Appendix A13.2
Flood Risk Assessment (FRA) Report

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EXECUTIVE SUMMARY

Barry Transportation (BT) was appointed by Galway City Council (GCC) to undertake the BusConnects Galway: Dublin Road Preliminary Design and Statutory Process. In order to support the planning application for the proposed development, a site-specific Flood Risk Assessment (FRA) was carried out.

This FRA is undertaken in accordance with "The Planning System and Flood Risk Management Guidelines for Planning Authorities" published in November 2009, jointly by the Office of Public Works (OPW) and the then Department of Environment, Heritage and Local Government (DoEHLG) and Circular PL 2/2014 (here after known as the Guidelines).

Galway City has historically been prone to fluvial and/or tidal flooding with some significant events occurring in recent years. However, the Proposed Development is at low risk of flooding from these sources. The risk of pluvial and groundwater flooding to the site is considered moderate and there is also a high/moderate risk from the mechanical/operational failure of the pumping stations proposed for two of the drainage networks. Mitigation measures have been proposed to reduce the flood risk.

The Proposed Development has an overall length of approximately 3.9 km of road infrastructure, cycle lane and pedestrian walkway upgrades but it doesn't interface with any watercourses. The site ground levels vary significantly throughout.

The scope of the Proposed Development is in keeping with the existing road profile and does not increase the risk of flooding elsewhere. In addition, surface water management measures including upgraded surface water drainage system, additional green area and SUDs where practicable, oversized pipes and attenuation tanks with flow control are incorporated in the design.

This FRA demonstrated that the risks relating to flooding can be reduced to acceptable levels and therefore comply with the Guidelines.

1 INTRODUCTION

1.1 Background

Barry Transportation (BT) was appointed by Galway City Council (GCC) to undertake the BusConnects Galway: Dublin Road Preliminary Design and Statutory Process. In order to support the planning application for the proposed development, a site-specific Flood Risk Assessment (FRA) was carried out.

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1.2 Proposed Development

BusConnects Galway: Dublin Road is a continuous 3.9 km corridor of high-quality pedestrian, cyclist and public transport facilities starting east of the Moneenageisha Junction and extending to the junction with Doughiska Road, tying into the Martin Junction. For the full length of the route a dedicated bus lane, segregated cycle lanes and footpaths are proposed on both sides of the road with the exception of the Coast Road Junction to the Doughiska Junction where two way cycle lanes are proposed. Dublin Road will remain two-way for general traffic. All major junctions along the route, including the Skerrit Roundabout, are proposed to be upgraded to include for bus priority measures, signalised pedestrian crossings and segregated cyclist facilities.

This route is a main arterial route into Galway City centre for both commuters and for tourists. It also runs adjacent to the Atlantic Technological University, Merlin Park Hospital, Bon Secours Hospital and a number of schools and other amenity locations.

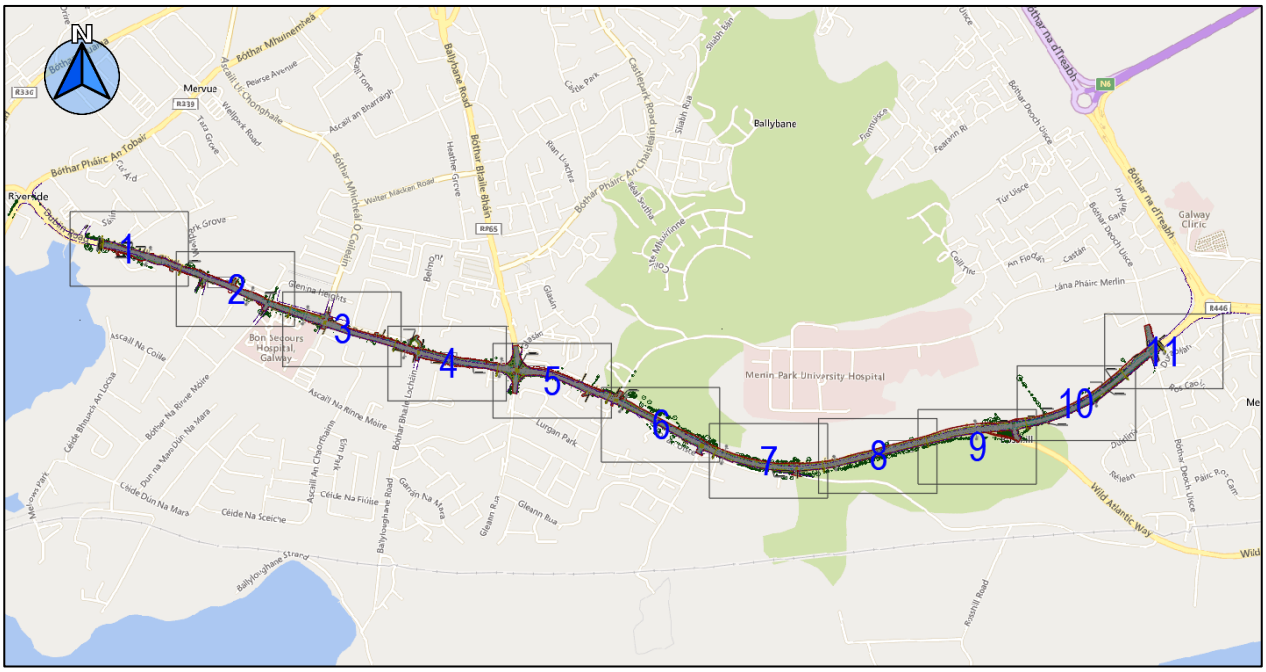

Figure 1 BusConnects Galway: Dublin Road of the Proposed Development Layout (Background: Microsoft Bing)

1.3 Site Location

The Proposed Development is located in Galway City and extends along the Dublin Road from the east of Moneenageisha Junction to Doughiska Road Junction. The total distance is approximately 3.9 km and includes as Roscam, Doughiska, Murrough, Renmore, Merlin Park and Wellpark.

Approximate points of Eastern and Western bounds to Irish Transverse Mercator (ITM) reference are as follows:

Eastern Bound: E: 534957.496, N: 725752.619

Western Bound: E: 531327.845, N: 726089.912

The location of the Proposed Development including Site Compounds is shown in Figure 2:

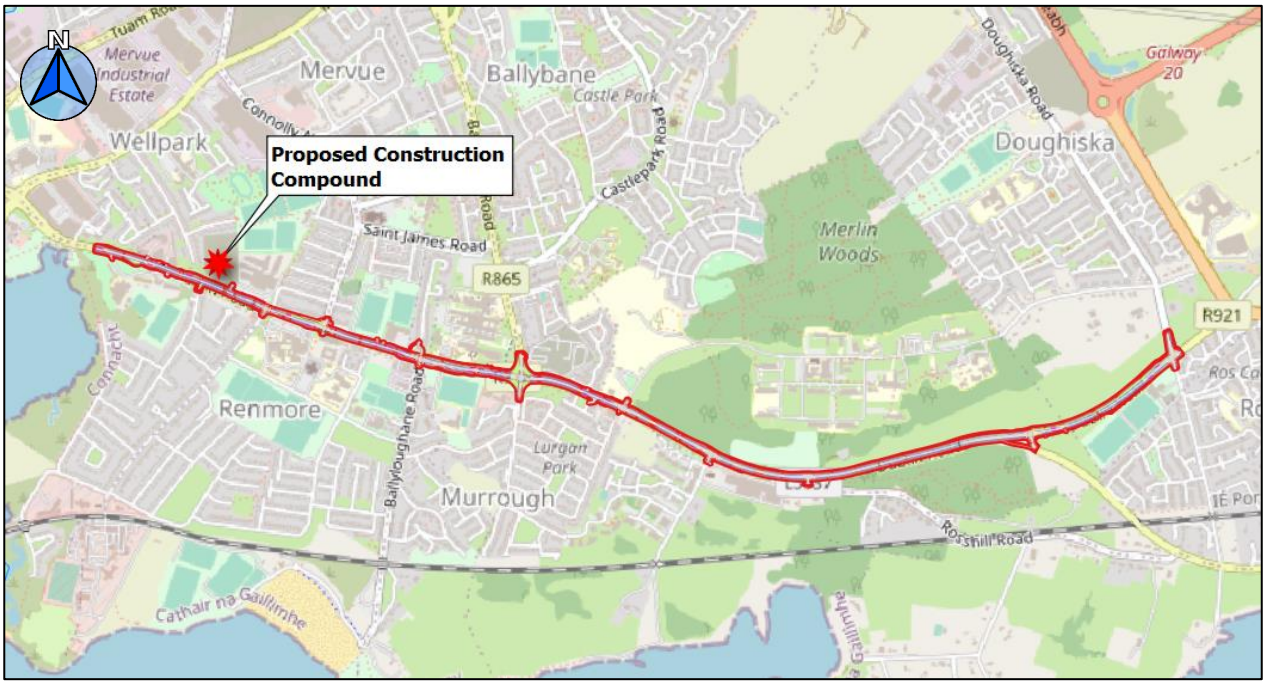

Figure 2 Site Location (Background: © Open Street Map)

There are no watercourses intersecting or immediately adjacent to the Proposed Development.

The site levels increases and decreases along the development with the lowest point of +7.31 m OD on the Western Extent and the highest point of +26.57 m OD on the Eastern Extent.

Figure 3 Site Topographic levels (Information: APEX Surveys, 20th December 2018, Background: © Microsoft Bing)

1.4 Scope of the Report

This FRA report contains the following information:

- Identification and confirmation of the sources of flooding which may affect the site.
- A qualitative assessment of the risk of flooding from the various sources to the site and to adjacent areas because of construction of the Proposed Development.
- Identification of possible measures which could mitigate the flood risk to acceptable levels, and
- Statement of residual flood risk.

1.5 Summary of Data Sources

Data relating to flood risk relevant to the Proposed Development and surrounding area has been obtained from the following sources:

- The historic flood data was obtained from the National Flood Hazard Mapping website www.floodmaps.ie.
- Aquifer vulnerability data was obtained from the Geological Survey of Ireland website www.gsi.ie
- CFRAM Flood Maps were obtained from the OPW website www.floodinfo.ie
- Galway City Development Plan (2023 – 2029) https://www.galwaycity.ie
- Topographical survey of the site,
- Proposed development planning application drawings.

2 FLOOD RISK ASSESSMENT METHODOLOGY

2.1 The Planning System & Flood Risk Management Guidelines

The methodology used for the flood risk assessment for the proposed development is based on 'The Planning System and Flood Risk Management, Guidelines for Planning Authorities' (2009)'. The FRM Guidelines require the planning system at national, regional and local levels to:

- Avoid development in areas at risk of flooding, particularly floodplains, unless there are proven wider sustainability grounds that justify appropriate development;
- Adopt a sequential approach to flood risk management when assessing the location for new development based on avoidance, reduction and then mitigation of flood risk; and
- Incorporate flood risk assessment into the process of making decisions on planning applications and planning appeals.

The sequential approach (see Figure 3.1 of the FRM Guidelines below) in flood risk management requires the following three steps to identify the necessity for the justification test for a development:

- Step 1: Identification of the Flood Zone at the proposed development site (Section 2.23 of the FRM Guidelines);
- Step 2: Identification of the vulnerability of the type of the proposed development (Table 3.1 of the FRM Guidelines); and
- Step 3: Using the matrix of vulnerability versus Flood Zone (Table 3.2 of the FRM Guidelines), identify the necessity for the justification test for the proposed development.

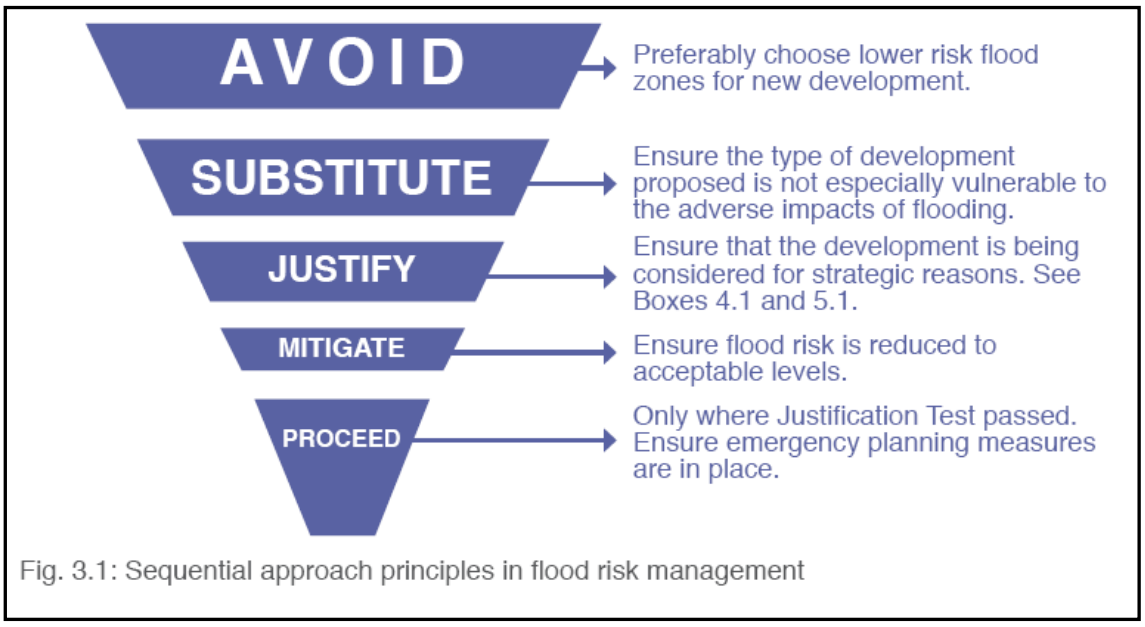

Fig. 3.1: Sequential approach principles in flood risk management

While Figure 3.1 of The FRM Guidelines sets out the broad philosophy underpinning the sequential approach in the flood risk management, Figure 3.2 of the Guidelines (shown below) describes the mechanism of the sequential approach for use in the planning process.

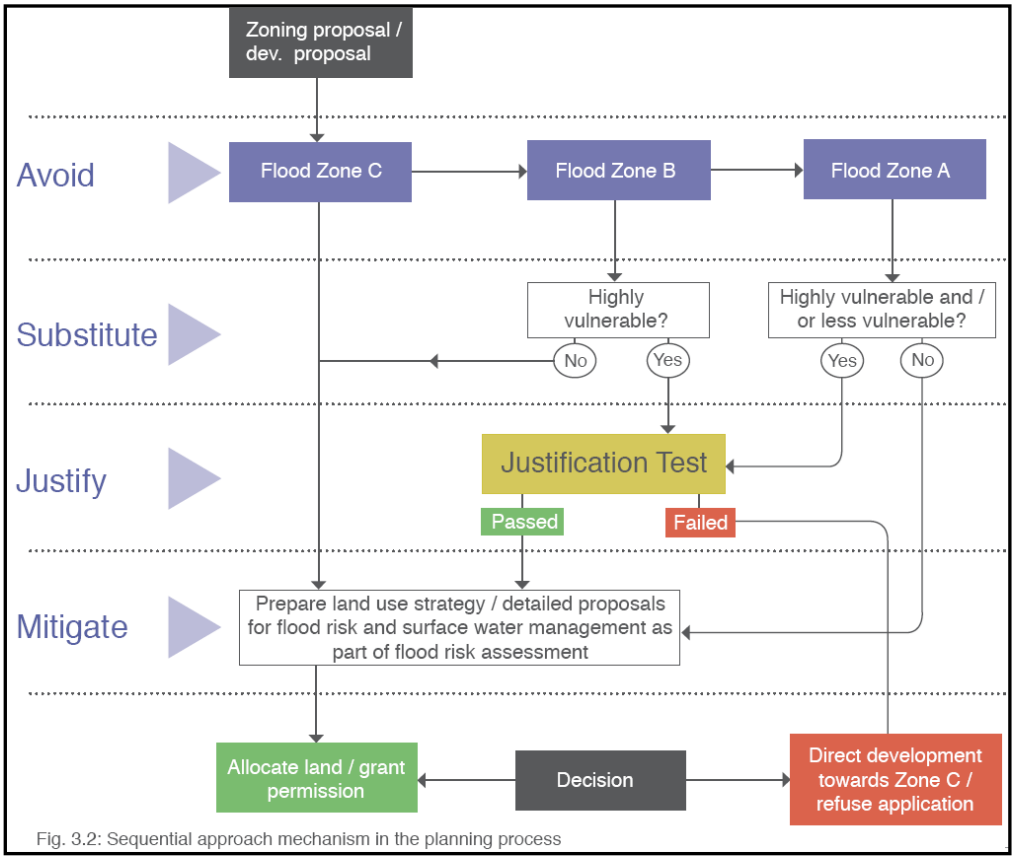

Fig. 3.2: Sequential approach mechanism in the planning process

According to the FRM Guidelines, Flood Zones are graphical areas within which the likelihood of flooding is in a particular range. They are a key tool in flood risk management within the planning process as well as in flood warning and emergency planning. There are three Flood Zones, namely,

Flood Zone A – where the probability of flooding from rivers and the sea is highest (greater than 1% AEP or 1 in 100 year for river flooding or 0.5% or 1 in 200 for coastal flooding);

Flood Zone B – where the probability of flooding from rivers and the sea is moderate (between 0.1% AEP or 1 in 1000 year and 1% AEP or 1 in 100 year for river flooding and between 0.1% AEP or 1 in 1000 year and 0.5% AEP or 1 in 200 year for coastal flooding); and

Flood Zone C – where the probability of flooding from rivers and the sea is low (less than 0.1% AEP or 1 in 1000 for both river and coastal flooding). Flood Zone C covers all areas of the plan which are not in zones A or B.

Flood Zones A, B and C are based on the current assessment of the 1% AEP and the 0.1% AEP fluvial events and the 0.5% AEP and 0.1% AEP tidal events, without the inclusion of climate change factors. Table 3.1 of the FRM Guidelines (see below) shows the classification of the vulnerability to flooding of different types of development.

Vulnerability class	Land uses and types of development which include*:
Highly vulnerable development (including essential infrastructure)	Garda, ambulance and fire stations and command centres required to be operational during flooding; Hospitals; Emergency access and egress points; Schools; Dwelling houses, student halls of residence and hostels; Residential institutions such as residential care homes, children's homes and social services homes; Caravans and mobile home parks; Dwelling houses designed, constructed or adapted for the elderly or, other people with impaired mobility; and Essential infrastructure, such as primary transport and utilities distribution, including electricity generating power stations and sub-stations, water and sewage treatment, and potential significant sources of pollution (SEVESO sites, IPPC sites, etc.) in the event of flooding.
Less vulnerable development	Buildings used for: retail, leisure, warehousing, commercial, industrial and non-residential institutions; Land and buildings used for holiday or short-let caravans and camping, subject to specific warning and evacuation plans; Land and buildings used for agriculture and forestry; Waste treatment (except landfill and hazardous waste); Mineral working and processing; and Local transport infrastructure.
Water-compatible development	Flood control infrastructure; Docks, marinas and wharves; Navigation facilities; Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location; Water-based recreation and tourism (excluding sleeping accommodation); Lifeguard and coastguard stations; Amenity open space, outdoor sports and recreation and essential facilities such as changing rooms; and Essential ancillary sleeping or residential accommodation for staff required by uses in this category (subject to a specific warning and evacuation plan).
*Uses not listed here should be considered on their own merits	

Table 3.1 Classification of vulnerability of different types of development

Table 3.2 of the FRM Guidelines (shown below) identifies the types of development that would be appropriate for each Flood Zone and those that would be required to meet the Justification Test. Since the Proposed Development is considered essential infrastructure and therefore, is classified as 'Highly vulnerable development', the section highlighted in Table 3.2 presents the required actions for each flood zone.

These "Highly vulnerable development" would only be appropriate in Flood Zone C or within Flood Zone A or B if they pass the Justification Test. The Proposed Development consists of the upgrade of existing roads to include Bus lanes, cycling and pedestrian infrastructure, amongst others. This will require widening of the existing road which will have to be assessed to determine if it will encroach on a Flood Zone A or B; in addition, if the Proposed Development is currently on one of these zones, the assessment is required to determine if the current situation has been made worse. This will be determined in Section 4 of the report.

	Flood Zone A	Flood Zone B	Flood Zone C
Highly vulnerable development (including essential infrastructure)	Justification Test	Justification Test	Appropriate
Less vulnerable development	Justification Test	Appropriate	Appropriate
Water-compatible development	Appropriate	Appropriate	Appropriate

Table 3.2: Matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test.

The FRM Guidelines (Chapter 2) outlines the following three stages of flood risk assessment:

Stage 1: Flood risk identification – to identify whether there may be any flooding or surface water management issues relating to the proposed development site that may warrant further investigations.

Stage 2: Initial flood risk assessment – to confirm sources of flooding that may affect the proposed development site, to appraise the adequacy of existing information and to determine what surveys and modelling approach is appropriate to match the spatial resolution required and complexity of the flood risk issues. This stage involves the review of existing studies and hydraulic modelling to assess flood risk and to assist with the development of FRM measures.

Stage 3: Detailed flood risk assessment – to assess flood risk issues in sufficient detail and to provide a quantitative appraisal of potential flood risk to a proposed or existing development, of its potential impacts on flood risk elsewhere and of the effectiveness of any proposed mitigation measures. This will typically involve use of an existing or construction of a hydraulic model across a wide enough area to appreciate the catchment wide impacts and hydrological process involved.

3 DRAINAGE AND HYDROLOGICAL CHARACTERISTICS

3.1 Existing Drainage Description

Based on the information received from Irish Water and Galway City Council, the Proposed Development is serviced by surface water and foul/combined drainage networks.. Flows are typically collected in standard gully grates and routed via a gravity network to outfall points. There are no formal SuDS/attenuation measures on the existing drainage networks to treat or attenuate run-off from the existing highway. There are some grassed areas and trees adjacent to paved areas which will provide some treatment of surface water runoff, but these have not been designed specifically as SuDS features.

A study based on information supplied by Irish Water and Galway City Council, indicated that the study area is split across seven catchments.. There are no existing watercourses and culverts crossing the Proposed Dublin Rd development. Therefore, the majority of drainage networks currently outfall to the sea eventually (Corrib Estuary and Oranmore Bay) and one network outfalls to Mutton Island Wastewater Treatment Plant.

3.2 Overview of Impacts of Proposed Works on Drainage / Runoff

The proposed works involve the widening of the existing road to incorporate bus lanes, cycle lanes and pedestrian footpaths. Therefore, an assessment was carried out on the existing drainage network and proposed works to determine the change in impermeable surface area along the Proposed Development.

The existing drainage network was split into catchments and each catchment area was broken down into relevant networks to determine the change in impermeable surface area along the Proposed Development. Where there is a net increase in impermeable surface area, a form of attenuation/mitigation is required prior to discharge. Consequently, where there is no net change or net decrease, then no form of attenuation will be required prior to discharge. A summary list of the networks, the associated chainage, and impermeable and permeable surface area differential is given in Table 3-1 .

Table 3-1 Summary of Increased Permeable and Impermeable Areas

Existing Catchment Reference	Network Reference	Chainage (m)	Road Corridor Area (m^2)	Change in Impermeable areas (m^2)	Change in Permeable areas (m^2)	Net Change in Impermeable areas (m^2)	Percentage Change (%)
Catchment Area 1	Network 1	0+000 to 0+360	8083	1726	322	1404	17
Catchment Area 3	Network 2	0+360 to 0+630	6241	656	38	618	10
Catchment Area 5	Network 3	0+630 to 1+140	12361	1884	686	1198	10
Catchment Area 5	Network 4	1+140 to 1+370	7171	1872	459	1413	20
Catchment Area 5	Network 5	1+370 to 1+650	9973	-958	1503	-2461	-25
Catchment Area 6	Network 6	1+650 to 2+175	12127	2461	0	2461	20

Catchment Area 6	Network 7	2+175 to 3+030	18820	3868	29	3839	20
Existing Catchment Reference	**Network Reference**	**Chainage (m)**	**Road Corridor Area (m^2)**	**Change in Impermeable areas (m^2)**	**Change in Permeable areas (m^2)**	**Net Change in Impermeable areas (m^2)**	**Percentage Change (%)**
Catchment Area 7	Network 8	3+030 to 3+800	19463	483	2108	-1625	-8
Catchment Area 7	Network 9	3+800 to 3+880	3310	373	0	373	11

3.3 Proposed Surface Water Drainage

The existing drainage networks are to be maintained and utilised as the main outfalls for the new drainage system. The design aims to replicate the existing situation where possible.

The following drainage elements are proposed:

- Sealed Drainage Systems.
- SuDS features. These were incorporated into the design where practicable.
- Oversized Storage Pipes.
- Gully gratings.
- Attenuation Storage Tanks incorporating flow control.
- Petrol Interceptors/ Bypass oil separators.

The proposed storage/ attenuation measures for each proposed network are summarised below in Table 3-2.

Table 3-2 Summary of proposed storage/attenuation measures and outfall locations

Network	Location	Approx. Impermeable Surface Area		Potential storage / attenuation measure	Network Outfall(s)	Final Discharge Point
		Existing (m^2)	Net Change (m^2)			
Network 1	0+000 to 0+360	6305	+1404	5.5m^3 oversized pipes	Outfall 1 - Mainline 0+033	Lough Atalia SAC
Network 2	0+360 to 0+630	5547	+618	8.9 m^3 oversized pipes	Outfall 2 – Mainline 0+360	Mutton Island WWTP
Network 3	0+630 to 1+140	9791	+1198	7 m^3 oversized pipes	Outfall 3 – Mainline 0+915	Ballyloughane Beach SAC
Network 4	1+140 to 1+370	4840	+1413	4.8 m^3 oversized pipes	Outfall 3 – Mainline 1+147	Ballyloughane Beach SAC
Network 5	1+370 to 1+650	9428	-2461	No attenuation provided	Outfall 5 – Skerrit Roundabout (south); Outfall 6 – Mainline 1+650	Ballyloughane Beach SAC
Network 6	1+650 to 2+175	9576	+2461	6.4 m^3oversized pipes	Outfall 7 – Mainline 2+170 / Existing 1500mm storm sewer tie in	Galway Bay SAC-North of Rabbit Island
Network 7	2+175 to 2+410	4557	+932	4 m^3oversized pipe	Outfall 7 – Existing 1500mm storm sewer tie in at Gleann Na Ri via rising main and proposed 225mm carrier drain.	Galway Bay SAC-North of Rabbit Island
Network 7	2+410 to 3+030	10366	+2907	Online attenuation tank – 85m x 5m x 3m deep	Outfall 7 – Existing 1500mm storm sewer tie in at Gleann Na Ri via rising main and proposed 225mm carrier drain	Galway Bay SAC-North of Rabbit Island
Network 8	3+030 to 3+800	16872	+1685	Online attenuation tank – 75m x 5m x 3m deep	Outfall 7 – Existing 1500mm storm sewer tie in at Gleann Na Ri via rising main and proposed 225mm carrier drain	Galway Bay SAC-North of Rabbit Island
Network 9	3+800 to 3+880	2937	+373	No attenuation provided – connect to existing 225mm storm network.	Outfall 9 – Mainline 3+810	Inner Galway Bay SAC – Near South Coast Rd

3.4 Existing Flood Studies

3.4.1 OPW CFRAM Study

The OPW, through its Catchment Flood Risk Assessment and Management (CFRAM) Programme, carried out the largest ever flood risk study in Ireland to date, undertaking a detailed engineering assessment of over 300 areas or communities believed to be at significant flood risk. A key output of the CFRAM Study

was the development and publishing of 40,000 flood maps showing the flood risk of communities throughout the country.

Fluvial and Coastal Flood Extent Mapping were reviewed as part of this report. The Western (CFRAM) Study covers this area of Galway but the flood extents don't impact on the development. Whilst the CFRAM maps do not show any flooding of the development, the CFRAM Mapping shows flooding around other areas near the Proposed Development such as the Lough Atalia which is affected by tidal flooding. The flood maps show the 10%, 1% and 0.1% AEP and are publicly available through the OPW website. An extract from the flood map produced for this area for the Current Scenario is shown in Section 4 below.

Localised flooding from sources other than rivers and the coast can still occur within Flood Zone A, B or C and need to be taken into account in the preparation of any Flood risk Assessment. Flooding from other sources does not inform the extents of the flood zones, in accordance with the Guidelines. Other potential sources of flooding that may affect the Proposed Development are examined in the Section 4 of this report.

3.4.2 Galway City Development Plan (2023-2029)

The Galway City Development Plan 2023-2029 sets out the policies and objectives for the development of the City over the plan period. The approach to Flood Risk Assessment is set out in Chapter 9.2 in Volume 1 of the Plan and in the Strategic Flood Risk Assessment (SFRA) in Volume 3.

In addition, Chapter 4 "Sustainable Mobility and Transportation" outlines the policy approach that aims to establish a more sustainable strategy to address current and future transport requirements .It focuses on reducing car dependency and supports a transition towards increased use of more sustainable active modes and public transport. The BusConnects Programme is a key part of Government Policy and Galway Transport Strategy (GTS) to improve public transport and address climate change. Bus Routes, Cycle Network and other proposed infrastructure as part of the BusConnects Galway are shown in the Land Use Zoning and Specific Objectives Map.

The SFRA of the Galway City Development Plan 2023-2029 includes a review of the land-use zonings in relation to flood risk and also recommends flood risk management policies and objectives. This was prepared in accordance with The Planning System and Flood Risk Management Guidelines for Planning Authorities and Technical Appendices, 2009. This SFRA is available as a stand-alone document on the Galway City County Council website at https://www.galwaycity.ie/development-plan-2023-2029 .

Section 5.4 "Drainage impact assessment" of the SFRA establishes the requirements of all proposed development, whether in Flood Zone A, B or C. It also considers the impact of surface water flood risks on drainage design, as required under Section 9.5 (SuDS) of the Development Plan.

4 FLOOD RISK ASSESSMENT

4.1 Introduction

As outlined in Section 2 of this report, the FRM guidelines identifies three stages of Flood Risk Assessment namely;

- Stage 1: Flood Risk Identification.
- Stage 2: Initial Flood Risk Assessment.
- Stage 3: Detailed Flood Risk Assessment.

4.2 Stage 1 – Flood Risk Identification

4.2.1 Past Flood Events

Records of past flood events were obtained from the OPW National Flood Hazard Mapping website (www.floodmaps.ie) and reports produced using the information submitted by Local Authorities and CFRAM Consultants.

An extract from the National Flood Hazard Mapping website report summary, indicating the locations of recorded flood events, is shown in Figure 3. There are no records of flood events occurring within the vicinity of the proposed development.

Figure 4 Past Flood Events – (Background: © Open Street Map)

The area approximately 680 m north of the Proposed Development is indicated to have flooded in the past while south of the development, there have been several flood events in Galway City, approximately 2 km away from the site location.

4.2.2 Fluvial Flood Risk Map

The Western CFRAM was completed in recent years and provided predicted fluvial and tidal flood maps in Galway City for a range of return periods.

There are no watercourses intersecting or adjacent to the Proposed Development, therefore, the Site is not in a fluvial flood risk area.

An extract from the National Flood Hazard Mapping Website is presented in Figure 4. The predicted extents for the 1 in 10-, 100- and 1000-year fluvial flood events are shown.

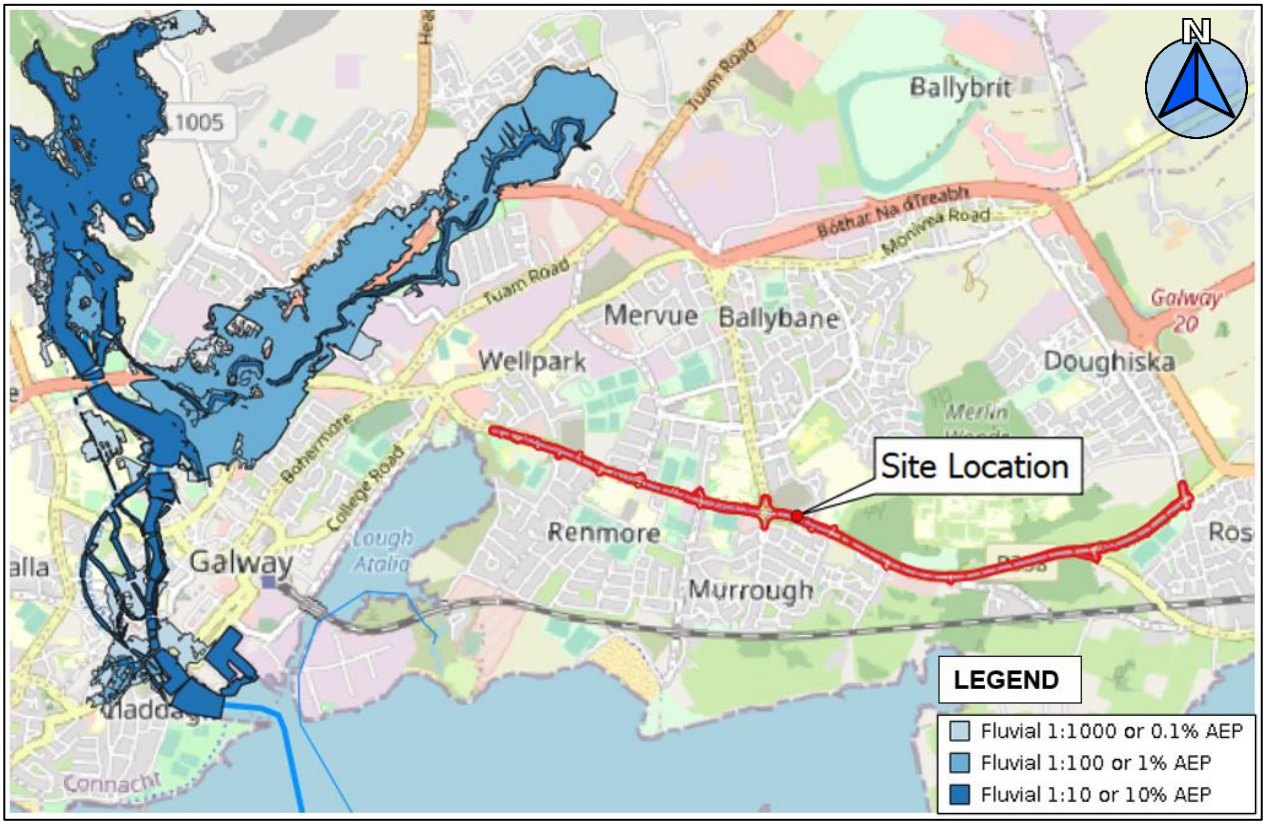

Figure 5 CFRAM River Flood Extents - Extract from National Flood Hazard Mapping Website, Current Scenario-(Background: © Open Street Map)

4.2.3 Tidal Flood Risk Map

An extract from the National Flood Hazard Mapping Website is presented in Figure 5. The predicted extents for the 1 in 10-, 200- and 1000-year tidal flood events are shown.

The flood map indicates that the site is outside of the tidal flood extents for the different return periods. However, the western tie in of the development is very close to the flood extent for all the flood events (approximately 60 m away).

Figure 6 CFRAM Tidal Flood Extents - Extract from National Flood Hazard Mapping Website, Current Scenario--(Background: © Open Street Map)

4.2.4 Pluvial Flooding

Pluvial flooding occurs when extreme rainfall overwhelms drainage systems or the soil infiltration capacity, causing excess rainwater to pond above ground at low points in the topography.

There have been no recorded instances of pluvial flooding events at the site. The Proposed Development will create additional impermeable area through widening of the carriageway and without mitigation it would lead to increased run off rates and faster time to peak flow in the existing drainage network.
The increase in pluvial risk to the site will be mitigated with SuDS and a drainage system which will contain oversized pipes. These measures will provide attenuation and ensure there is no increase in pluvial flood risk to the site.

4.2.5 Groundwater Flooding

Groundwater flooding can occur during lengthy periods of heavy rainfall, typically during late winter/early spring when the groundwater table is already high. If the groundwater level rises above ground level, it can pond at local low points and cause periods of flooding.

To assess the risk of groundwater flooding to the site, the Geological Survey Ireland (GSI) Groundwater Flooding Probability maps were obtained from floodinfo.ie.

An extract of the map is presented in Figure 7. It should be noted that the groundwater flooding data maps are only indicative. These maps are developed to indicate areas of high groundwater likelihood given the karst limestone rock formation found in this western area of the country.

The map suggests that the site and areas in the vicinity are not identified at risk of groundwater flooding.

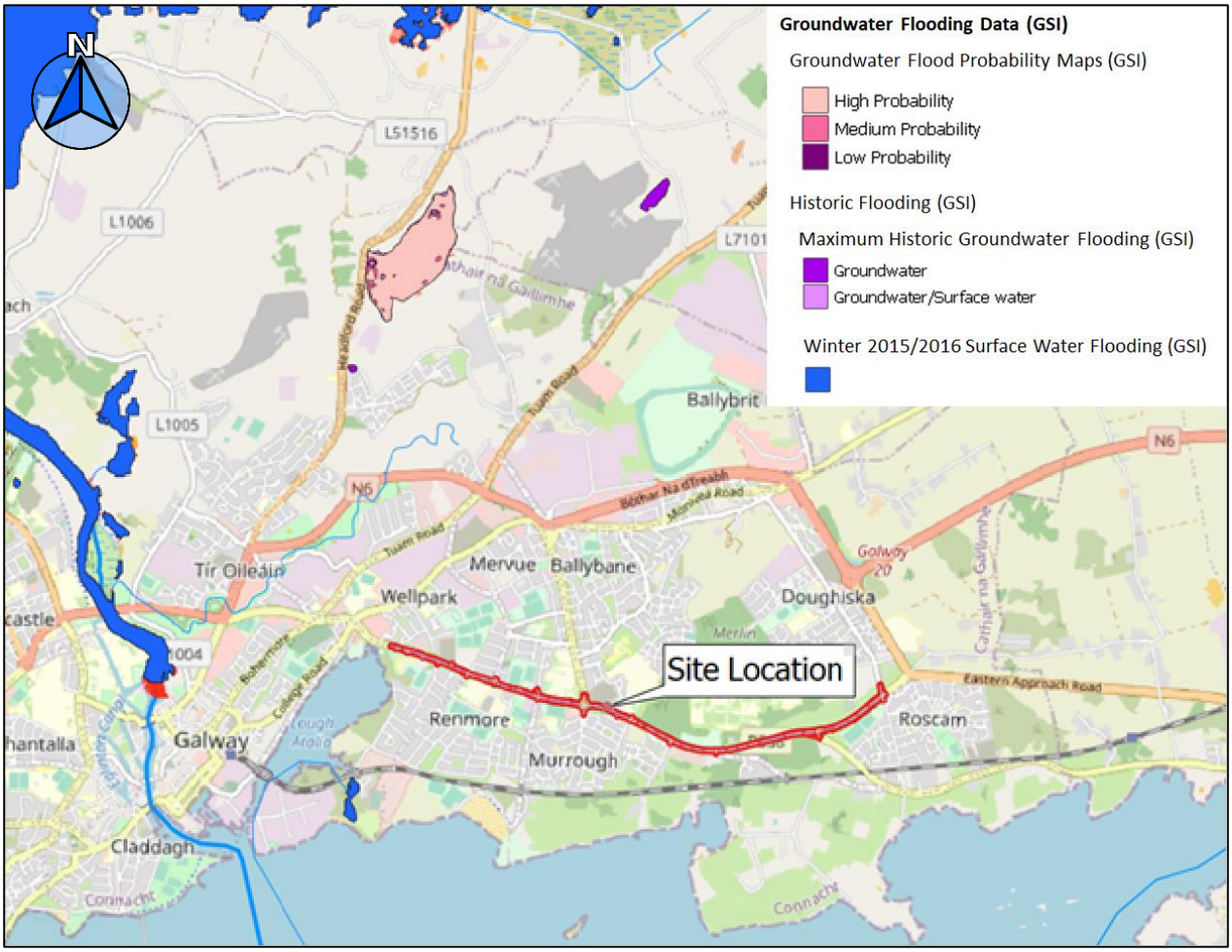

Figure 7 Extract from GSI Groundwater Flood Map (floodinfo.ie)- (Background: © Open Street Map)

Figure 8 presents information on the Geological Survey of Ireland (GSI) groundwater vulnerability at the Proposed Development. It can be seen from the figure that the groundwater vulnerability is indicated as Extreme Vulnerability for at least half of the site on the eastern side, with High and Moderate Vulnerability on the western half of the development and a small area of Rock at or near surface in other locations.

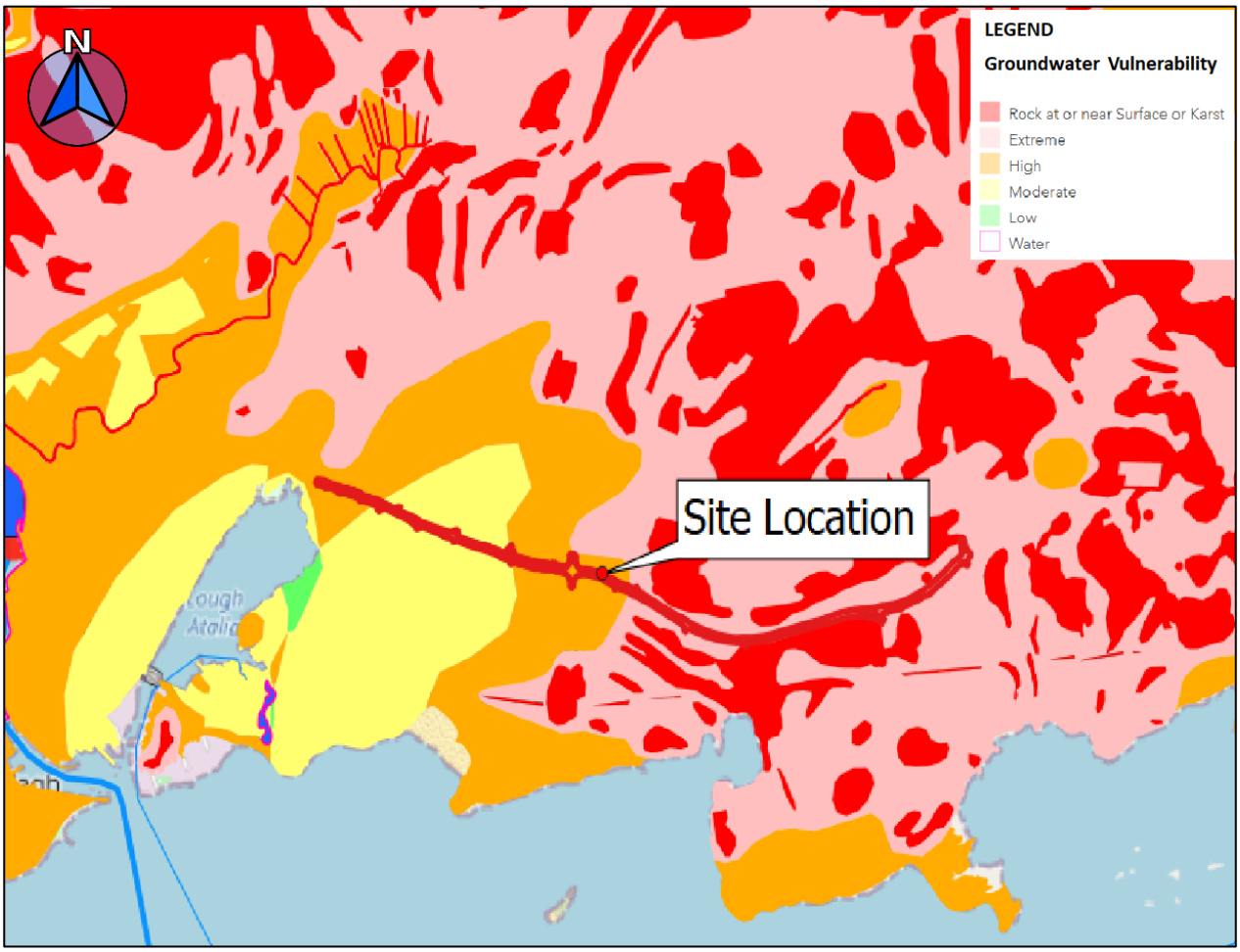

Figure 8 Extract from GSI spatial resources Groundwater Vulnerability Mapping

4.2.6 Mechanical/Operational Failure

Networks 7 and 8 convey flows to the existing drainage via two stormwater rising main pumps. The failure of the pumping stations or a power outage has the potential to cause flooding.

4.2.7 Conclusion of Stage 1 - FRA

The various sources of flooding were assessed and was determined that the site is at low risk of fluvial and coastal flooding (Flood Zone C) but there is a moderate risk of pluvial and groundwater flooding. There is also a risk of flooding from failure of the pumping stations that is assessed as a moderate/high risk.

The Proposed Development is considered a Highly Vulnerable Development but since it is not located in a Flood Zone A or B, the Site is not subject to a Justification Test as per the Guidelines. The purpose then of this FRA is the management and mitigation of surface water flooding that could be caused by the development or current surface water issues.

5 FLOOD RISK AND MITIGATION

5.1 Flood Risk

Sections 3 and 4 of this report described the drainage and hydrological characteristics of the existing and proposed development as well as existing flood studies. This confirmed that there might be a moderate risk of pluvial and groundwater flooding as well as moderate/high risk from mechanical/operational failure of the pumps that requires to be considered in the design.

5.2 Mitigation

The following flood risks are present and mitigation measures have been proposed as follows:

- **Increase in impermeable surface areas through widening of the carriageway.** Road drainage outfalls discharging to receiving surface water networks without flow attenuation could increase downstream flows and cause local flooding. This has been mitigated in the drainage design through suitably sized attenuation storage tanks incorporating flow control ,oversized storage pipes and SuDS measures. Oversized storage pipes will provide additional capacity within the drainage system and reduce the likelihood of surface water surcharge onto the public road during an intense storm event.
  In addition, the proposal includes other drainage design measures such as additional gullies which will provide additional capacity within the system.
- **2 No. Surface water pump stations at low points in Networks 7 and 8.** There is a flood risk associated with this system as it is at risk from power outages, and mechanical failures. The attenuation tanks are designed so that surface water will not flood the public road, in the case of pump failure.
- As with all drainage systems, the new drainage system had the potential to become blocked, which could cause flooding. A routine maintenance plan of the drainage system is proposed as a mitigation measure.

Residual risk is defined as risks that remain after all risk avoidance, substitution and mitigation measures have been taken. Following the mitigation measures proposed for the various flood risk sources, the moderate risk of pluvial and moderate/high risk for the mechanical/operational failure of the pumps have been reduced to acceptable levels. However, there is always a residual risk and flood risk is never zero but this risk can be managed during the construction and operation of the Proposed Development.

6 CONCLUSIONS

This FRA was carried out as part of the Planning Application for the proposed Bus Connects Galway: Dublin Road.

- The Proposed Development is at low risk of fluvial and tidal floodings (Flood Zone C). Flood risk from pluvial, groundwater and mechanical/operational failure of the pumps have also been assessed for the construction and operation stages of the development. The initial flood risk was found to be moderate for pluvial and moderate/high for the pump failure.
- Mitigation measures have been included for the proposed drainage works which has reduced the flood risk to acceptable levels. Surface water management measures including upgraded surface water drainage system, additional green area and SuDS features, oversized pipes and attenuation tanks with flow control are incorporated in the design.
- The scope of the Proposed Development is in keeping with the existing road profile and does not increase the risk of flooding elsewhere.

In conclusion, there is still some residual risk but these can be managed during the construction and operation phases of the Proposed Development. This FRA has demonstrated that the Proposed Development is in compliance with the core principles of the Planning System and Flood Risk Management Guidelines for Planning Authorities.