Carrigtwohill to Midleton Inter-urban Cycle Route Phase 2 Flood Risk Assessment

FRA Report

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Contract

This report describes work commissioned by John O Callaghan, on behalf of Atkins. Anastasiya Ilyasova and Ross Bryant of JBA Consulting carried out this work.

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Purpose

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Abbreviations

AEP ..... Annual Exceedance Probability
CFRAM ..... Catchment Flood Risk Assessment and Management
DoEHLG..... Department of the Environment, Heritage, and Local Government
FARL..... FEH index of flood attenuation due to reservoirs and lakes
FB ..... Freeboard
FFL..... Finish Floor Level
FRA..... Flood Risk Assessment
FSR..... Flood Studies Report
FSU..... Flood Studies Update
GL ..... Ground Level
GSI..... Geological Survey of Ireland
LHB ..... Left Hand Bank
OPW ..... Office of Public Works
PFRA ..... Preliminary Flood Risk Assessment
RFI ..... Request for Further Information
RHB ..... Right Hand Bank
RR..... Rainfall-Runoff
SAAR ..... Standard Average Annual Rainfall (mm)
SFRA ..... Strategic Flood Risk Assessment
URBEXT ..... FEH index of fractional urban extent
WL..... Water Level

1 Introduction

Under the Planning System and Flood Risk Management Guidelines for Planning Authorities (DoEHLG & OPW, 2009) the proposed development must undergo a Flood Risk Assessment to ensure sustainability and effective management of flood risk.

1.1 Terms of Reference and Scope

JBA Consulting was appointed by Atkins to prepare a Flood Risk Assessment (FRA) for Phase 2 of the Carrigtwohill to Midleton Inter-urban Cycle Route.

1.2 Flood Risk Assessment; Aims and Objectives

This study is being completed to inform the future development of the site as it relates to flood risk. It aims to identify, quantify, and communicate to Planning Authority officials and other stakeholders the risk of flooding to land, property and people and the measures that would be recommended to manage the risk.

The objectives of this FRA are to:

- Identify potential sources of flood risk.
- Confirm the level of flood risk and identify key hydraulic features.
- Assess the impact that the proposed development has on flood risk.
- Develop appropriate flood risk mitigation and management measures which will allow for the long-term development of the site.

Recommendations for development have been provided in the context of the OPW / DECLG planning guidance, "The Planning System and Flood Risk Management". A review of the likely effects of climate change, and the long-term impacts this may have on any development has also been undertaken.

For general information on flooding, the definition of flood risk, flood zones and other terms see 'Understanding Flood Risk' in Appendix A.

1.3 Development Proposal

The project involves the development of a cycle route between the towns of Carrigtwohill and Midleton. The Carrigtwohill to Midleton Inter-Urban cycle route will form part of larger strategic cycle network, while being designed to have the greatest impact and benefit on the local communities and towns that it connects. The local route will connect planned urban expansion areas in Carrigtwohill and Midleton, ensuring sustainable transport modes (walking, cycling and train use in particular) at an early stage in the development of the new residential areas, while also linking the UEA's to economic centres in Little Island, Carrigtwohill and Midleton. The route further provides permeability links off the main route to existing town centres and villages, public transport facilities (existing and planned) and education centres. The route will provide high-quality pedestrian and cycling infrastructure and will be predominantly off-road, encouraging users of all abilities to cycle, thereby contributing to a greater reduction in car dependence.

The construction of the proposed development will involve excavation to sub-formation level, laying and compaction of capping/ sub-base layers and laying a 4m wide asphalt path along the length of the route. Drainage, lighting, road signs and markings and services will be installed along the length of the route. A typical cross-section is presented on Figure 1-3. When required, any ditches will be replaced by a drainage channel approximately 2m wide.

See Figure 1-1 and Figure 1-2 for proposed site layout.

Figure 1-1: Proposed site layout (west)

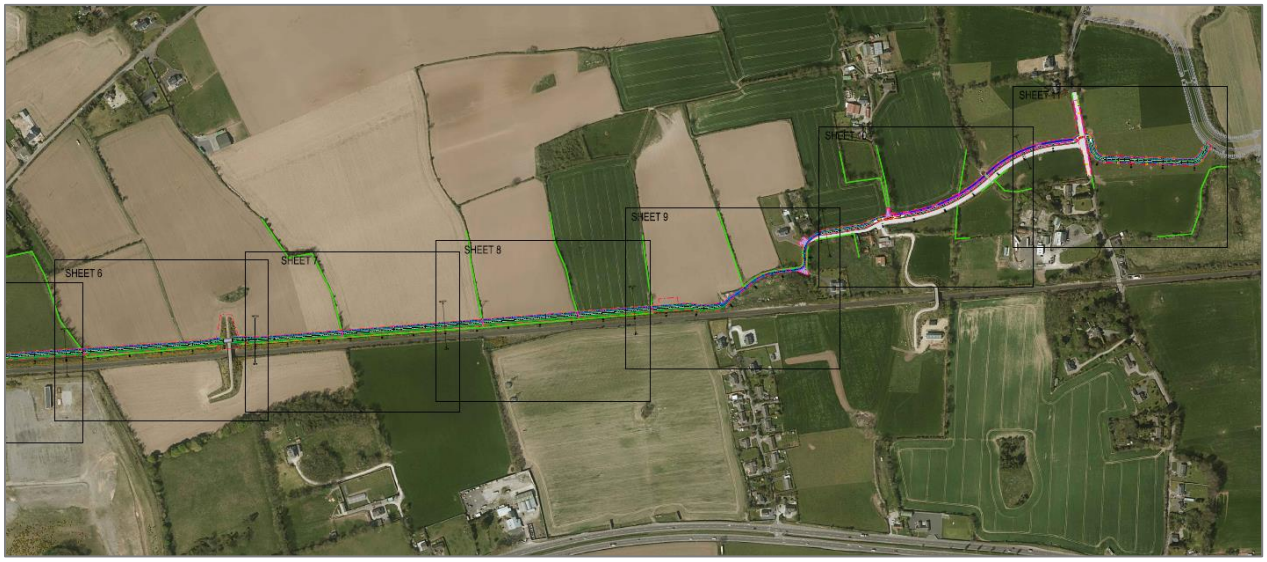


Figure 1-2: Proposed site layout (east)

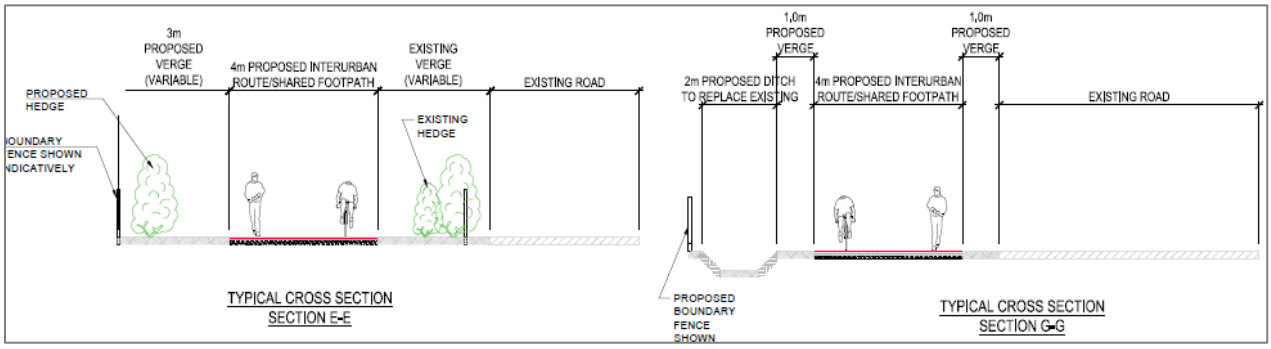


Figure 1-3: Typical cross-section

1.4 Report Structure

Section 2 of this report gives an overview of the study location and associated watercourses. Section 3 contains background information and initial assessment of flood risk. Mitigation measures are outlined in Section 4, while conclusions are provided in Section 5.

2 Site Background

This section describes the watercourses, geology, and wider geographical area in Carrigtwohill.

2.1 Location

The proposed cycle route is located in northeast of the Carrigtwohill and north of the Cork to Midleton Railway. The site location is presented on Figure 2-1.

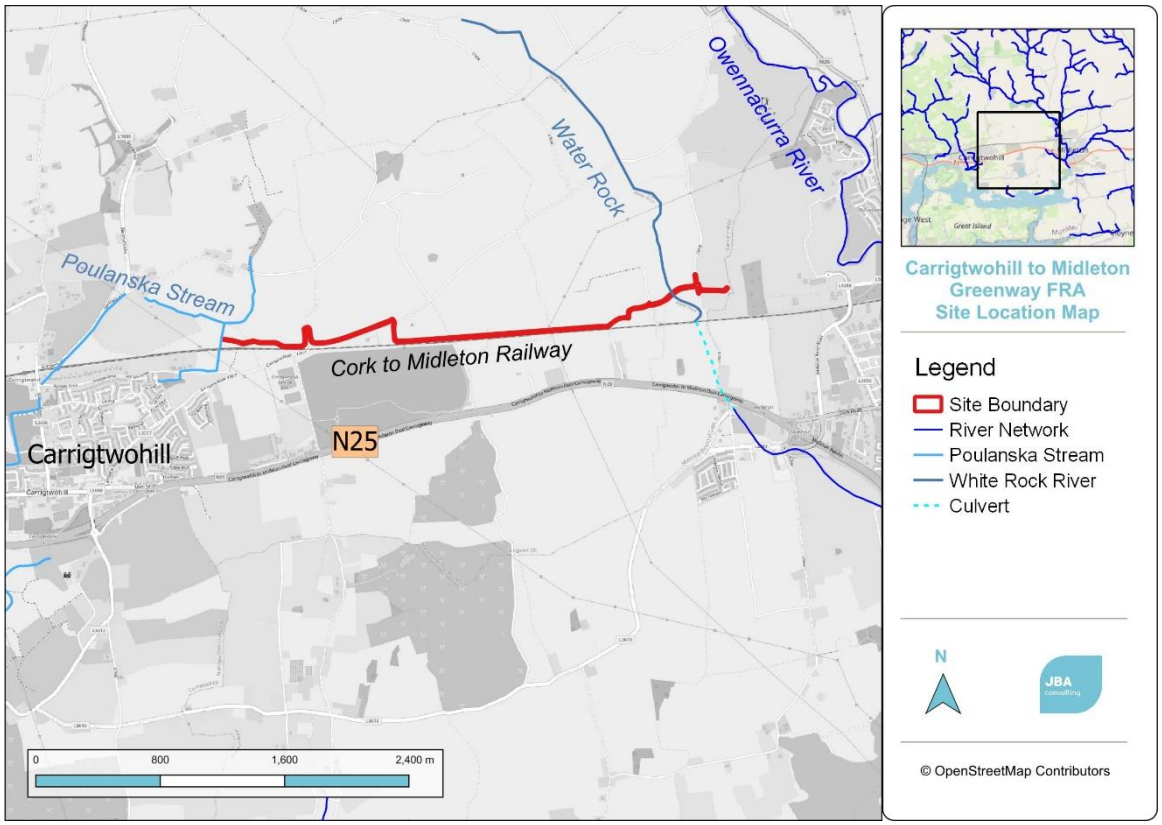


Figure 2-1: Site location

2.2 Watercourses

The nearest watercourse to the site is the Water Rock Stream, which is flowing beneath the proposed site to the east. Another small watercourse is flowing west of the proposed route which is identified as the Poulanska Stream.

The Owennacurra River is flowing north to south 700m from the eastern site boundary and the Woodstock Stream is located 0.7km from the western boundary. The watercourses are shown on Figure 2-1.

2.3 Site Topography

The site is currently greenfield. Across the route, the topography is generally flat with no prevailing slope. The elevation is varying between 20mOD and 25mOD.

2.4 Site Geology

The Geological Survey of Ireland (GSI) groundwater and geological maps of the site were reviewed. The subsoil (quaternary sediments) present under the site is Sandstone till Devonian (TDSs). The subsoils at site are presented on Figure 2-2.

The underlying bedrock is classified as the Waulsortian Limestones which is described as Massive unbedded lime-mudstone.

Review of the GSI historic groundwater mapping database shows some recorded groundwater flooding near N25, approximately 150m from the site. There are some karst features identified near the site (Refer to Figure 2-3).

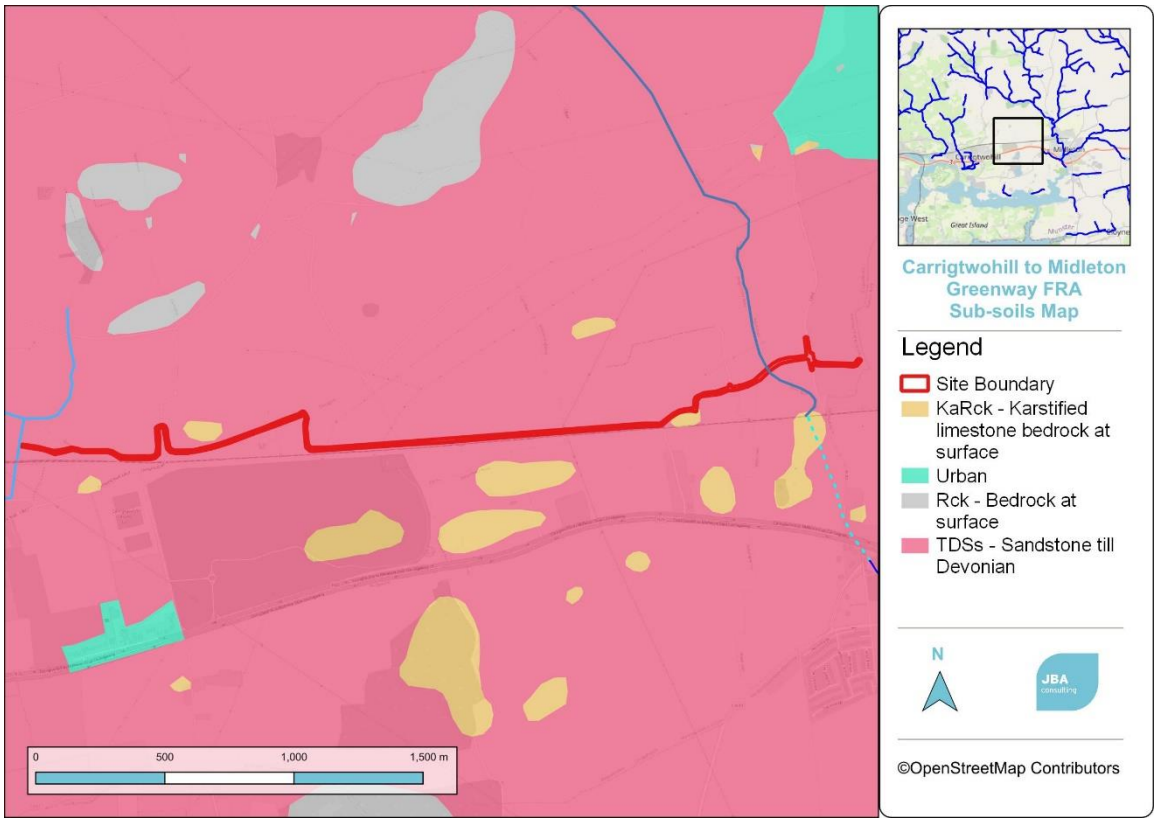


Figure 2-2: Sub-soils (Quaternary Sediments) type (Source: GSI Database)

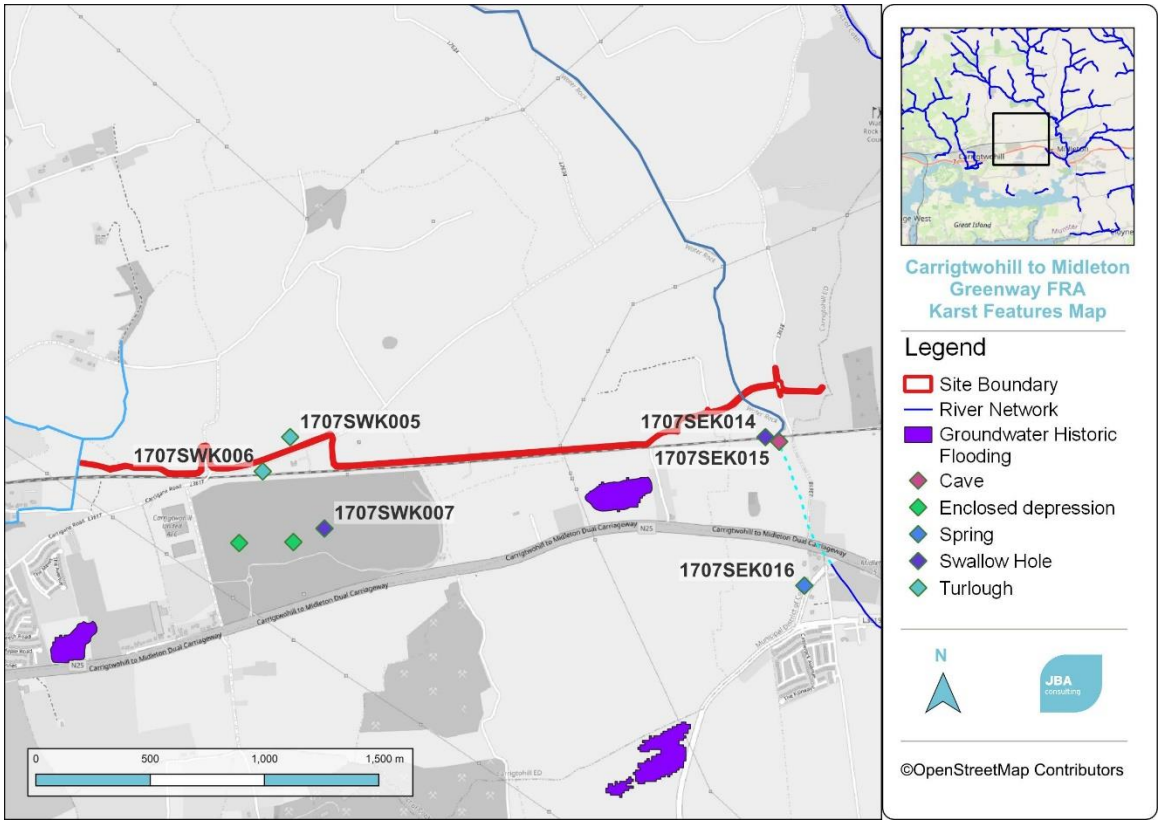


Figure 2-3: Karst Features

3 Flood Risk Identification

An assessment of the potential for and scale of flood risk at the site is conducted using historical and predictive information. This identifies any sources of potential flood risk to the site and reviews historic flood information. The findings from the flood risk identification stage of the assessment are provided in the following sections.

3.1 Flood History

Several sources of flood information were reviewed to establish any recorded flood history at, or near the site. This includes the OPW's website, www.floodinfo.ie and general internet searches.

3.1.1 Floodinfo.ie

The OPW host a National Flood hazard mapping website, www.floodinfo.ie, which highlights areas at risk of flooding through the collection of recorded data and observed flood events. See Figure 3-1 for historic flood events in the area.

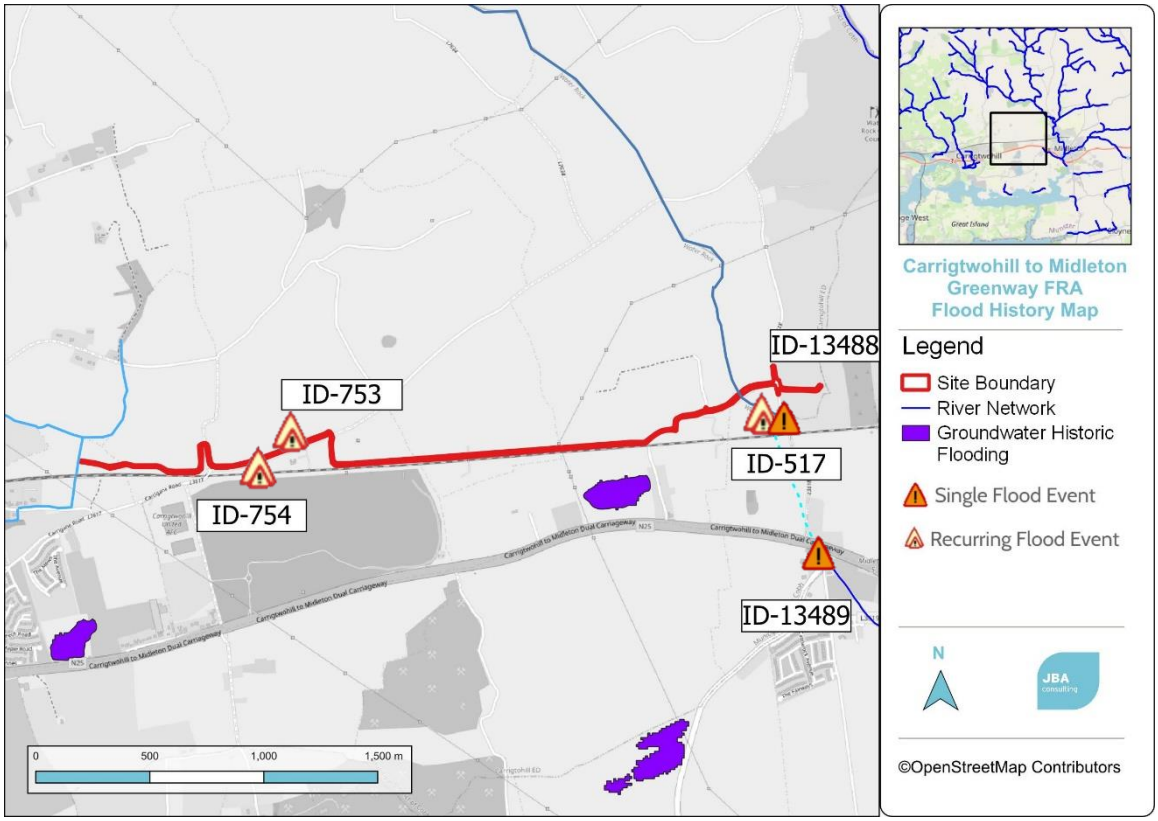


Figure 3-1: Floodinfo.ie

Review of Figure 3-1 shows there are three locations near the site boundary with recurring floods. The source of flooding was from Turlough:

- ID-753 - Ballyadam, Carrigane
- ID-754 - Ballyadam, Cork

The above two flood locations on floodinfo.ie are supported with a note dated 2005 year with a list of turlough locations for a wider area. The note states that some townlands and a few coordinates for the turlough locations required modification, which have been corrected in the GIS and flood events in conjunction with the GSI and/or other flood reports. The accuracy of the location points is 20m.

There are records of flood events recorded on the Water Rock Stream:

- ID-517 - Water Rock House - The house and lands has been subject of two severe flooding in 1993 and 1995.
- ID-13488 and ID-13489 - Flooding at Midleton on 29/12/2015.

3.1.2 Cork County Council Flood History

The Cork County Council lead for the Midleton Flood Relief Scheme was contacted to gather a more complete record of flood events. Several recent events were noted:

- Regular flooding on Bailick Road during high tide events; specifically 18/02/2022, 18/05/2022 and 07/11/2022 where the road was impassible and access to properties was cutoff for a period of time. Flooding caused by combination of high tide, strong winds, storm events, and low defence levels at locations along Bailick road. No internal flooding to properties reported.
- Regular flooding on Bailick Road during high tide events in 2023. Details as above.
- Minor pluvial flooding on Main Street north of junction with Broderick Street in front of 4 properties (22/08/2023 – Storm Betty). Issue due to rainfall intensity / pipe size across Broderick Street; water level built up until it crested the crown of the road. No internal flooding to properties occurred.

3.1.3 Internet Searches

An internet search was conducted to gather information about whether the site was affected by flooding previously. Midleton is shown to be subject to regular flooding, including the recent extreme flood event that occur on 18th October 2023. Flooding occurred at Water Rock House during this flood event. No flooding incidents were recorded at site or in near area apart from the events mentioned above.

3.2 Predictive Flooding

The area has been a subject of the following predictive flood mapping or modelling studies and other related studies and plans:

- Lee Catchment Flood Risk Assessment and Management Study (CFRAM)
- National Indicative Flood Mapping Study (NIFM)
- Strategic Flood Risk Assessment (SFRA) for Cork County Council (CCC) Development Plan (DP) 2022-2028
- Carrigtwohill Flood Risk Assessment Study - Groundwater Flood Risk Assessment 2012
- Water Rock Urban Expansion Area Infrastructure Works - Flood Risk Assessment 2018
- Carrigtwohill URDF Initiative - UEA Infrastructure Flood Risk Assessment 2023
- Midleton Flood Relief Scheme (FRS)

The level of detail presented by each method varies according to the quality of the information used and the approaches involved.

3.2.1 Lee Catchment Flood Risk Assessment and Management Study

The primary source of data with which to identify flood risk to the site is the Lee Catchment Flood Risk Assessment and Management Study (Lee CFRAM Study). The Lee CFRAM Study commenced in 2016. Fluvial and tidal flood maps have since been finalised for Lee catchment and an extract covering the site is presented in Figure 3-2.

The CFRAM consists of detailed hydraulic modelling of Lee River and its tributaries and coastline and flood extent maps for the fluvial and tidal scenarios have been completed. The relevant flood maps are available on the OPW www.floodinfo.ie website and can be viewed on public consultation website.

Review of the CFRAM mapping shows that the site is outside of any fluvial and tidal flood source and therefore is located in Flood Zone C with low probability of flooding. The Water Rock Stream is not modelled under the CFRAM study.

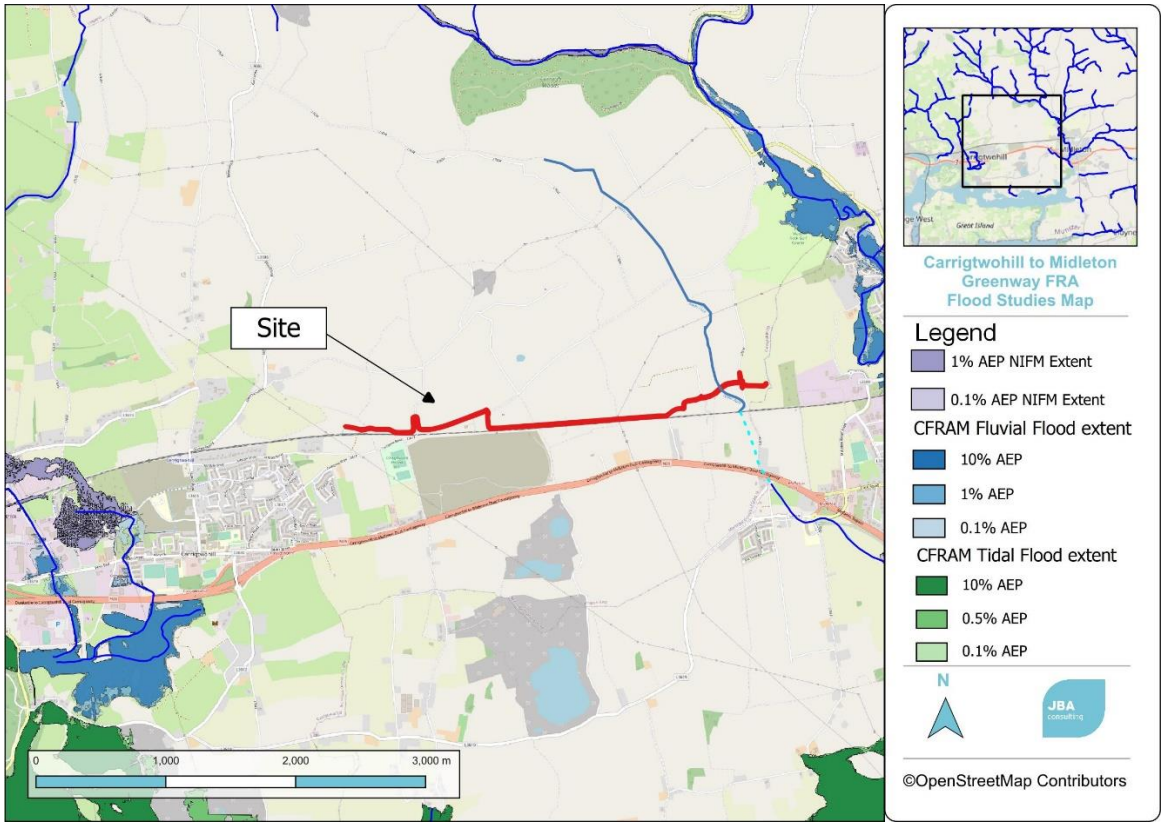


Figure 3-2: Lee CFRAM Fluvial Flood Map (Source: Floodinfo.ie)

3.2.2 National Indicative Flood Mapping Study (NIFM)

Data has been produced for catchments greater than 5km^2 in areas for which flood maps were not produced under the National CFRAM Programme and should be read in this context. The NIFM datasets have been edited to remove overlaps with the datasets produced under the National CFRAM Programme and other flood studies. The NIFM datasets should be read in conjunction with the outputs of the National CFRAM Programme and other studies. Refer to Figure 3-2 for NIFM flood extents.

3.2.3 Strategic Flood Risk Assessment for Cork County Development Plan 2022-2028

The SFRA for Cork County Development Plan has been prepared in accordance with the requirements of the DoEHLG and OPW Planning Guidelines, The Planning System and Flood Risk Management; these guidelines were issued under the Planning and Development Act 2000 (as amended) and recognise the significance of proper planning to manage flood risk.

The SFRA has reviewed a number of datasets which record historical and/or predicted flood extents such as CFRAM, FRS and previous flood maps from CCCDP SFRA. These studies were used to inform the flood risk and flood zones in the area with some exceptions. As seen on Figure 3-5 there is predicted flooding from Water Rock Stream, however there is no overtopping of the existing bridge and when the cycle route crosses the stream, it will use existing infrastructure and therefore there is no indication of flood risk to the site. The site is therefore located in Flood Zone C.

Flood risks from pluvial and groundwater sources have not been modelled in detail within the SFRA.

The proposed cycle route crosses lands zoned as Key Residential and Green Infrastructure in the Development Plan.

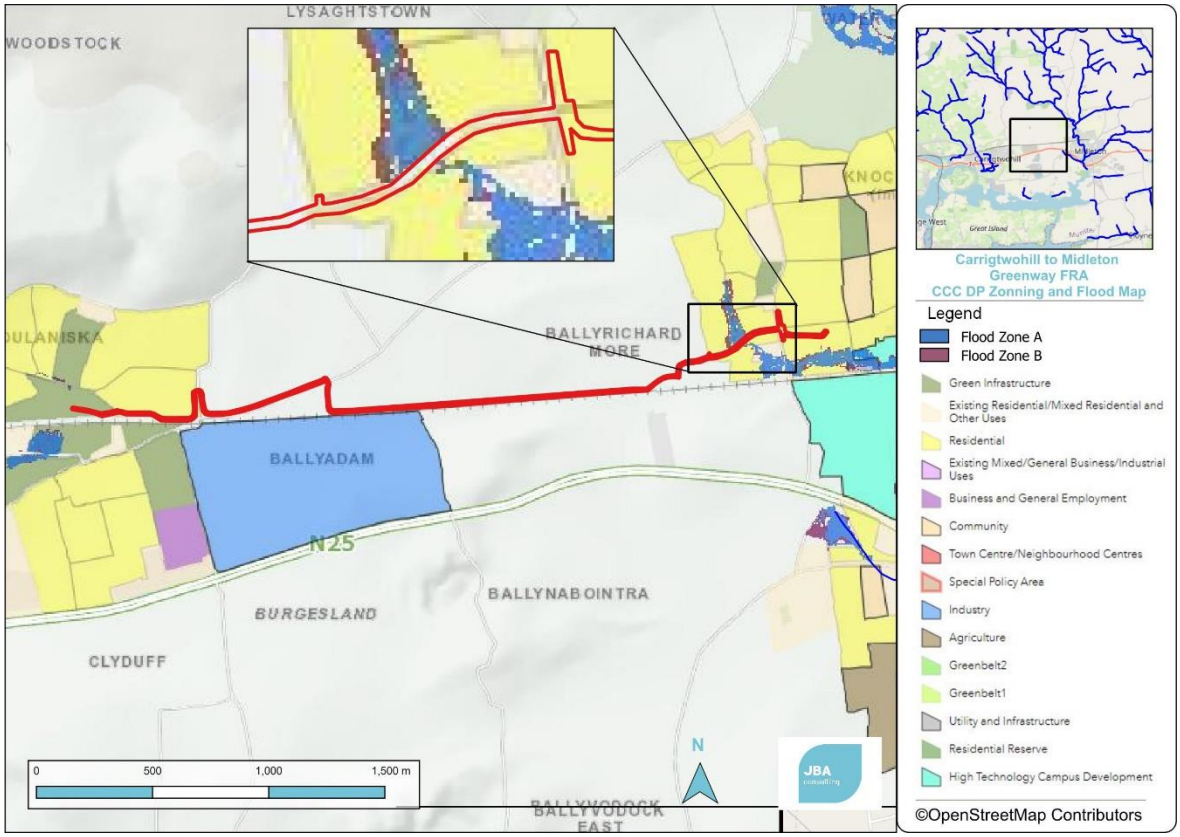


Figure 3-3: Extract from Cork County Council Development Plan SFRA Flood Zone Map

3.2.4 Carrigtwohill Flood Risk Assessment Study - Groundwater Flood Risk Assessment

Cork County Council appointed Peter Conroy (Independent Hydrogeologist) and JBA Consulting to carry out the Carrigtwohill Flood Risk Assessment Study. The project outcomes were an indicative assessment of current and potential future groundwater flood risk, including areas potentially affected and the degree and extent of flooding based as far as possible on quantitative data and detailed recommendations for future monitoring and work to assess the groundwater hazard and risk quantitatively.

The two flood event locations identified in Section 3.1.1 has been reviewed under this study. The following information has been sourced: "These turloughs appear to have been infilled by IDA site works. The infilling appears to have diverted the upwelling groundwater to the adjacent local road. It is not clear if the current upwelling derives from overtopping the infilled turloughs or if a new pathway has been created." Extract from the FRA is presented on Figure 3-4.

1707SWK005	Turlough	GSI Ballyadam Turloughs. Recorded location approx. 350 m north of actual site.
1707SWK006	Turlough	

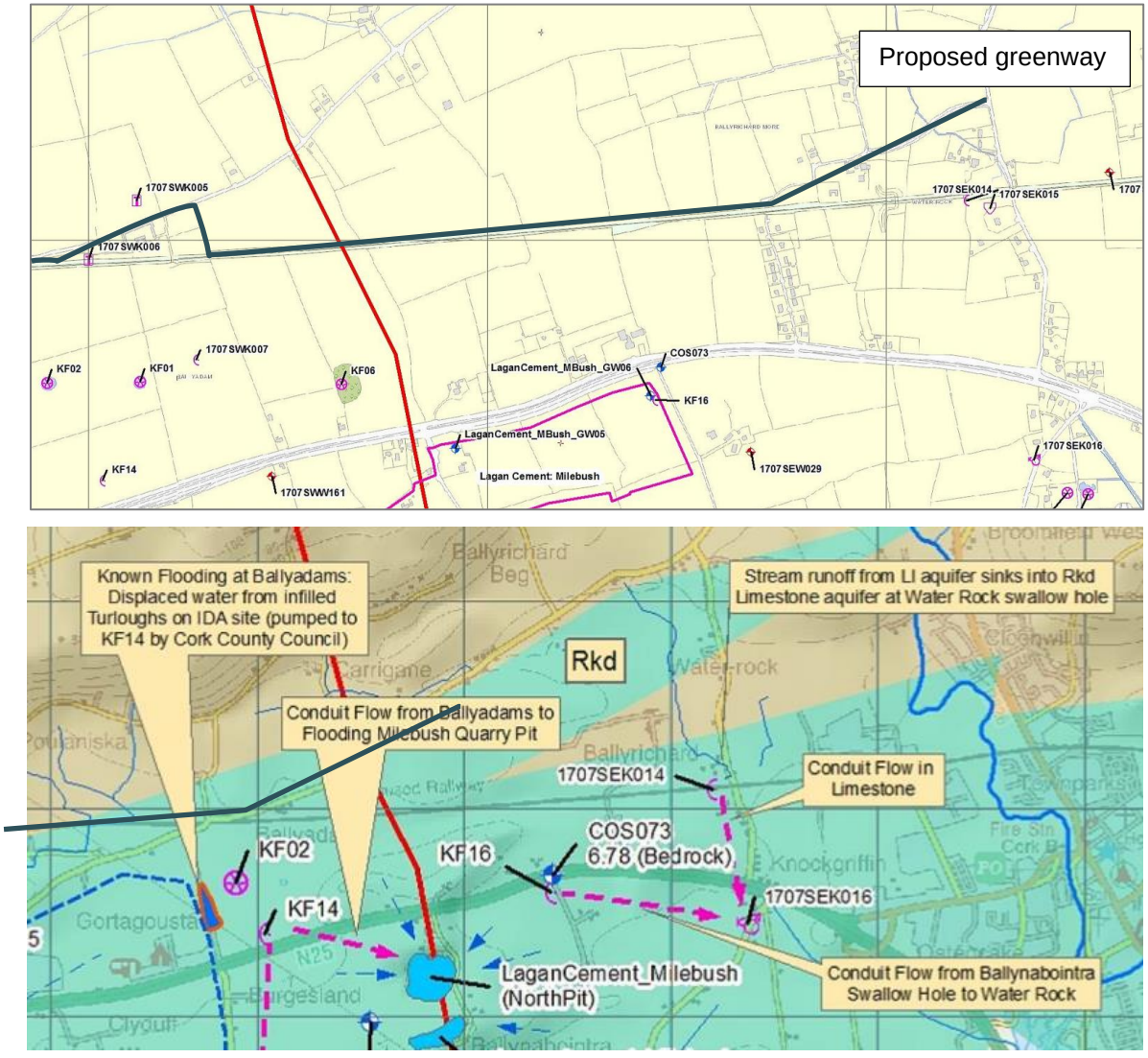


Figure 3-4: Extract from FRA map with karst feature's locations

3.2.5 Water Rock Urban Expansion Area Infrastructure Works - Flood Risk Assessment 2018

A site-specific Flood Risk Assessment specifically for the Water Rock UEA Infrastructure Works was prepared in November 2018 and includes detailed hydraulic modelling and analysis of the Water Rock Stream that flows along the western side of the UEA and discharges to the estuary south of Midleton. In addition, this FRA incorporates the recently revised (January 2018) Flood Zone Mapping provided by the Lee CFRAM study where relevant to the UEA which summarises flood risk associated with the Owenacurra River.

Under the FRA, a hydraulic model has been developed for Water Rock Stream using HEC-RAS for various scenarios and flood events. Figure 3-5 and Figure 3-6 shows the flood extents for the 1%AEP, 0.1% AEP Present Day Scenario. There is no overtopping of the existing bridge.

Figure 3-5: Flood Extent for Water Rock 1%AEP

Figure 3-6: Flood Extent for Water Rock 0.1%AEP

3.2.6 Carrigtwohill URDF Initiative - UEA Infrastructure Flood Risk Assessment 2023

Under Phase 1 of the Midleton Inter-urban Cycleway (2020), the Poulanska Stream was modelled, and the resulting flood extents of 1% AEP and 0.1% AEP fluvial flood risk are presented on Figure 3-7. The proposed route is shown to be outside of any flood extents of Poulanska Stream, therefore will not be impacted during a 1% AEP and 0.1% AEP flood event.

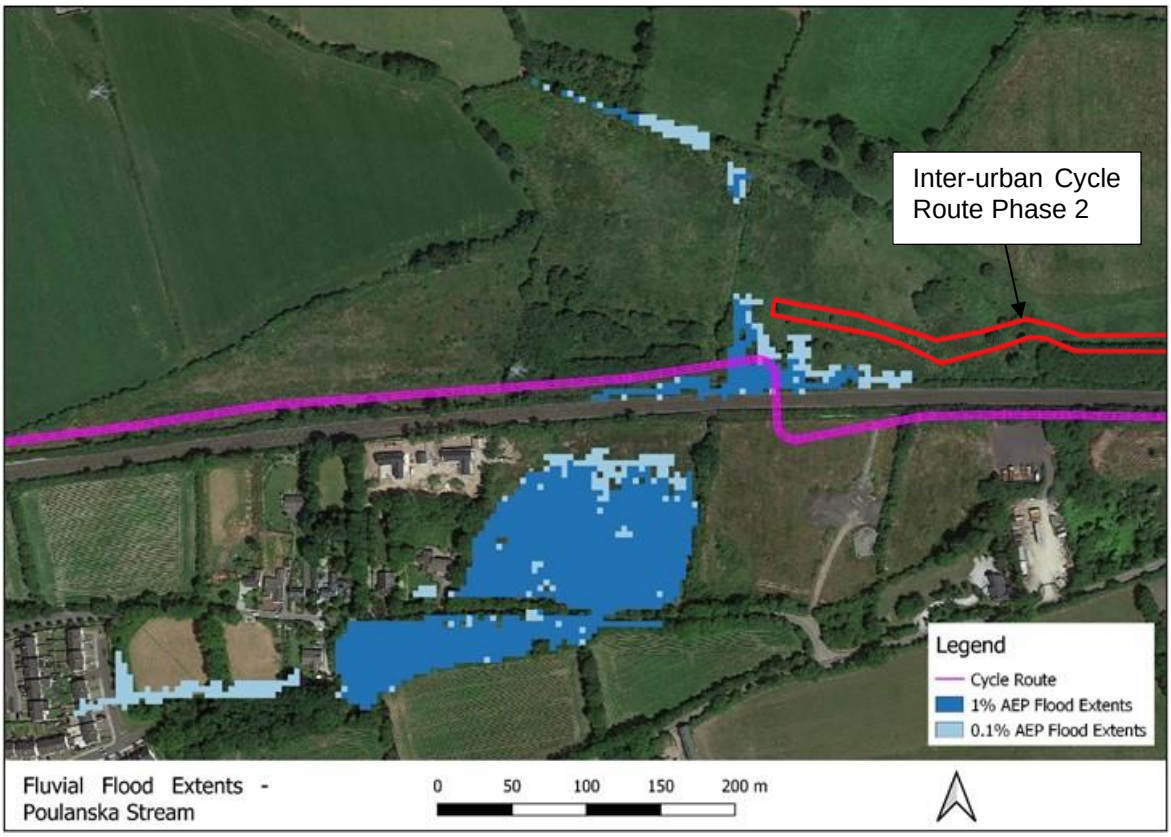


Figure 3-7: Poulanska Fluvial Flood Extent

3.2.7 Midleton Flood Relief Scheme

The OPW in partnership with Cork County Council recognised the high levels of existing flood risk in the River Lee Catchment conveyed in the Lee CFRAM Study. Cork County Council has also recognised that groundwater and pluvial flooding are significant sources of flood risk in Midleton. A flood scheme is currently being developed for the town to address the flood sources. The aim of the scheme is to protect properties from all sources of flooding.

Detailed hydraulic modelling and flood extent maps are available for the Midleton area. The relevant flood maps are available on the www.floodinfo.ie website and can be viewed on Midleton Project Information public consultation website.

The Water Rock Stream is modelled under the Midleton FSR. Review of the Midleton FRS mapping shows that the site is outside of any fluvial and tidal flood source and therefore is located in Flood Zone C with low probability of flooding.

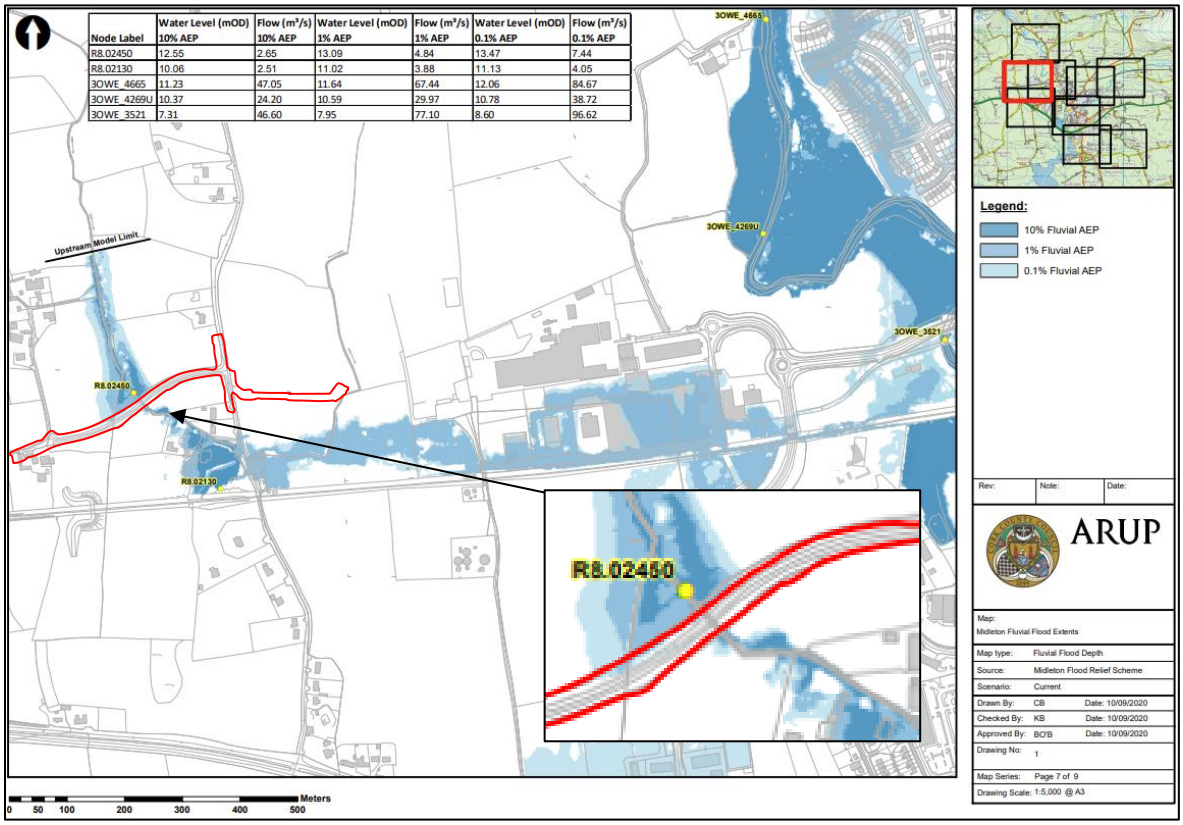


Figure 3-8: Midleton Flood Relief Scheme

3.2.8 Storm Babet Flood Event

Storm Babet passed over Midleton over the 17th and 18th of October 2023 which resulted in extreme rainfall and subsequently fluvial flooding across the town. A report has been prepared by Arup on behalf of Cork County Council to prepare a post -flood event report and impact on Midleton.

The report has been based but not limited to the following datasets.

- Recorded rainfall and radar information from the event,
- Observations and anecdotal information collected by staff from Arup, CCC and the OPW,
- part of the post event site visits,
- Wrack mark surveys1 which indicate possible maximum water levels,
- Extensive number of photographs and video footage from social media posted by members of the public,
- Report and further information supplied by CCC,
- Aerial imagery of the event taken by Guileen Coast Guard,
- Drone footage of the event posted online by a member of the public. This data is not time stamped but is likely to be close to the peak,
- CCTV footage supplied to Arup by AIB,
- Information directly supplied to CCC/Arup by the general public,
- Existing LiDAR/ Topographic survey information,
- Media Reports.

As stated above, the comprehensive review of the rainfall data has been undertaken. The result from the analysis confirms that the storm lasted approx. 35 hours with rainfall totals varying from 75mm to 120mm across the gauge network. The closest gauge to the site is the N25 Midleton bypass station recorded a total of 103.2mm which is the equivalent of a 1:44 year return event.

The flood extents have been compared to the modelled 0.1% AEP flood events prepared under the Midleton FRS. The Storm Babet flood extents are similar to the modelled 0.1% AEP extents in places; however it is noted in the report further work is required to accurately determine the Storm Babet return period and the comparison does not suggest that the flood event had a 0.1% AEP return period. It was also noted that boundary walls and other structures have not been modelled under the Midleton FRS which would have an impact on flood events.

With reference to the Carrigtwohill-Midleton to cycle route, the Storm Babet flood event report did not any evidence of the proposed route during storm event. The result closely matches the predicted 0.1% AEP flood event under the Midleton FRS which does not show any predicted inundation of the cycle route.

3.3 Flood Sources

The initial stage of a Flood Risk Assessment requires the identification and consideration of probable sources of flooding. Following the initial phase of this Flood Risk Assessment, it is possible to summarise the level of potential risk posed by each source of flooding. The flood sources are described below.

3.3.1 Fluvial

Review of the available Cork Development Plan SFRA, Water Rock UEA FRA and Inter-urban Cycle Route Phase 1 FRA mapping confirms that the proposed greenway is not at risk of inundation. The flood extents for the Water Rock stream don't overtop the existing road crossing, therefore confirming that the culvert has sufficient capacity to convey the predicted 1% and 0.1% AEP flood events. The proposed cycle route is outside the Poulanska Stream flood mapping for 1% AEP and 0.1% AEP.

The cycle route does not cross any other river body in the study area.

3.3.2 Tidal

The site is located far from the tidally influenced areas; therefore, tidal flooding is not considered as presenting a flood risk to the development and is screened out at this stage.

3.3.3 Pluvial/ Surface Water

Pluvial flooding is the result of rainfall-generated overland flows that arise before run-off can enter a watercourse or sewer. There have been no identified instances of pluvial flooding along the proposed route. The mitigation measures specific to pluvial flooding will be further discussed in Section 4.2.1.

3.3.4 Groundwater

Groundwater flooding results from high sub-surface water levels that impact upper levels of the soil strata and overland areas that are usually dry.

Review of the past flood events information indicate two recurring flood locations from turlough close to the site (Ref to Section 3.1.1), but their location is not precise and there is no other source to confirm the flood risk from the turlough. There is historic groundwater risk mapped along the N25 (Ref. to Figure 3-1) however it located far from the proposed route and therefore has no impact to the site.

Having reviewed the GSI data, groundwater flooding will not be considered and has been screened out at this stage.

4 Flood Risk Assessment and Mitigation

4.1 Flood Risk

Having reviewed the available sources of flooding information outlined in Section 3, there is no identified historic flooding within the site. Where the proposed cycle route crossed over the Water Rock Stream, it does so using the existing road crossing and therefore the proposed cycle route is assessed as being in **Flood Zone C**.

4.2 Mitigation Measures

4.2.1 Surface Water/Pluvial Risk Management - Drainage Design

There are existing drains in the area that provide a storm water drainage of the railway and other transport infrastructure. Where necessary any drains removed during construction will be replaced.

The cycle route will be 4m wide, consisting of an asphalt surface with a minimum planted verge of 3m on either side where this is feasible. The path will be constructed at-grade or slightly raised above existing ground levels and will be constructed with a crossfall of between 1.0-2.0% to allow over the edge drainage into the grassed verge. A filter pipe will be laid within the verge to collect and attenuate excess run-off in the verge. The natural drainage system will also be augmented by SuDS features such as planted swales and rain gardens where required.

The above measures will minimise the risk of pluvial flooding along the greenway route.

4.3 Climate Change

In accordance with the OPW guidelines, it is necessary to assess the risk associated with climate change, which under the medium range future scenario (MRFS) corresponds with an increase in flows of 20% for the 1% AEP flood event, or a 0.5m increase in tide levels. The climate change flood maps are available from the Water Rock UEA FRA (Refer to Section 3.2.5). The 1% AEP Climate Change extent is presented on Figure 4-1, there is no overtopping of the existing bridge, and the cycle path is designed to fit the existing culvert width.

Figure 4-1: 1% AEP Climate Change Flood Extent

4.4 Residual Risk

Residual risks are defined as risks that remain after all risk avoidance, substitution and mitigation measures have been taken. The flood risk assessment identifies the potential blockage of the culvert along the Water Rock Stream.

The potential blockage of the 1% AEP flood event can be represented by the 0.1% AEP flood event, which confirms that the cycle route will not be inundated during the potential blockage of the existing bridge.

5 Conclusion

JBA Consulting were commissioned by Atkins to undertake a Flood Risk Assessment (FRA) for proposed cycle route site between Carrigtwohill and Midleton.

Having reviewed the available information there are some historic flood event records in the area, however none is affecting the route itself. The nearest potential source of flooding has been identified as the Water Rock Stream which is flowing beneath the existing bridge under the proposed greenway. Review of predictive flood mapping identify that there is no overtopping of the bridge and the site residing in Flood Zone C.

Drainage of the path will comprise natural, over-the-edge drainage into a filter drain running parallel to the cycleway. The natural drainage system will be augmented by SuDS features where required.

The Climate Change scenario has been reviewed and there is no overtopping of the existing bridge during 1% AEP Climate Change event.

Potential blockage along the Water Rock Stream has been assessed by substituting the 0.1% AEP event to represent blockage during the 1% AEP flood event. The results confirm that the cycle route will not be impacted from the potential blockage of the existing culvert system along the Water Rock Stream.

The Flood Risk Assessment was undertaken in accordance with 'The Planning System and Flood Risk Management' guidelines and is in agreement with the core principles contained within.

Appendices

A Appendix - Understanding Flood Risk

Flood Risk is generally accepted to be a combination of the likelihood (or probability) of flooding and the potential consequences arising. Flood Risk can be expressed in terms of the following relationship:

Flood Risk = Probability of Flooding x Consequences of Flooding

A.1 Probability of Flooding

The likelihood or probability of a flood event (whether tidal or fluvial) is classified by its Annual Exceedance Probability (AEP) or return period years, a 1% AEP flood 1 in 100 chance of occurring in any given year. In this report, flood frequency will primarily be expressed in terms of AEP, which is the inverse of the return period, as shown in the table below and explained above. This can helpful when presenting results to members of the public who may associate the concept of return period with a regular occurrence rather than an average recurrence interval and is the terminology which will be used throughout this report.

Table: Conversion between return periods and annual exceedance probabilities

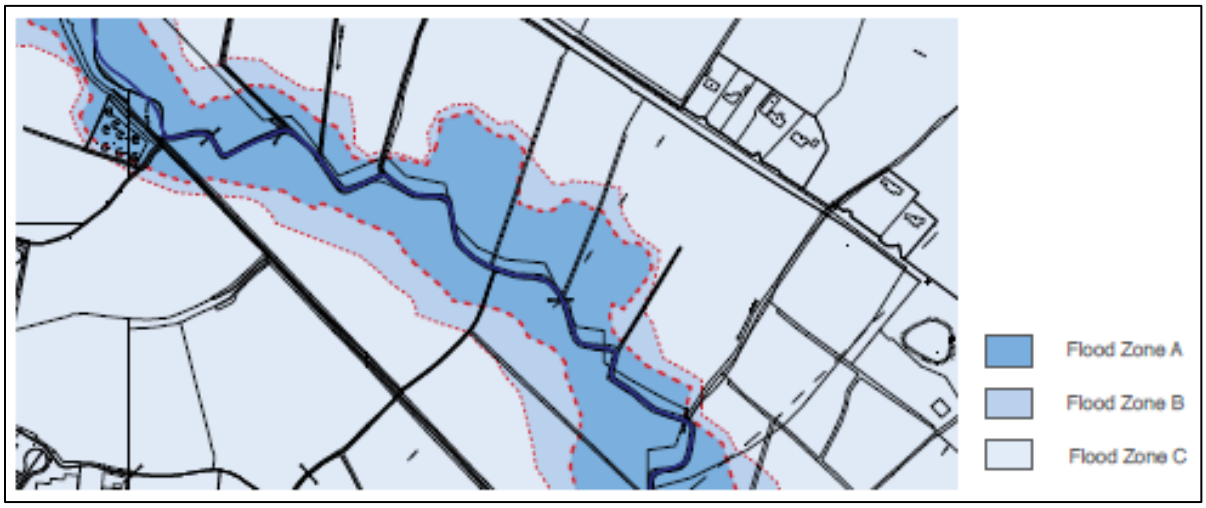
Return period (years)	Annual exceedance probability (%)
2	50
10	10
50	2
100	1
200	0.5
1000	0.1

A.2 Flood Zones

Flood Zones are geographical areas illustrating the probability of flooding. For the purpose of the Planning Guidelines, there are 3 types of levels of flood zones, A, B and C.

Zone	Description
Flood Zone A	Where the probability of flooding is highest, greater than 1% (1 in 100) from river flooding or 0.5% (1 in 200) for coastal/ tidal Flooding
Flood Zone B	Moderate probability of flooding, between 1% and 0.1% from rivers and between 0.5% and 0.1% from coastal/ tidal.
Flood Zone C	Lowest probability of flooding, less than 0.1% from both rivers and coastal/ tidal.

It is important to note that the definition of the flood zones is based on an undefended scenario and does not take into account the presence of flood protection structures such as flood walls or embankments. This is to allow for the fact that there is a residual risk of flooding behind the defences will be maintained in perpetuity.



A.3 Consequences of Flooding

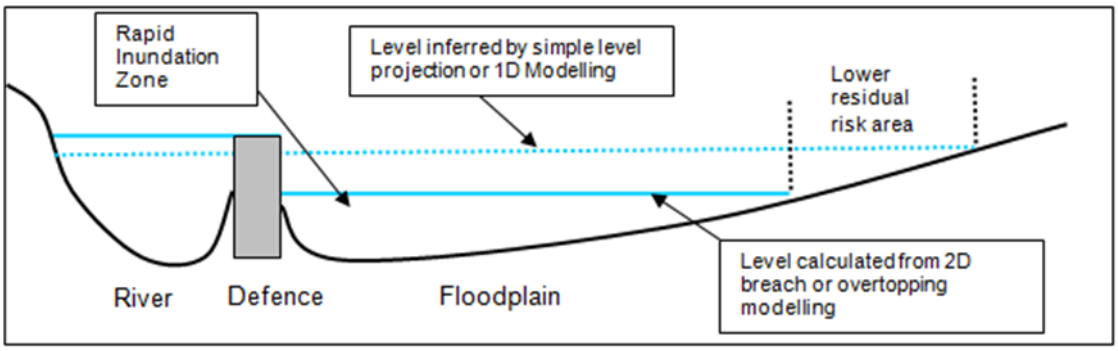
Consequences of flooding depend on the Hazards caused by flooding (depth of water, speed of flow. Rate of onset, duration, wave-action effects, water quality) and the vulnerability of receptors (type of development, nature, e.g. age-structure of the population, presence and reliability of mitigation measures etc.)

The 'Planning System and Flood Risk Management' provides three vulnerability categories, based on type of development, nature, which are detailed in Table 3.1 of the Guidelines, and are summarised as:

- **Highly vulnerable**, including residential properties, essential infrastructure, and emergency service facilities
- **Less vulnerable**, such as retail and commercial and local transport infrastructure, such as changing rooms.
- **Water compatible**, including open space, outdoor recreation and associated essential infrastructure, such as changing rooms.

A.4 Residual Risk

The presence of flood defences, by their very nature, hinder the movement of flood water across the floodplain and prevent flooding unless river levels rise above the defence crest level or a breach occurs. This known as residual risk:



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