04 + 900, associated with the Mayne River.
- Swords Road (R132), Ch A05 +700 – A05 + 800, associated with Santry River.
- Drumcondra Road Lower (N1), Ch A09 + 800 – A10 +150, associated with the River Tolka.

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

5.2.1 Swords Road (R132), Ch A03 + 400 – A03 + 825 associated with the Cuckoo Stream

The Stage 1 assessment indicated that Swords Road (R132), Ch A03 + 400 – A03 + 825 is at risk from fluvial flooding. The Eastern CFRAM study modelled the Cuckoo Stream at its crossing with the Proposed Scheme at Swords Road (R132). The predicted flood extent is shown in Figure 5.1.

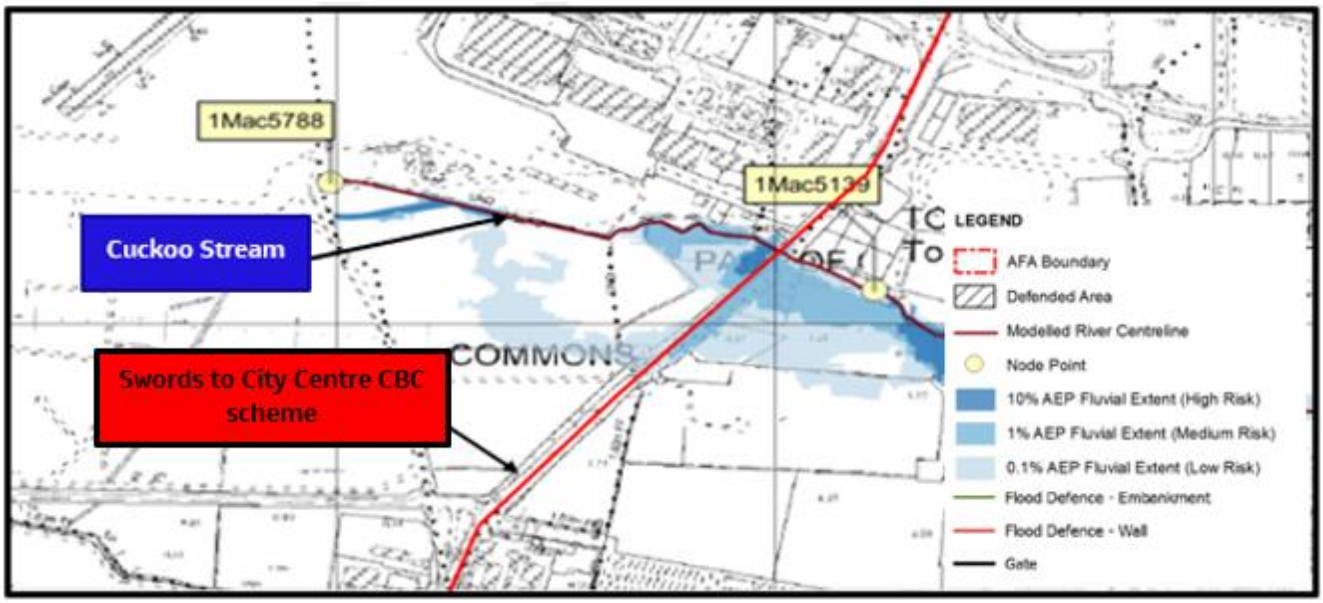


Figure 5.1 Eastern CFRAM study, Swords Road (R132), Ch A03 + 400 – A03+825

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 ground level for the Proposed Scheme ; refer to Table 5.1. It should be noted that the finished ground level is unchanged from the existing ground level within Ch A03 + 400 – A03 + 825.

Table 5.1 Design Cuckoo Stream Fluvial Flood Levels for the Proposed Scheme. (Swords Road (R132), Ch A03 + 400 – A03 + 825)

AEP Event	Flood Level (mAOD) @ 1Mac5788	Flood Level (mAOD) @ 1Mac5139	Calculated Flood Level at R132	Minimum Ground Level (mAOD)	Difference / Freeboard Allowance (m)
10% (1 in 10)	56.26	52.78	54.45	54.70	+0.25
1% (1 in 100)	56.67	52.98	54.75		-0.05
0.1% (1 in 1000)	56.94	53.11	54.95		-0.25

* Calculated level obtained by interpolation between nodes 1Mac5788 and 1Mac5139. Chainage adjusted based on apparent backing-up of flows upstream of the R132

As shown, The Proposed Scheme is at risk of flooding in the 1% and 0.1 AEP floods. This appears to be due to limited capacity of the culvert passing beneath the road which backs up flows upstream, with flows then overtopping the R132 to the south of the Cuckoo Stream. Flooding is predicted to a depth of approximately 0.25m and 0.05m in the 0.1%, and 1% AEP floods respectively.

The Proposed Scheme does not require modification of the existing river crossing of the Cuckoo Stream 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 Cuckoo Stream as a consequence of the Proposed Scheme.

Ch A03 + 400 – A03 + 825 Fluvial Flood Risk Assessment Summary:

- Between Ch A03 + 400 – A03 + 825, the Swords to City Centre CBC scheme is located in Flood Zone A;
- There is no change in flood risk to or arising from the Swords to City Centre CBC scheme from the Cuckoo Stream as existing ground levels are unchanged and no modifications are undertaken to the existing culvert structure over the watercourse;
- A Stage 3 FRA is not required as no works are proposed that will affect the hydraulic capacity of the existing culvert over the Cuckoo Stream;
- No change in ground levels are proposed meaning there will also be no change in the extent of fluvial flooding.
- A flood depth of 0.25m in the 0.1% AEP flood is also unlikely to affect the use of the road by buses

5.2.2 Swords Road (R132), Ch A04 + 450 – A04 + 900 associated with the Mayne River

The Stage 1 assessment indicated that Swords Road (R132), Ch A04 + 450 – A04 +900, is at risk of fluvial flooding. The Eastern CFRAM study modelled the Mayne River at its crossing with the Proposed Scheme at Swords Road (R132).

The predicted flood extent is shown in Figure 5.2.

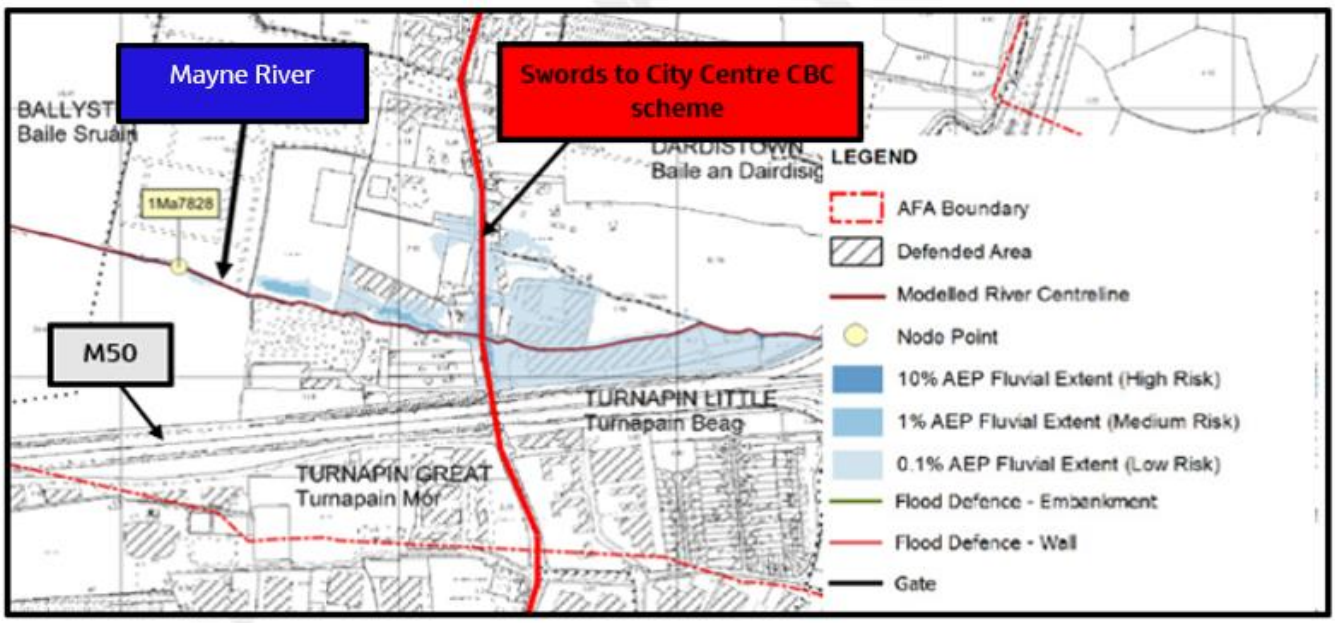


Figure 5.2 Eastern CFRAM study, Swords Road (R132), Ch A04 + 450 – A04 + 900

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 ground 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 A04 + 450 – A04 + 900.

Table 5.2 Mayne River Fluvial Flood Levels for the Proposed Scheme, Swords Road (R132), (Ch A04 + 450 – A04 + 900)

AEP Event	Flood Level (mAOD)	Minimum Ground Levels (mAOD)	Difference / Freeboard Allowance (m)
10% (1 in 10)	53.13	53.6	0.47
1% (1 in 100)	53.81		-0.21
0.1% (1 in 1000)	54.24		-0.64

* Values obtained from node 1Ma7828

As shown, Proposed Scheme is at risk of flooding in the 1% and 0.1 AEP floods. Flooding is predicted to a depth of approximately 0.64m and 0.21 m in the 0.1% and 1% AEP floods respectively.

The Proposed Scheme does not result in any change to existing ground levels within this reach. No works are undertaken either to the existing culvert which conveys the Mayne beneath the road. There will therefore be no impact on the existing risk or extent of flooding in this location from the Mayne River as a consequence of the scheme.

Ch A04 + 450 – A04 + 900 Fluvial Flood Risk Assessment Summary:

- Between Ch A04 + 450 – A04 +900, the Swords to City Centre CBC scheme is located in Flood Zone A;
- There is no change in flood risk to or arising from the Swords to City Centre CBC scheme from the Mayne River 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 river or predicted extent of flooding.
- No change in ground levels are proposed meaning there will also be no change in the extent of fluvial flooding.

5.2.3 Swords Road (R132), Ch A05 + 700 – A05 + 850 associated with the Santry River

The Stage 1 assessment indicated that Swords Road (R132), Ch A05 + 700 – A05 + 850 is at risk of fluvial flooding. The Eastern CFRAM study modelled the Santry River at its crossing with the Proposed Scheme at Swords Road (R132). The predicted flood extent is shown in Figure 5.3.

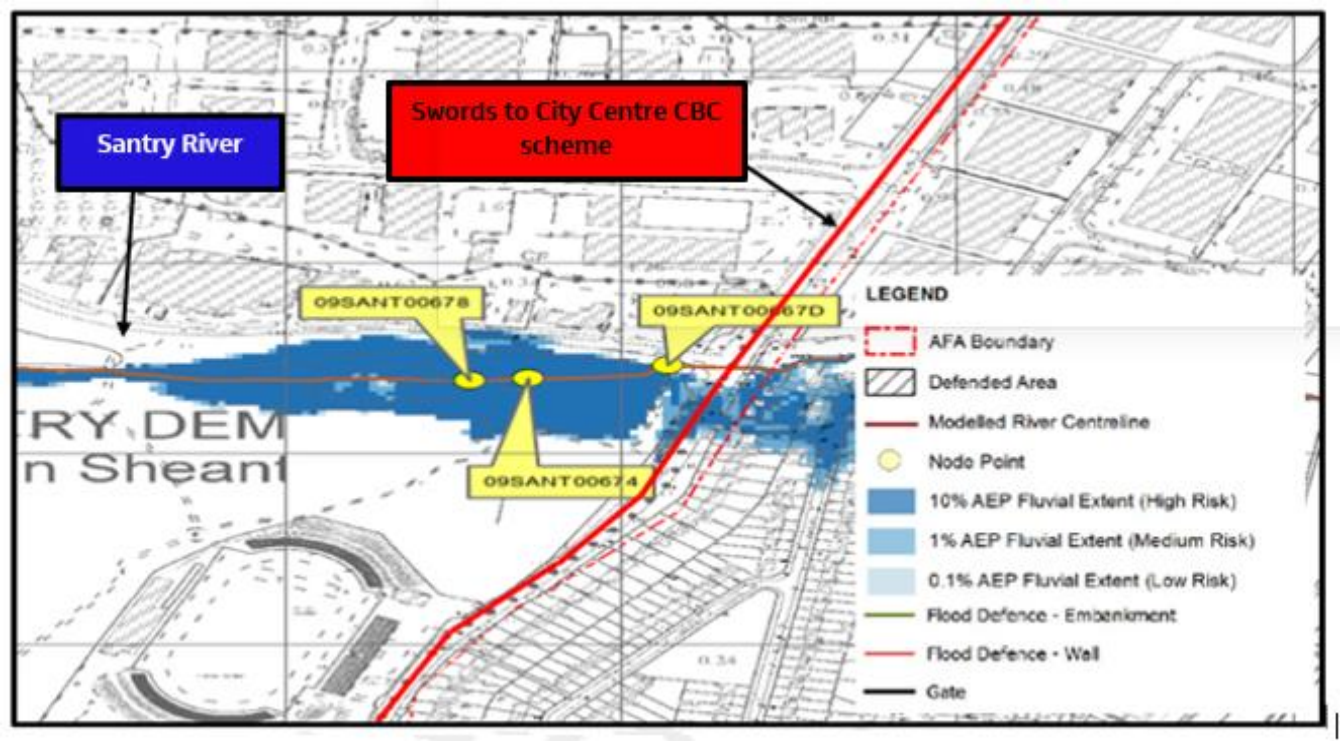


Figure 5.3 Eastern CFRAM study, Swords Road (R132), Ch A05 + 700 – A05 + 850

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 ground level for the Proposed Scheme ; refer to Table 5.3. It should be noted that the finished ground level is unchanged from the existing ground level between Ch A05 + 700 and A05 + 850.

Table 5.3 Santry River Fluvial Flood Levels for Proposed Scheme (Swords Road (R132), Ch A05 + 700 – A05 + 850)

AEP Event	Flood Level (mAOD)	Minimum Ground Levels (mAOD)	Difference / Freeboard Allowance (m)
10% (1 in 10)	47.91	47.70	-0.21
1% (1 in 100)	48.02		-0.32
0.1% (1 in 1000)	48.08		-0.38

* Values obtained from node 09SANT00667D

As shown, The Proposed Scheme is at risk of flooding in the 10%, 1% and 0.1 AEP floods. Flows are backed-up upstream of the road and then overtop it to the south of the Santry River. Flooding is predicted to a depth of approximately 0.38 m, 0.32m and 0.21m in the 0.1%, 1% and 10% AEP floods respectively. Use of the road with care should be practicable during the 10% AEP flood. The predicted flood depths for the 1% and 0.1% AEP floods could be prohibitive to light traffic due to the risk of floatation.

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.

It should be noted that as the nearest model node (09SANT00667D) is upstream of the culvert crossing, there is the potential flood depths on Swords Road (R132) to be overestimated. This is because hydraulic losses would be expected to be incurred as the river flows over the floodplain prior to inundating the road.

The Proposed Scheme does not result in any change to existing ground levels within this reach and nor works are undertaken to the existing culvert which conveys the Santry beneath the road. There will therefore be no impact on the existing risk or extent of flooding in this location from the Santry River as a consequence of the Proposed Scheme.

Ch A05 + 700 – A05 + 850 Fluvial Flood Risk Assessment Summary:

- Between Ch A05+700 – A05+850, the Swords to City Centre CBC scheme is located in Flood Zone A;
- There is no change in flood risk to or arising from the Swords to City Centre CBC scheme from the Santry River as existing ground levels are unchanged and no modifications are undertaken to the existing culvert conveying the river beneath the road;
- A Stage 3 FRA is not required as no works are proposed that will affect the hydraulic capacity of the existing culvert over Santry River;
- No change in ground levels are proposed, meaning there will also be no change in the extent of fluvial flooding.

5.2.4 Drumcondra Road Lower (N1), Ch A09 + 800 – A10 + 150 associated with the River Tolka

Frank Flood Bridge is an existing structure that carries the Proposed Scheme over the River Tolka; refer to Figure 5.4. The Proposed Scheme requires an increase in the road width over the Frank Flood Bridge. Increasing the width of the existing bridge is not practicable so a new footbridge immediately upstream of the existing bridge.

The proposed new bridge is located immediately upstream of the existing Frank Flood Bridge and spans the Area Benefitting from Defence (ABD) provided by the River Tolka Flood Relief Scheme (FRS); refer to Figure 5.4. The ABD is stated as providing a 1% AEP Standard of Protection. No property flooding has been recorded at this location since the construction of the Tolka River FRS.

The OPW do not have a current model of the Tolka River and existing flood maps are not considered to be reliable. A Stage 3 Flood Risk Assessment was therefore completed for the proposed bridge, which is described in Section 8 below.

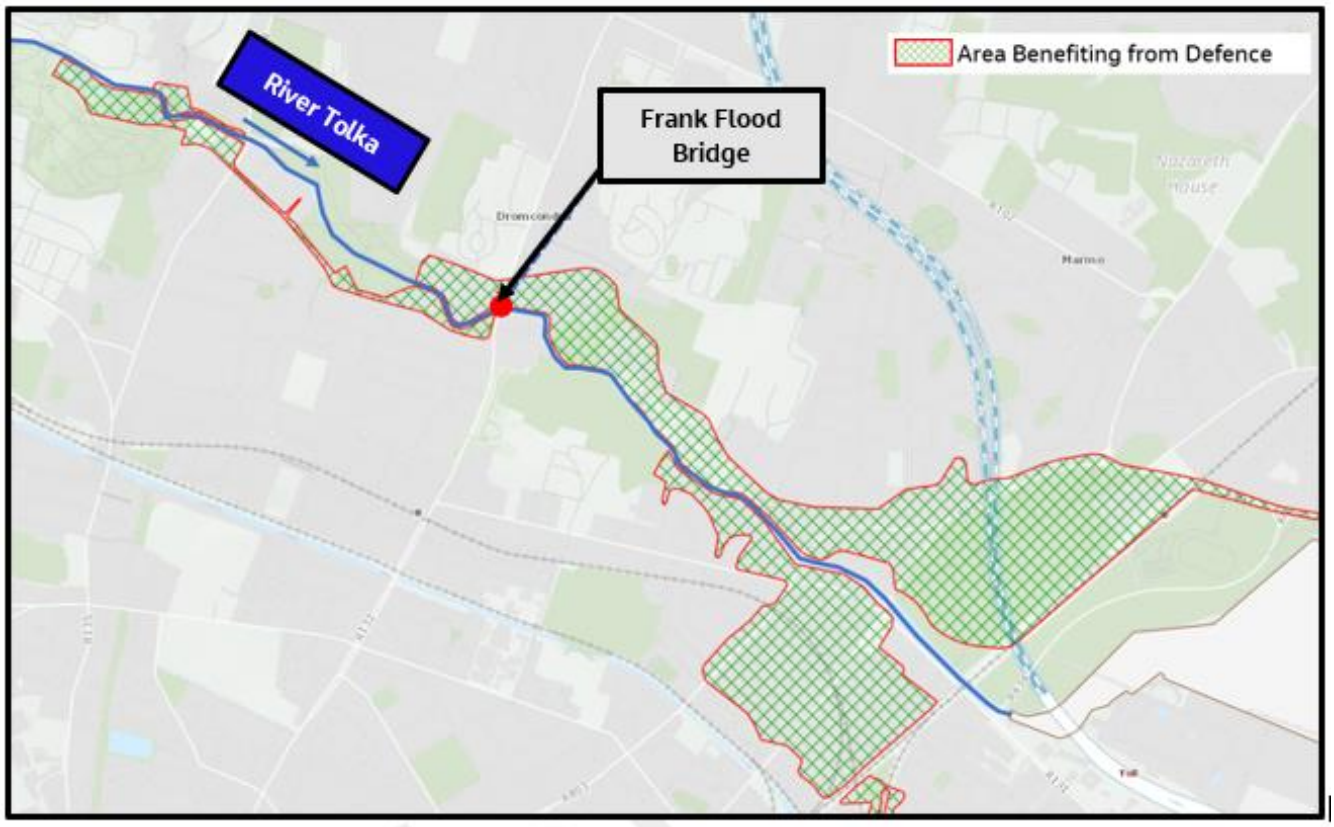


Figure 5.4 River Tolka FRS Area Benefitting from Defence (ABD).

5.2.5 Fluvial Flood Risk Summary

The Flood Risk Assessment identified parts of the Proposed Scheme are at risk from fluvial flooding from the Cuckoo Stream (0.1% and 1% AEP Floods), Mayne River (0.1% and 1% AEP Fluvial Extents) and Santry River (0.1%, 1% and 10% AEP Floods). With reference to the Flood Risk Management (FRM) Guidelines, these parts of the route will be identified as being located in Flood Zone A. As the Proposed Scheme comprise adjustment to an existing highway, no works can be reasonably undertaken to reduce the existing risk of flooding. There is no impact on flood risk from these watercourses as:

- No works are undertaken to the culverts which convey these watercourses beneath the road; and
- There is no change in the level of highway or ground levels within the areas at risk of flooding that might impact on flow conveyance or floodplain extent.

A Justification test will be completed for the Proposed Scheme to demonstrate compliance with the Justification test as set in the Flood Risk Management (FRM) Guidelines.

A new footbridge/cycle bridge will be constructed immediately upstream of the existing Frank Flood Bridge crossing of the Tolka River. A Stage 3 Flood Risk Assessment was completed for the proposed new bridge, which is described in Section 8 below.

5.3 Initial Pluvial Flood Risk Assessment

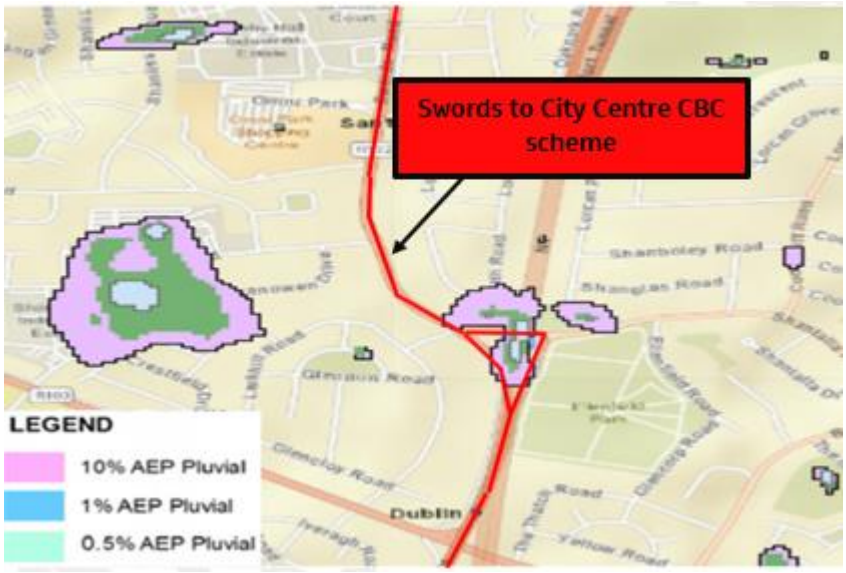
Pluvial flooding occurs during periods of heavy rainfall, when the rainfall rate is greater than the infiltration capacity. It is usually associated with high intensity rainfall events (typically > 30mm/h) resulting in overland flow

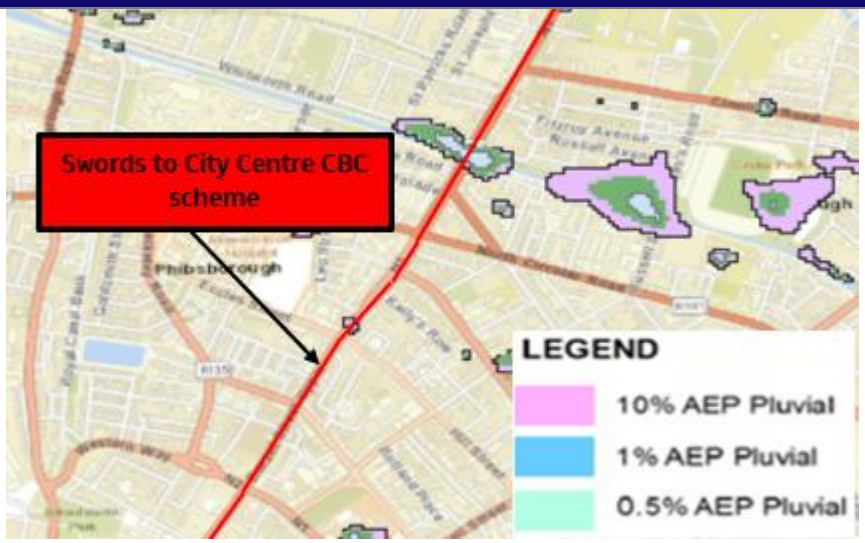
and ponding in depressions in the topography. In urban situations underground sewerage/drainage systems and surface watercourses may be overwhelmed.

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 5.4 shows sections of the Proposed Scheme at the Airport Roundabout, Santry bypass and the Royal Canal crossing that are at risk of pluvial flooding.

Table 5.4 Pluvial Flood Risk Areas

Location	Comments
	**Airport Roundabout**
	**Santry Bypass**

Location	Comments
	**N1/ Royal Canal crossing**

To reduce the risk of pluvial flooding would require extensive replacement and upgrade of the existing drainage network along the full extent and probably external to the Proposed Scheme. This is beyond the scope of the project.

In line with the Dublin City Development Plan SFRA and GDSDS, drainage from any new impermeable surfaces that are created by the scheme will be attenuated using Sustainable Drainage Systems (SuDS), based on guidance stated in *The SuDS Manual CIRIA 753*. These measures will ensure no net increase in run off from the Swords Scheme or additional flows being discharged to the existing drainage networks.

The existing risk of pluvial flooding to the Proposed Scheme is therefore unchanged. There is no change of use proposed as part of the Proposed Scheme 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 5.3. To reduce the risk of flooding from Artificial Drainage Systems would require extensive replacement and upgrade of the existing drainage network along the full extent and probably external to the Proposed Scheme. This is beyond the scope of the project.

As noted, in line with the Dublin City and Fingal Development Plans SFRAs, drainage from any new impermeable surfaces that are created by the scheme will be attenuated using Sustainable Drainage Systems (SuDS), based on guidance stated 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.

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. It is noted that there are no historic records of groundwater flooding along the Proposed Scheme. Ground conditions along the Proposed Scheme typically comprise underlying clay deposits. Such conditions reduce the likely of groundwater flooding as they provide a barrier to any rising water table.

It can therefore be concluded that the risk of flooding to the Proposed Scheme from groundwater is low.

5.6 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 5.5 summarises the predicted impacts of both scenarios on predicted sea levels, river flows and rainfall depths over the next 100-years.

Table 5.5 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%

The Mid-Range Future Scenario (MRFS) scenario is intended to represent the 'likely' future scenario based on a range of forecasts. The High-End Future Scenario (HEFS) represents a more extreme forecast that is at the upper end of accepted projections.

For the purposes of this flood risk assessment, the potential impact of climate change on flood risk to the Proposed Scheme has been made relative to the MRFS scenario as suggested in the recent document Ref PL 2/2014 issued by the Department of Housing, Local Government and Heritage. Table 5.6 summarises the potential flood risk impacts of climate change on the Proposed Scheme.

Table 5.6 Climate Change Impact

Source of Flooding	Likely Impacts of Climate Change	Discussion
Coastal	No change	There is no existing risk of coastal flooding to the Proposed Scheme. Future climate change will not result in potential flooding of the route from coastal sources.
Fluvial	Increase in some locations, see notes	Future climate change has the potential to increase the risk from fluvial flooding to the Proposed Scheme: • Site analysis showed that the Gaybrook has been diverted and presently, only a sweetening flow is maintained where it passes beneath the R132. Climate change is highly unlikely to result in flooding from the Gaybrook as the sweetening flow is very small. • As stated in Section 4, the existing road level exceeds the River Sluice 0.1% AEP flood level by 2.14m. Future climate will still not result in flooding of the road as the maximum increase in flood level during the 0.1% AEP flood from climate change is around 0.8m • The impacts of Climate Change on flood risk from the Cuckoo Stream, Mayne River and Santry River are discussed in further detail below.
Estuarine	No change	There is no risk of coastal flooding to the Proposed Scheme. As a consequence, there is also no risk of estuarine flooding.
Pluvial	No change (Proposed systems) Increase (Existing systems)	Future climate change will result in increased rainfall depths over the Proposed Scheme. The impacts are as follows: ▪ 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.

Future climate change has the potential to increase the risk of fluvial flooding to the Proposed Scheme from the Cuckoo Stream, Mayne River and Santry River. Table 5.7, Table 5.8 and Table 5.9 compare the maximum forecast

increase in fluvial flood levels with the effects of climate change against the proposed route ground levels. Note these ground levels are unchanged from the existing ground levels.

Table 5.7 Cuckoo Stream Fluvial Flood Levels with the effects of Climate Change for the Proposed Scheme. (Swords Road (R132), Ch A03 + 400 – A03 + 825)

AEP Event	Flood Level at R132	Minimum Ground Level (mAOD)	Difference / Freeboard Allowance (m)
10% (1 in 10)	54.51	54.70	0.19
1% (1 in 100)	54.80		-0.10
0.1% (1 in 1000)	55.00		-0.30

Table 5.8 Mayne River Fluvial Flood Levels with the effects of Climate Change for the Proposed Scheme, Swords Road (R132), (Ch A04 + 450 – A04 + 900)

AEP Event	Flood Level (mAOD)	Minimum Ground Levels (mAOD)	Difference / Freeboard Allowance (m)
10% (1 in 10)	53.31	53.60	0.29
1% (1 in 100)	53.94		-0.34
0.1% (1 in 1000)	54.37		-0.77

Table 5.9 Santry River Fluvial Flood Levels with the effects of Climate Change for Proposed Scheme (Swords Road (R132), Ch A05 + 700 – A05 + 850)

AEP Event	Flood Level (mAOD)	Minimum Ground Levels (mAOD)	Difference / Freeboard Allowance (m)
10% (1 in 10)	47.94	47.70	-0.24
1% (1 in 100)	48.05		-0.35
0.1% (1 in 1000)	48.11		-0.41

The impacts of climate change on flood risk for the three watercourses to the Proposed Scheme can be summarised as follows:

- **Cuckoo Stream:** climate change results in a 0.07m increase in flood levels, slightly increasing the depth of flooding for the 1% and 0.1% AEP floods. The Proposed Scheme is still not at risk during the 10% AEP flood. Owning to the marginal increase in water levels, this does not change the conclusions drawn for flood risk for the current situation.

- **Mayne River:** climate change results in a 0.18m increase in flood levels, increasing the depth of flooding for the 1% and 0.1% AEP floods. The Proposed Scheme is still not at risk during the 10% AEP flood.

- **Santry River:** climate change results in a 0.03m increase in flood levels, very slightly increasing the depth of flooding for the 10%, 1% and 0.1% AEP floods. Owning to the marginal increase in water levels, this does not change the conclusions drawn for flood risk for the current situation.

Climate change is only predicted to have noble impact on fluvial flood risk for the Mayne River. There is little impact on flood risk for the Santry River and Cuckoo Stream as the existing floodplain extent mitigates the additional flows from climate change.

As noted, the Proposed Scheme comprises modifications to an existing highway. It is not considered to be practicable to change the level of the highway to allow for the effects of future climate change. No works are proposed to change the road level or existing culvert whether the Proposed Scheme crosses either the Cuckoo

Stream or Mayne and Santry Rivers. The impacts of climate change are therefore considered to be appropriately addressed by the Proposed Scheme.

5.7 Summary of Flood Risk

The flood risk to the Proposed Scheme is summarised in Table 5.10 below.

Table 5.10 Summary of Flood Risk to Proposed Development

Flood Risk	Summary of Impact	Notes
Coastal	Low	The risk of coastal flooding is low
Fluvial	High	The following reaches of the Proposed Scheme are at risk from fluvial flooding: ▪ Swords Road (R132), Ch A03+550 – A03+825. Associated with the Cuckoo Stream. ▪ Swords Road (R132), Ch A04+450 – A05+250. Associated with the Mayne River. ▪ Swords Road (R132), Ch A05+700 – A05+800. Associated with the Santry River. As noted, the proposed works comprise extension to an existing highway, maintaining the existing level of flood risk. No change in ground level is proposed or any change to the existing culvert crossings. The risk of flooding. is considered to be acceptable.
Estuarine	Low	The risk of estuarine flooding is low.
Pluvial	Low	Parts of the scheme are at risk of pluvial flooding due to the limited capacity of the existing drainage network. Widescale improvement to the existing drainage network to alleviate this risk, which would likely extend beyond the Site Boundary, is considered to be beyond the scope of the Proposed Scheme. 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 to ensure no net increase in runoff from the Proposed Scheme.
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 to ensure no net increase in runoff from the Proposed Scheme.
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 Proposed Scheme is at risk from fluvial flooding from the Cuckoo Stream, Mayne River, Santry River and River Tolka. The Proposed Scheme could result in an increase in the risk of fluvial flooding if it were to:

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

Section 5 showed that no works are proposed to modify the level of the road or existing culvert where it crosses the Cuckoo Stream, Mayne River or Santry River. The scheme therefore has no impact on the conveyance of these existing watercourses, floodplain network and floodplain storage availability.

A new bridge crossing is required of the River Tolka which is assessed in Section 7.

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 not at risk from estuarine flooding. The Proposed Scheme therefore has not impact on estuarine flood risk.

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 Scheme increase the rainfall runoff rate?
- Will the Proposed Scheme 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 Strategy[1] 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), Greater 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.

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

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.

6.5 Impacts on Flooding from Artificial Drainage Systems

As noted, any increase in impermeable surface areas associated with the works is catered for in 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 using SuDS to ensure no change on existing runoff rates that are discharged to any existing drainage system or outfall to a watercourse. The SuDS measures have been designed in accordance with the CIRIA SuDS manual C753 (2015), Greater Dublin Regional Code of Practice and associated GDSDS Technical Documents.

The methodology to design the additional stormwater network and associated SuDS measures is set out in the overarching Drainage Strategy[2]. For the Proposed Scheme, 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 to 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 approach 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
Less Preferred Approach	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, SuDS measures are implemented to ensure no increase in the net rate of runoff from any new impermeable areas.

The proposed drainage design for the Proposed Scheme is presented in the drainage drawings showing new impermeable areas and their associated SuDS measures. All measures and their associated drainage networks have

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

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.

- **Section 1: Pinnock Hill Roundabout to Airside Junction**
  - A proposed underground geocellular tank of 150 m^3 under R132 (Ch A00+000 – Ch A00+050) will capture runoff from the additional 2965 m^2 of impermeable area through the existing surface network and two additional 225 mm pipes. The permissible outflow is 2l/s.
  - Where the kerbline is to be changed, existing gullies to be removed and to be replaced with side entry gullies on Swords Road (R132) (Ch A00+000 – Ch A00+650).

    Two new 225 mm surface water proposed pipes to drain 198 m^2 of impermeable areas along Nevinstown Lane (approx. 150 m east to Airside Junction). These pipes will provide 6m^3 of attenuation and will discharge to the existing surface water network. The existing rate of discharge to the surface network will be maintained with water stored in the new pipes as required.
  - Existing gullies to be removed and to be replaced with side entry gullies on the eastern side of Swords Road (R132) (Ch A00+750 – Ch A00+900).
  - 802 m^2 of new impermeable area to be drained by a new surface water drainage system running along the western side of Swords Road (R132), (Ch A00+750 – Ch A00+800). This water pipe system runs to a 25 m^3 swale to attenuate to the existing runoff rate. Existing gullies to be removed and to be replaced with side entry gullies.
  - A 2.4 m wide by 60m long swale is proposed south of the Airside Junction along Boroimhe Road. The swale will provide a storage volume of 56 m^3 with a permissible outflow of 2l/s.
  - A new 500 mm filter drain is proposed along the western side of Boroimhe Road (south of Airside Junction) collecting surface water from a proposed new 225 mm surface water pipe. Online attenuation is provided to ensure a maximum permissible outflow of 2l/s.

- **Section 2: Airside Junction to Northwood Avenue**
  - Existing gullies to be removed and replaced with side entry gullies and new network provided Swords Road (R132) (Ch A01+050 – Ch A01+500) to drain 463 m^2 of new impermeable area. Online attenuation to maintain existing
  - Two dry detention basins (167 m^3 and 120 m^3) are proposed on the western side of Swords Road (R132), (Ch A01+400 – Ch A01+550). The permissible outflow is 2l/s for both detention basins.
  - 2167 m^2 of additional impermeable area will be drained using additional side entry gullies. A new 225mm piped network will discharge flows to a bioretention zone for attenuation prior to discharge (Ch A01+650 – A02+150).
  - A bioretention zone (200 m^3) is proposed along Swords Road (R132), (Ch A01+800 – Ch A02+000) to cater for additional runoff within this reach.
  - New 225 mm surface water pipes with online attenuation to drain new impermeable areas along the western side of Swords Road (R132) and Stockhole Lane, (Ch A02+050 – Ch A02+150).
  - New 225 mm surface water pipes to drain 1328 m^2 of new impermeable areas along the western side of Swords Road (R132), (Ch A02+250 – Ch A02+650) to a proposed 465 m^3 underground attenuation tank.
  - An additional 802 m^2 of impermeable area along the eastern side of Swords Road (R132) (Ch 02+250 – Ch 02+650) will drain through an upgraded network n to a proposed underground attenuation tank prior to discharge.

- Proposed new oversized 500 mm pipes to drain 702 m^2 new impermeable areas along the western side of Swords Road (R132), (Ch A02+650 – Ch A02+900), providing an attenuation volume of 25m^3.
- A 375 mm oversized pipe has been proposed along the western side of Swords Road (R132), (Ch A03+050 – Ch A03+200) to attenuate runoff from an additional 259 m^2 of impermeable area. This pipe will discharge to existing surface water network.
- An additional 98m^2 of impermeable area on the western side of Swords Road (R132) will drain through new 225 mm pipes to a proposed dry detention basin prior to discharge (Ch A04+100 –
- 479 m^2 of new impermeable area along the either side of Swords Road (R132) (Ch A05+400 – A05+700) to be drained be attenuated by an oversized pipe prior to discharge to the existing surface network.
- Underground attenuation tank of 9 m^3 under the eastern side of Swords Road (R132), (Ch A04+700 – Ch A04+725). The permissible outflow is 2l/s.
- Additional 343 m^2 of impermeable area on the eastern side of Swords Road (R132) (Ch 04+700 – Ch 05+050) will be drained and attenuated through an oversized pipe network.
- Additional 1765 m^2 of impermeable area on either side of Swords Road (R132) (Ch 05+000 – Ch 05+400) will be drained and attenuated through an oversized pipe network.
- 557 m^2 of additional impermeable area on either side of the Swords Road (R132) (Ch A05+400 – A05+750) will be drained and attenuated through an oversized pipe network prior to outfall to the existing network.

- **Section 3: Northwood Avenue to Shantalla Road**
  - 564 m^2 of new impermeable area along the either side of Swords Road (R132) (Ch A05+700 – A06+100) to be drained and attenuated via a new oversized pipe network.
  - 606 m^2 of additional impermeable area on either side of Swords Road (R132) (Ch 06+300 – A06+500) will be drained by an upgraded network and attenuated by a proposed dry detention basin.
  - A 34 m^3 proposed dry detention basin is located at the eastern side of Swords Road (R132) (Ch A06+300 – Ch A06+350), capturing the additional impermeable area being discharged to the existing network. The permissible outflow is 2l/s.
  - A proposed oversized pipe on the western side of Swords Road (R132) (Ch 06+500 - Ch 06+750) will attenuate flows from the 510 m^2 of additional impermeable area.
  - 1003 m^2 of new impermeable area along the eastern side of Swords Road (R132) (Ch A06+750 – A07+000) to be drained and attenuated via a new oversized pipe network.
  - 193 m^2 of additional impermeable area along the eastern side of Swords Road (R132) (Ch A07+200 – Ch A07+400) to be drained and attenuated via a new oversized pipe network.

- **Section 4: Shantalla Road to Botanic Avenue**
  - 707 m^2 of new impermeable area along the eastern side of Swords Road (N1) (Ch A07+700 – A07+850) to be drained and attenuated via a new oversized pipe network.
  - 1665 m^2 of new impermeable area along either side of Swords Road (N1) (Ch A08+050 – A08+350) to be drained by a new storm water pipe and attenuated by a 97 m^3 dry detention basin (Ch A08+250).

- 428 m^2 of additional impermeable area along the eastern side of Swords Road (N1) (Ch A08+350 – Ch A08+800) to be drained and attenuated via a new oversized pipe network.
- 200 m^2 of new impermeable area along the eastern side of Swords Road (N1) (Ch A08+800 – A09+500) to be drained and attenuated via a new oversized pipe network.
- An oversized pipe has been proposed along the western side of Drumcondra Road Lower, (Ch A10+150 – Ch A10+500), collecting and attenuating runoff from 213 m^2 of additional impermeable area.

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 Scheme 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 Scheme is not at risk of coastal flooding.	No impact
Fluvial	No Impact	The is no impact on flooding for the Cuckoo Stream or Mayne and Santry Rivers. The flood risk impact of the new bridge on the River Tolka is assessed in Section 7.	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	Increase	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. Stage 3. Detailed Flood Risk Assessment Recommendations

7.1 Introduction

This section follows on from the findings in the Stage 2: Initial Flood Risk Assessment that the River Tolka will be subject to a Stage 3 Detailed Flood Risk Assessment to assess the fluvial flood risk and identify the requirement for any mitigation measures due to the construction of a new footbridge/cycle bridge immediately upstream of the existing Frank Flood Bridge.

Both qualitative and quantitative appraisals of potential flood risk to the Proposed Scheme is provided, assessing its potential impacts on flood risk elsewhere and of the effectiveness of any proposed mitigation measures.

Frank Flood Bridge (formerly known as Drumcondra Bridge, refer to Figure 7.1) is an existing structure that carries the preferred route corridor over the Tolka River. The proposed corridor is wider than the existing arrangement and consequently a proposed independent parallel footbridge bridge will be provided.

Figure 7.1 Image of Frank Flood Bridge

The existing bridge consists of a 3-span masonry arch with a total length of 19.48m and a width of 19.43m. The bridge was constructed in circa 1813 and is included in the Industrial Heritage Record. The new highways arrangement will result in the removal of the western footpath and the introduction of a northbound bus lane running adjacent to the western parapet. This will require strengthening of the spandrel wall to accommodate the increase in surcharge. Mitigation measures will also be introduced to reduce the risk of collision with the substandard western parapet.

The proposed bridge consists of a 50m, 2-span steel structure comprising central varying depth box girder with a tie down arrangement at the north of the structure. The span arrangement is governed by the flood plain on the south side of the river which needs remain open for high flow situations. North span will be 38m and south span

will be 12m. Distance between the deck soffit and the ground varies. A minimum clearance of 1.5m is provided at the abutments.

The bridge deck superstructure will be continuous. It will be supported on bearings at both abutments and central pier. Additionally, the superstructure will be connected to an independent pile group via mechanical pin connections.

The proposed vertical alignment for the new structure has been determined by the hydraulic considerations and visual impact to the existing bridge. The structural envelope is therefore defined by the crowns of the arches such that there is no constriction of flow and the top of the existing parapet as shown in Figure 7.2.

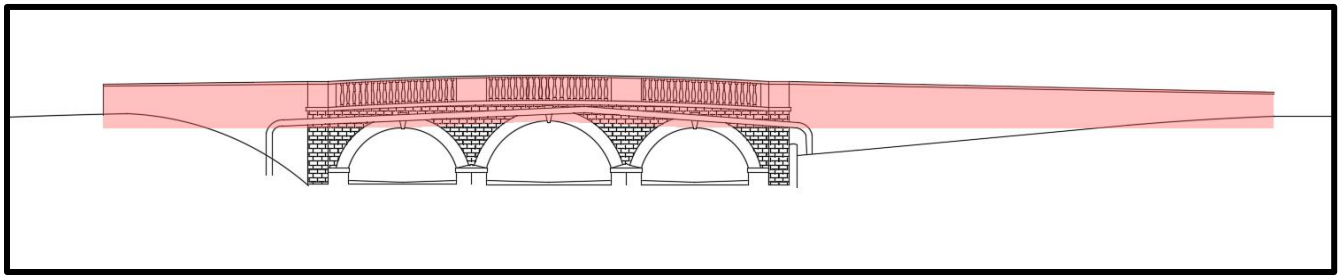


Figure 7.2 Structural Envelope for the Proposed Bridge

7.2 Flood History

There is history of flooding from the River Tolka in the vicinity of the Frank Flood Bridge dating back to 1880. The largest flood in the record occurred in 2002 with peak flow estimated to be 97m³/s. The River Tolka Flooding Study Final Report prepared for Dublin City Council (2003) indicates that a flood with a 1% Annual Exceedance Probability (AEP), or a 1-in-100 year flood event, has a peak flow of 90m³/s. Peak flows associated with the most significant floods on the Tolka are presented in Table 8.1 below

Table 7.1: Summary of peak flows from past flood events on Tolka River

Year	Peak Flows (m³/s)
1880	71
1954	85
1986	57
2002	97

The River Tolka Flood Relief Scheme (FRS) was constructed in 2008/09 to reduce flood risk. Upstream of the Frank Flood Bridge, the scheme includes flood defences along on both the north and south banks. The Area Benefitting from Defence (ABD) from the River Tolka FRS is shown in Figure 7.3 below. The ABD is stated as providing a 1% AEP Standard of Protection. No property flooding has been recorded at this location since the construction of the River Tolka FRS.

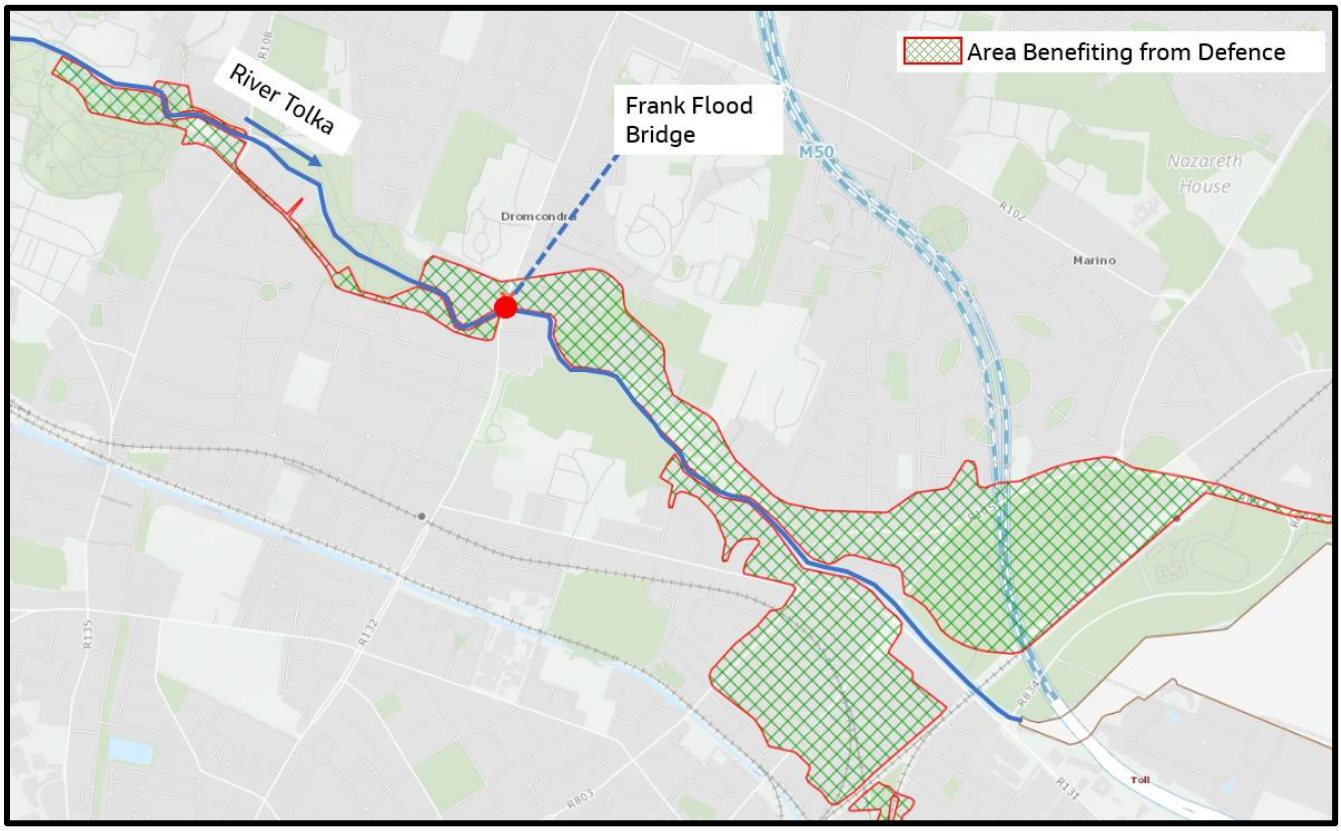


Figure 7.3 Area benefiting from defence

7.3 Qualitative Hydraulic Analysis

7.3.1 Existing Situation

Frank Flood Bridge comprises a three-span masonry bridge. The arches are approximately 4m wide and 6m high. The three arches have soffit levels of approximately 7.00m AOD, 7.33m AOD, and 7.01m AOD on the northern, middle, and southern arches respectively.

Frank Flood Bridge is a potential restriction to flow along the River Tolka with the effective flow area through the bridge approximately 60m^2. During flood conditions, flows can be backed-up by the bridge as the hydraulic capacity is limited by the three bridge arches.

Existing flood defences are located on the north and south bank of the River Tolka up stream of Frank Flood Bridge. The defences have a crest level of 7.77mOD and are stated to provide a 1% AEP standard of flood protection. The defences are designed to allow for backing-up of flows by the bridge during flood conditions.

7.3.2 Proposed new Bridge

The proposed works comprise construction of a two-opening bridge located approximately 3m upstream of the existing Frank Flood crossing. The existing Frank Flood Bridge is retained and not modified.

Further details for the proposed structure are shown in Figure 7.4 and Figure 7.5. Refer to structures drawings for the drawings of the layout and cross-section of the proposed bridge.

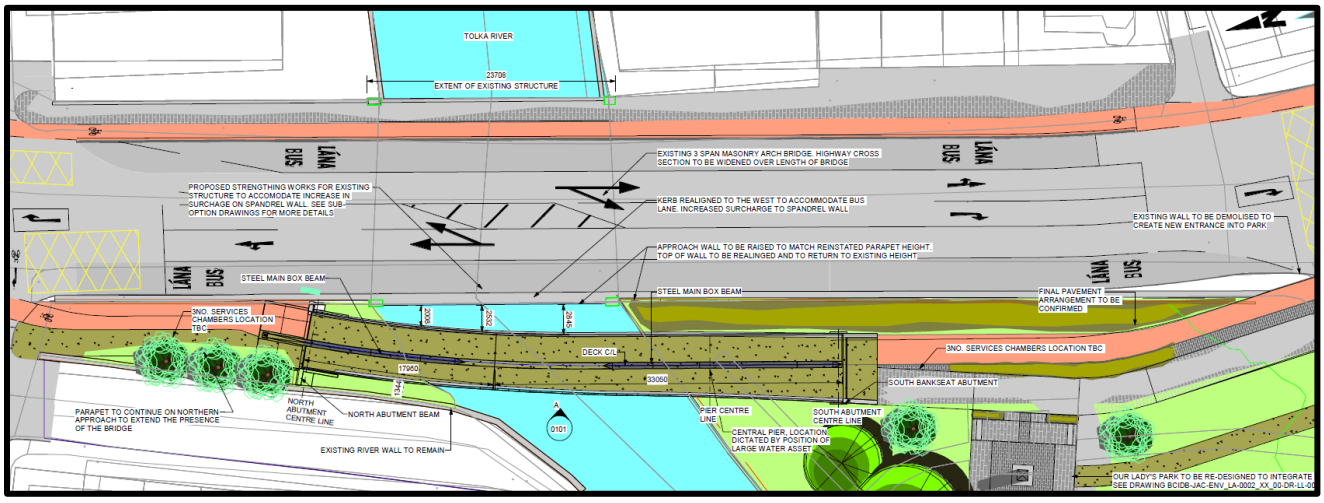


Figure 7.4 Layout for the Proposed bridge

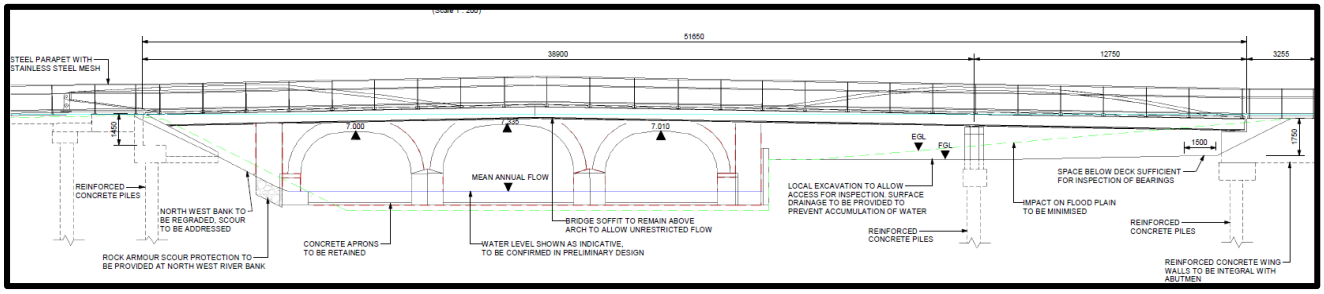


Figure 7.5 Cross Section for the Proposed bridge

The key hydraulic design features for the new bridge are as follows:

- The proposed soffit level is 7.421m OD, 7.568m OD, and 7.489m OD above the north, centre, and south arches respectively. The design of the bridge soffit has been limited by the requirement for the bridge to meet existing road/pavement levels on the north/south bank where it meets the R132. The proposed soffit levels still exceed the existing maximum soffit level of Frank Flood Bridge of 7.33mOD

- The effective flow area through the bridge is approximately 120m^2. This compares to an effective flow area through the existing Frank Flood Bridge of approximately 60m^2.

- The floodplain beneath the proposed bridge span on the south bank is to be lowered. This will provide additional floodplain storage and will increase the effective channel section flow area immediately upstream of Frank Flood Bridge by approximately 13m^2.

- The existing flood defence level of 7.77mOD on both banks of the river will be maintained by the new bridge.

The proposed bridge should not impact on flood levels and will have only a marginal impact on the existing hydraulic channel characteristics of the River Tolka. This is because the flow area and soffit levels of the existing Frank Flood Bridge are significantly less and below those proposed for the new bridge respectively. This will mean that in a flood, flows will continue to be backed-up by the existing Frank Flood Bridge when its existing soffit levels are reached before the new bridge could have any hydraulic effect.

Lowering of the floodplain beneath the new bridge on the south bank has the potential to reduce flood levels upstream of the bridge. Any change in flood levels upstream will be relatively minor however, as flood levels will continue to be controlled by the hydraulic capacity and backwater effect of Frank Flood Bridge. The overall

increase in floodplain storage provided by the floodplain lowering works is also small in the context of typical flood volumes on the River Tolka.

There will be no change in flood levels downstream of Frank Flood Bridge. This is because flows passing downstream will be continued to be controlled by the existing capacity of Frank Flood Bridge.

There will be no change in the standard of flood protection provided by the existing flood defences. This is because the height of the defences was determined based on the hydraulic capacity of the existing Frank Flood bridge. As noted, flood levels will continue to be determined by the existing capacity of Frank Flood Bridge following completion of the new crossing.

7.4 Quantitative Hydraulic Analysis

To verify the findings of the qualitative analysis, a hydraulic model of the River Tolka was built to assess the existing (baseline) and the post-development flood conditions along a 1.1 km in length of the River Tolka upstream and downstream of the Frank Flood Bridge.

Cross section data was obtained from the OPW and a 1-D model was constructed using Flood Modeller. As the model was solely used to assessed the hydraulic impacts of the new bridge, all flows were assumed to be contained in-bank as defined by the channel survey extents. Figure 7.6 provides an overview of the extents of the model and cross section locations.

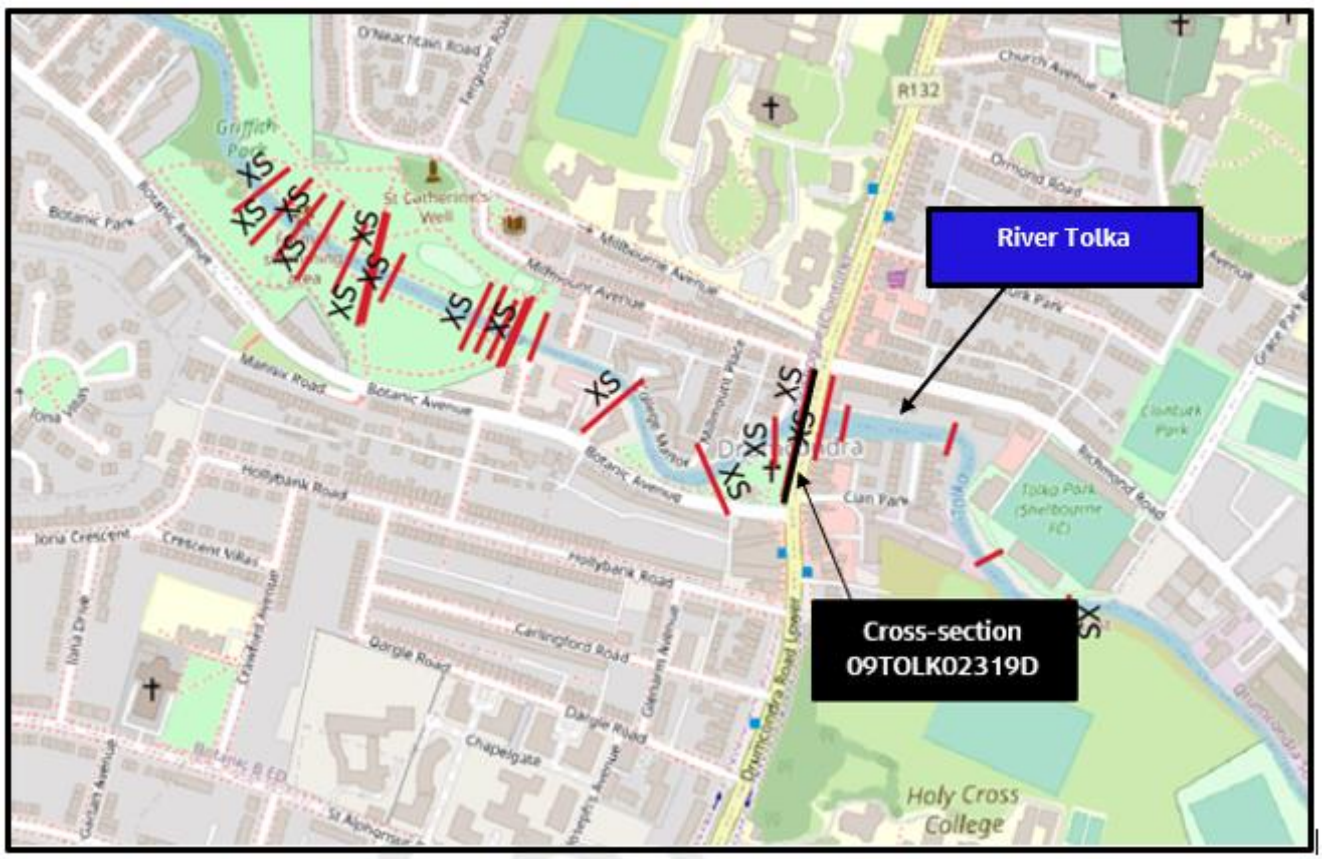


Figure 7.6 Cross sections incorporated into the model.

Hydraulic roughness, or friction, is represented by Manning's roughness coefficient 'n' in hydraulic models. The value of 'n' accounts for a range of factors that influence the overall roughness, either in the channel or across the

floodplain. Factors included within the overall evaluation of Manning's roughness coefficient 'n' include bed materials and their size, vegetation, surface irregularities, channel bed forms, erosional and depositional features, channel sinuosity and obstructions. They usually range from 0.025 (for relatively smooth surfaces and un-vegetated channels) up to 0.090 for out of bank flows across woodlands. The Manning's roughness coefficient 'n' for the River Tolka was taken to be between 0.025 and 0.04 in the river channel (depending on the existence of a bridge structure) and 0.06 in the floodplain.

The model was run in steady state for the flow scenarios listed in Table 7.1. A Non-Critical Depth Boundary was applied as the downstream boundary condition. A sensitivity analysis was completed to confirm that the downstream boundary did not influence water levels at Frank Flood Bridge.

7.4.1 Impact of the proposed works on fluvial flood risk

Four flow scenarios were simulated to assess the impact of the proposed new bridge on peak water levels. These scenarios included:

- A flow of 90m3/s which equates to the 1% AEP design flow using for the River Tolka FRS
- A flow of 97m3/s which equates to the largest gauged flow recorded in 2002.
- A flow of 120m3/s applied as a 20% increase on the 2002 flow for the pruposes of a a sensitivity assessment.

Outputs from the model for the current situation and following construction of the proposed bridge are presented in Table 7.1. The results are presented solely for Section 09TOLK02319D, located immediately upstream of the new bridge where any impacts would be greatest.

Table 7.1 Peak water levels for the current situation

Flow Scenario (m^3/s)	Peak Water Level (mAOD)		Difference
	Current situation	After the construction of the new bridge	
80	6.27	6.27	0.00
90	6.52	6.52	0.00
97	6.70	6.70	0.00
120	7.32	7.32	0.00

The model results confirm that the proposed new bridge has no impact on flood levels up to a flow of 120 m^3/s. This is to be expected as the hydraulic capacity of the proposed bridge is significantly larger that the hydraulic capacity of the existing bridge that is located downstream. The model therefore confirms the findings of the qualitative analysis.

7.4.2 Impact of the proposed works on fluvial flood risk

The OPW were consulted on the proposed design. The OPW did not state any preference for the proposed bridge form and advised that its main requirement was to ensure that the bridge has sufficient conveyance capacity to convey the design flow with 300mm freeboard allowance. The design of the proposed bridge with its soffit levels exceeding that of the existing bridge was noted as the existing bridge will to determine flood levels in this location.

A fully completed Section 50 application will be required for the new crossing subject to acceptance of the scheme's planning application.

7.5 Stage 3 Assessment Conclusion

Conceptually it was shown that the proposed bridge will not impact on flood levels and will have only a marginal impact on the existing hydraulic channel characteristics of the Tolka River. This is because the flow area and soffit levels of the existing Frank Flood Bridge are significantly less and below those proposed for the new bridge respectively. This will mean that in a flood, flows will continue to be backed-up by the existing Frank Flood Bridge when its existing soffit levels are reached before the new bridge could have any hydraulic effect.

Lowering of the floodplain beneath the new bridge on the south bank will also create additional floodplain storage upstream of the existing bridge. This will not impact flood levels however, as these will continue to be controlled by the hydraulic capacity and backwater effect of Frank Flood Bridge. The overall increase in floodplain storage provided by the floodplain lowering works is also small in the context of typical flood volumes on the Tolka River.

There will be no change in flood levels downstream of Frank Flood Bridge. This is because flows passing downstream will be continued to be controlled by the existing capacity of Frank Flood Bridge.

There will be no change in the standard of flood protection provided by the existing flood defences. This is because the height of the defences was determined based on the hydraulic capacity of the existing Frank Flood Bridge. As noted, flood levels will continue to be determined by the existing capacity of Frank Flood Bridge following completion of the new crossing.

A hydraulic model was constructed and, with a flow of 120m3/s, which significantly exceeds the design flow for the River Tolka FRS, the proposed bridge has no impact on flood levels.

8. Flood Risk Management and Evaluation

8.1 The Sequential Approach to Development Planning

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 Scheme 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 issues 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.

8.1.1 Justification Test

'The Planning System and Flood Risk Management, Guidelines for Planning Authorities' (2009)', 5.15, Box 5.1 sets out the criteria for the Justification Test and is replicated below in Figure 8.1. An assessment of the Proposed Scheme against these criteria is presented in Table 8.1.

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.

Figure 8.1 Justification Test Criteria

Table 8.1 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. Frank Flood Bridge (formerly known as Drumcondra Bridge) is an existing structure that carries the preferred route corridor over the Tolka River. The proposed corridor is wider than the existing arrangement and consequently a proposed independent parallel footbridge bridge will be provided. 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.	As shown in Sections 5, 6 and 7, 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.	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. 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. SuDS measures implemented as part of the scheme will also improve the quality of runoff, delivering a net benefit to the environment.	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.	As stated in Sections 5 and 6, the development 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	The Proposed Scheme meets the objectives set out in the Dublin City Development Plan 2016-2022. as it forms a key part of achieving the required rate of sustainable	Yes

Criteria to be satisfied	Justification	Criteria Met
objectives in relation to development of good urban design and vibrant and active streetscapes.	urban growth by promoting active travel and public transport.	

Whilst a Justification Test is not considered to be necessary for the Proposed Scheme , the Proposed Scheme 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)'.

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 Cuckoo Stream, Mayne River, Santry River and River Tolka to parts of the scheme.

Pluvial Flooding

There is a risk of pluvial flooding along the entire Swords 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 Swords 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 Cuckoo Stream, Mayne River, Santry River and River Tolka.

The Proposed Scheme will not affect any of the existing bridges or culverts on the Cuckoo Stream, Mayne River and Santry River where they cross the scheme. In these locations, the proposed works typically comprise reorientation 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 Cuckoo Stream, Mayne River or Santry River to reduce the risk of fluvial flooding from the watercourses. No works are undertaken to change the level of the road or adjacent lands that will impact the floodplain and any associated storage for any of these watercourses.

At the existing Frank Flood Bridge crossing of the River Tolka, a new bridge has been proposed upstream of of the existing crossing (with the existing bridge retained). Qualitative and quantitative analysis completed for a Stage 3 Assessment carried show that the proposed bridge will not impact on flood levels for the River Tolka. This is because the flow area and soffit levels of the existing Frank Flood Bridge are significantly less and below those proposed for the new bridge respectively. This will mean that in a flood, flows will continue to be backed-up by the existing Frank Flood Bridge when its existing soffit levels are reached before the new bridge could have any hydraulic effect.

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.

Increased rainfalls 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.

The impact of climate change on coastal flooding is not applicable to the Proposed Scheme as the current and future risk is low.

A Stage 3 Detailed Risk Assessment was considered necessary at the Frank Flood Bridge over Tolka River due to the construction of a new bridge upstream of it. Results show that there will be no change in flood risk patterns or processes as consequence of the Proposed Scheme.

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	√	Dublin City Development Plan 2016-2022 (Strategic Flood Risk Assessment) and Fingal County Council Development Plan 2017-2023.
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 07 April 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

Node Label	Water Level (mOD) 10% AEP	Flow (m3/s) 10% AEP	Water Level (mOD) 1% AEP	Flow (m3/s) 1% AEP	Water Level (mOD) 0.1% AEP	Flow (m3/s) 0.1% AEP
2Saaa1428	22.4	0.27	23.15	0.46	23.22	0.8
01STRE00970	15.51	0.28	15.66	0.41	15.79	0.48
3Ga5126	41.87	0.14	42.13	0.14	42.37	0.14
3Ga3779	23.83	0.05	24.08	0.11	25.57	0.21
3Ga2074	14.89	2.72	15.03	4.4	15.11	6.12
3Ga1525	10.71	3.48	10.9	6.03	11.02	8.63
3Gab213	28	0.2	28	0.2	28.07	0.2
4Wab561	0	0	0	0	0	0

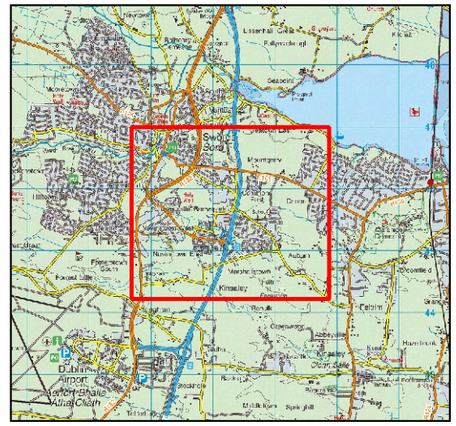
318000 318500 319000 319500 320000 320500

246500 246000 245500 245000 244500

SWORDS GLEBE
Gleib Shoird
TOWN
Páirc
SWORDS DEMESNE
Dímeín Shoird
MOUN
Cnocá
MOUNTGORRY
Cnocán Ghofraidh
MILTONSFIEL
Páirceanna Bl
YELLOW WALL
Na Ballaí Bui
4Wab561
COMMONS E
An Coimín Th
CREMONA
Cremona
CROWSCASTLE
Caisleán na bPréachán
3Gab213
3Ga3779
DRINAN
Draighnean
3Ga2074
NEVINST
Baile Nao
3Ga5126
NEVINSTOWN EAST
Baile Naoimhín Thoir
TH
n Theas
DRINAN
Draighnean
AUBURN
Auburn
3Ga1525
MARSHALLSTOWN
Baile an Mharascalaigh
2Saaa1428
01STRE00970
FELTRIM
Faoldroim

250 0 250 500 750 1000 Meters

Location Plan:



LEGEND

- AFA Boundary
- Defended Area
- Modelled River Centreline
- Node Point
- 10% AEP Fluvial Extent (High Risk)
- 1% AEP Fluvial Extent (Medium Risk)
- 0.1% AEP Fluvial Extent (Low Risk)
- Flood Defence - Embankment
- Flood Defence - Wall
- Gate
- NODE123 — Node Label
- x.x% AEP — Standard of Protection of Flood Defence

IMPORTANT USER NOTE:
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OPW
Oifig na nOibreacha Poiblí
The Office of Public Works

The Office of Public Works
Jonathan Swift Street
Trim
Co. Meath

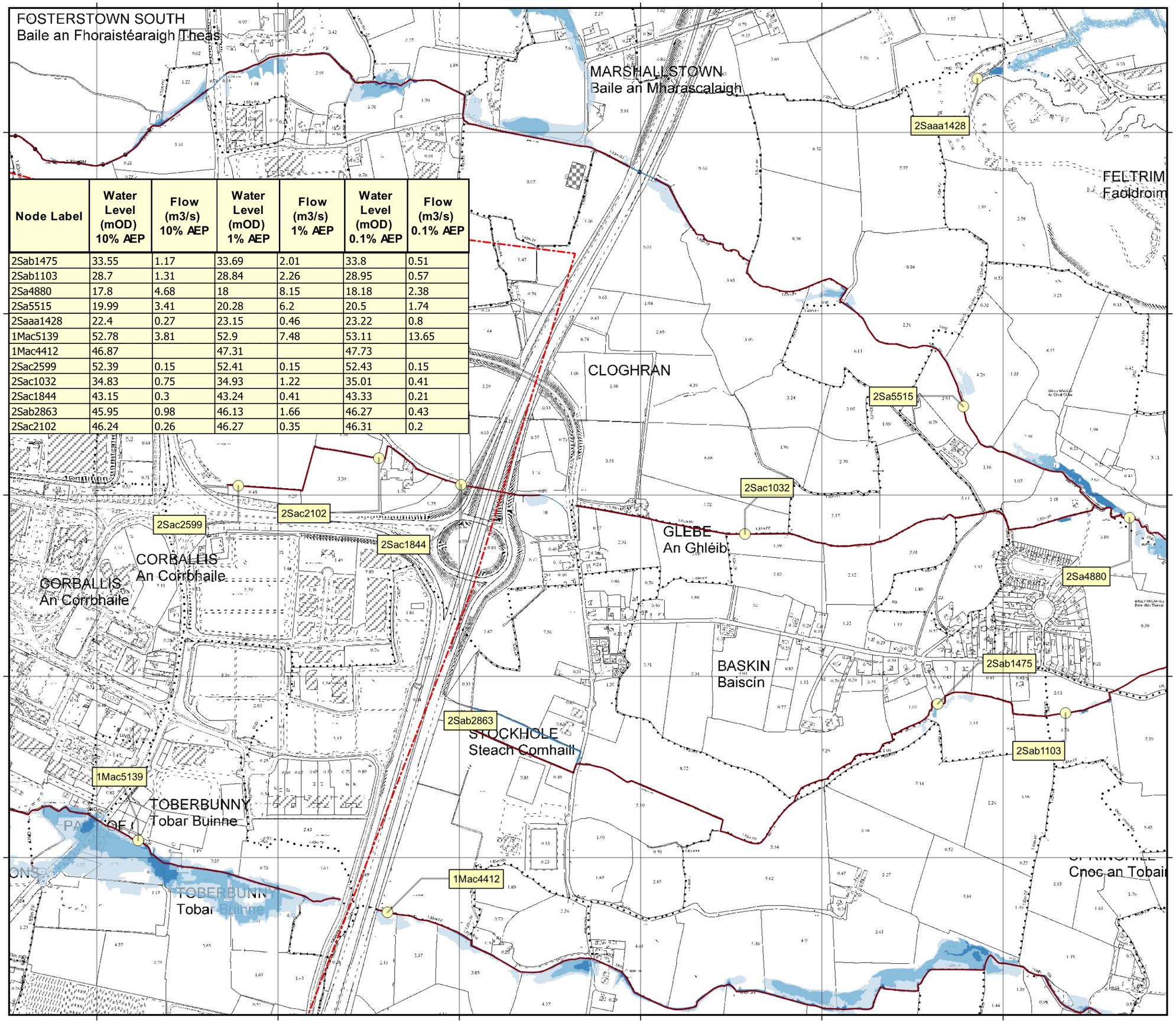
Project:
FINGAL EAST MEATH FRAM STUDY

Map: **SWORDS FLUVIAL EXTENT MAP**

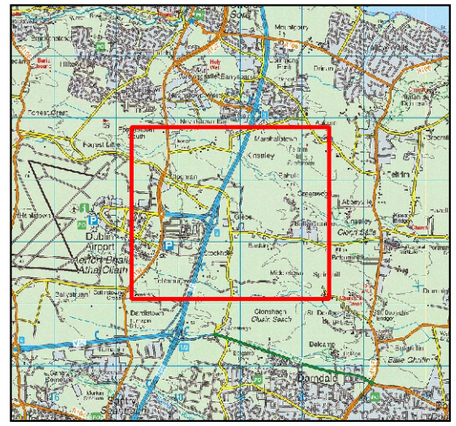
Map Type:	EXTENT		
Source:	FLUVIAL		
Map Area:	HPW		
Scenario:	CURRENT		
Drawn by:	IH	Date:	Mar - 2019
Checked by:	TC	Date:	Mar - 2019
Approved by:	GP	Date:	Mar - 2019

Map No.: E08SWO_EXFCD_F1_34
Revision: F1
Map Scale: 1:10000 Plot Scale: 1:1 @ A3

Node Label	Water Level (mOD) 10% AEP	Flow (m3/s) 10% AEP	Water Level (mOD) 1% AEP	Flow (m3/s) 1% AEP	Water Level (mOD) 0.1% AEP	Flow (m3/s) 0.1% AEP
2Sab1475	33.55	1.17	33.69	2.01	33.8	0.51
2Sab1103	28.7	1.31	28.84	2.26	28.95	0.57
2Sa4880	17.8	4.68	18	8.15	18.18	2.38
2Sa5515	19.99	3.41	20.28	6.2	20.5	1.74
2Saaa1428	22.4	0.27	23.15	0.46	23.22	0.8
1Mac5139	52.78	3.81	52.9	7.48	53.11	13.65
1Mac4412	46.87		47.31		47.73	
2Sac2599	52.39	0.15	52.41	0.15	52.43	0.15
2Sac1032	34.83	0.75	34.93	1.22	35.01	0.41
2Sac1844	43.15	0.3	43.24	0.41	43.33	0.21
2Sab2863	45.95	0.98	46.13	1.66	46.27	0.43
2Sac2102	46.24	0.26	46.27	0.35	46.31	0.2



Location Plan:



LEGEND

- AFA Boundary
- Defended Area
- Modelled River Centreline
- Node Point
- 10% AEP Fluvial Extent (High Risk)
- 1% AEP Fluvial Extent (Medium Risk)
- 0.1% AEP Fluvial Extent (Low Risk)
- Flood Defence - Embankment
- Flood Defence - Wall
- Gate
- NODE123 — Node Label
- x.x% AEP — Standard of Protection of Flood Defence

IMPORTANT USER NOTE:
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Jonathan Swift Street
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Project:
FINGAL EAST MEATH FRAM STUDY

Map: **BELCAMP PARK FLUVIAL EXTENT MAP**

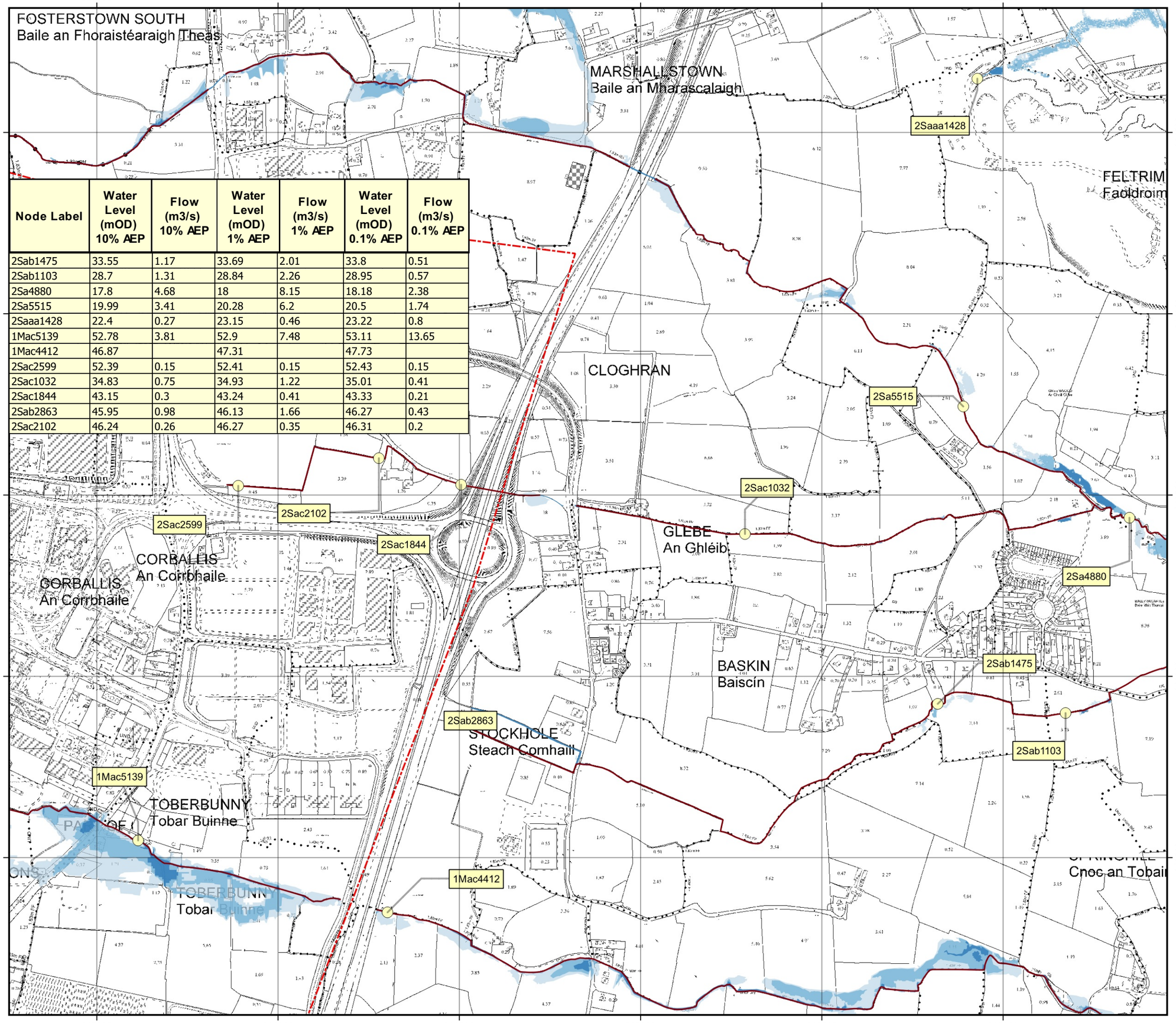
Map Type:	EXTENT		
Source:	FLUVIAL		
Map Area:	HPW		
Scenario:	CURRENT		
Drawn by:	IH	Date:	Mar - 2019
Checked by:	TC	Date:	Mar - 2019
Approved by:	GP	Date:	Mar - 2019

Map No.: E09BEL_EXFCD_F1_37

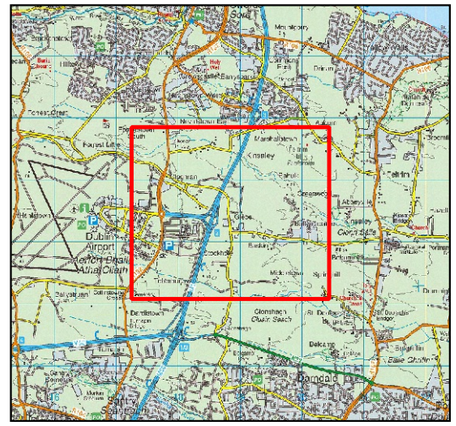
Revision: F1

Map Scale: 1:10000 Plot Scale: 1:1 @ A3

Node Label	Water Level (mOD) 10% AEP	Flow (m3/s) 10% AEP	Water Level (mOD) 1% AEP	Flow (m3/s) 1% AEP	Water Level (mOD) 0.1% AEP	Flow (m3/s) 0.1% AEP
2Sab1475	33.55	1.17	33.69	2.01	33.8	0.51
2Sab1103	28.7	1.31	28.84	2.26	28.95	0.57
2Sa4880	17.8	4.68	18	8.15	18.18	2.38
2Sa5515	19.99	3.41	20.28	6.2	20.5	1.74
2Saaa1428	22.4	0.27	23.15	0.46	23.22	0.8
1Mac5139	52.78	3.81	52.9	7.48	53.11	13.65
1Mac4412	46.87		47.31		47.73	
2Sac2599	52.39	0.15	52.41	0.15	52.43	0.15
2Sac1032	34.83	0.75	34.93	1.22	35.01	0.41
2Sac1844	43.15	0.3	43.24	0.41	43.33	0.21
2Sab2863	45.95	0.98	46.13	1.66	46.27	0.43
2Sac2102	46.24	0.26	46.27	0.35	46.31	0.2



Location Plan:



LEGEND

- AFA Boundary
- Defended Area
- Modelled River Centreline
- Node Point
- 10% AEP Fluvial Extent (High Risk)
- 1% AEP Fluvial Extent (Medium Risk)
- 0.1% AEP Fluvial Extent (Low Risk)
- Flood Defence - Embankment
- Flood Defence - Wall
- Gate
- NODE123 — Node Label
- x.x% AEP — Standard of Protection of Flood Defence

IMPORTANT USER NOTE:
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Project:
FINGAL EAST MEATH FRAM STUDY

Map: **BELCAMP PARK FLUVIAL EXTENT MAP**

Map Type:	EXTENT		
Source:	FLUVIAL		
Map Area:	HPW		
Scenario:	CURRENT		
Drawn by:	IH	Date:	Mar - 2019
Checked by:	TC	Date:	Mar - 2019
Approved by:	GP	Date:	Mar - 2019

Map No.: E09BEL_EXFCD_F1_37

Revision: F1

Map Scale: 1:10000 Plot Scale: 1:1 @ A3

316000 316500 317000 317500 318000 318500 319000

243000 242500 242000 241500 241000

COLLINSTOWN
Báile Choilín

CORBALLIS
An Corrbhaile

CORBALLIS
An Corrbhaile

STOCKHOLE
Steach Comhaill

1Mac5788

1Mac5139

TOBERBUNNY
Tobar Buinne

COMMONS

TOBERBUNNY
Tobar Buinne

1Mac4412

1Mae298

BALLYSTRUAN
Baile Sruáin

1Ma7828

1Ma8373

DARDISTOWN
Baile an Dairdisigh

TURNAPIN LITTLE
Turnapain Beag

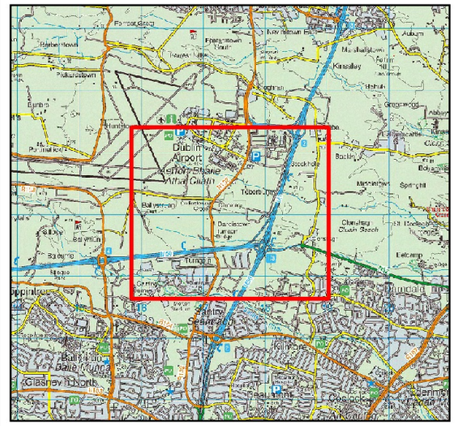
TURNAPIN GREAT
Turnapain Mór

Node Label	Water Level (mOD) 10% AEP	Flow (m3/s) 10% AEP	Water Level (mOD) 1% AEP	Flow (m3/s) 1% AEP	Water Level (mOD) 0.1% AEP	Flow (m3/s) 0.1% AEP
1Ma8373	59.53	0.15	59.80	0.15	60.09	0.15
1Ma7828	55.87	2.65	56.14	4.63	56.39	7.80
1Mac5788	56.26	5.06	56.67	9.30	56.94	16.07
1Mac5139	52.78	3.81	52.90	7.48	53.11	13.65
1Mac4412	46.87		47.31		47.73	
1Mae298	58.90	0.15	59.03	0.15	59.16	0.15

316000 316500 317000 317500 318000 318500 319000

250 0 250 500 750 1000 Meters

Location Plan:



LEGEND

- AFA Boundary
- Defended Area
- Modelled River Centreline
- Node Point
- 10% AEP Fluvial Extent (High Risk)
- 1% AEP Fluvial Extent (Medium Risk)
- 0.1% AEP Fluvial Extent (Low Risk)
- Flood Defence - Embankment
- Flood Defence - Wall
- Gate
- NODE123 — Node Label
- x.x% AEP — Standard of Protection of Flood Defence

IMPORTANT USER NOTE:
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Co. Meath

Project:
FINGAL EAST MEATH FRAM STUDY

Map: **Mayne Model**
FLUVIAL FLOOD EXTENT MAP

Map Type:	EXTENT		
Source:	FLUVIAL		
Map Area:	HPW		
Scenario:	CURRENT		
Drawn by:	IH	Date:	Dec - 2017
Checked by:	JM	Date:	Dec - 2017
Approved by:	JM	Date:	Dec - 2017

Map No.:
MAY/HPW/EXT/CURS/001

Revision: F1

Map Scale: 1:10,000 Plot Scale: 1:1 @ A3

Node Label	Water Level (OD) 10% AEP	Flow (m³/s) 10% AEP	Water Level (OD) 1% AEP	Flow (m³/s) 1% AEP	Water Level (OD) 0.1% AEP	Flow (m³/s) 0.1% AEP
09SANT00767	51.38	2.57	51.59	3.99	51.70	5.17
09SANT00713II	49.31	2.88	49.44	4.56	49.54	6.21
09SANT00678	47.91	3.03	48.02	4.91	48.09	6.85
09SANT00674	47.91	3.05	48.02	4.97	48.08	6.95
09SANT00667D	47.91	3.03	48.01	3.06	48.08	3.06
09SANT00616I	42.94	3.46	43.18	5.84	43.48	8.52

Turnapain Beag

TURNAPIN GREAT
Turnapain Mór

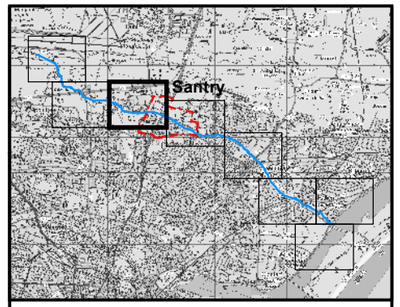
SANTRY DEM
Dímein Sheant

09SANT00767
09SANT00713I!
09SANT00678
09SANT00674
09SANT00667D
09SANT00616I

316200 316400 316600 316800 317000 317200 317400 317600

241400 241200 241000 240800 240600 240400

0 50 100 200 300 400 500 Metres



IMPORTANT USER NOTE:
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Legend

- 10% Fluvial AEP Event
- 1% Fluvial AEP Event
- 0.1% Fluvial AEP Event
- Modelled River Centreline
- AFA Extents
- Node Point
- Node ID Node Label

FINAL

REV:	NOTE:	DATE:
01	Amendment to flood zones to include Raheny AFA	15/12/17

EASTERN CFRAM STUDY
CATCHMENT FLOOD RISK ASSESSMENT AND MANAGEMENT

OPW
The Office of Public Works
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Trim
Co Meath

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Elmwood House
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Belfast
BT12 6RZ
T +44(0) 28 90 667914
F +44(0) 28 90 668286
W www.rpsgroup.com
E ireland@rpsgroup.com

Map:
Santry Fluvial Flood Extents

Map Type:	EXTENT	
Source:	FLUVIAL	
Map Area:	HPW	
Scenario:	CURRENT	
Drawn By :	C.C.	Date : 15 December 2017
Checked By :	A.S.	Date : 15 December 2017
Approved By :	S.P.	Date : 15 December 2017

Drawing No. :
E09SAY_EXFCD_F1_03

Map Series : Page 3 of 8

Drawing Scale : 1:5,000 @A3