Raheen
Flood Risk Assessment

Technical Report

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DW Raheen Developments Ltd

JBA Project Manager

Ross Bryant
24 Grove Island
Corbally
Limerick
Ireland

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Contract

This report describes work commissioned by Gary Lawlor of Lawlor Burns & Associates on behalf of DW Raheen Developments Ltd, by an email dated August 2017. Ross Bryant, Orla Hannon and Paul Browne of JBA Consulting carried out this work.

Prepared by ..... Orla Hannon BSc (Hons)
Assistant Analyst

Paul Browne BEng (Hons) MIEI
Assistant Engineer

Reviewed by ..... Ross Bryant BSc MSc CEnv MCIWEM C.WEM
Principal Analyst

Purpose

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Abbreviations

AEP	Annual Exceedance Probability
CFRAM	Catchment Flood Risk Assessment and Management
DECLG	Department of Environment, Community and Local Government
DoEHLG	Department of the Environment, Heritage and Local Government
EPA	Environmental Protection Agency
FRA	Flood Risk Assessment
GDSDS	Greater Dublin Strategic Drainage Strategy
GSI	Geological Survey of Ireland
LAP	Local Area Plan
mOD	Meters above Ordnance Datum
OPW	Office of Public Works
PFRA	Preliminary Flood Risk Assessment
SFRA	Strategic Flood Risk Assessment

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 (FRA) to ensure sustainability and effective management of flood risk.

1.1 Terms of Reference

JBA Consulting was appointed by DW Raheen Developments Ltd to prepare an FRA for the proposed development of a site located in Raheen, Co. Limerick.

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 development proposal is outlined as follows:

DW Raheen Developments Ltd. are seeking a ten year permission for a strategic housing development consisting of the provision of 384 residential house and apartment units on a ca. 10.44 hectare site located in Ballykeeffe, Raheen, Co. Limerick.

The site is greenfield land that is enclosed by existing residential development to the south and east, the R510 to the west and open land to the north. Access to the site is provided by an existing entrance off a roundabout on the R510 regional road.

The proposed development will provide as follows:

- 202 no. housing units, comprising a variety of forms to include bungalows, detached, semi-detached and terraced houses. A mix of house sizes are proposed to include 20 no. two bedroom houses, 156 no. three bedroom houses and 26 no. four bedroom houses.
- 182 apartment and duplex units across 25 small scale blocks, 2 to 4 storeys in heights, throughout the development. The apartments and duplexes provide a mix of one, two, three and four bed units, comprising of 10 no. four bedroom duplex units, 10 no. three bedroom duplex units, 6 no. two bedroom duplex units, 18 no. three bedroom apartments, 92 no. two bedroom apartments and 46 no. one bedroom apartments.

The proposed development also includes;

- A childcare facility measuring 761.75m2, providing 79 childcare places (55 full time and 24 after school places), located at the south-western edge of the development.
- The provision of 377 no. car parking spaces and 311 secured bicycle parking spaces.
- The provision of 3 no. ESB sub-stations, ancillary services and infrastructure works including foul and surface water drainage, attenuation areas, landscaped public open spaces (approximately 29,500m2, or 28.2% of the total site area), landscaping, lighting, internal roads, cycle paths, and footpaths.

A Natura Impact Statement (NIS) and Environmental Impact Assessment Report (EIAR) have been prepared in respect of the proposed development.

Refer to Figure 1-1 for the proposed development overview.

Figure 1-1 Proposed Development Overview (Source: Gleeson McSweeney Architects)

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. Site specific mitigation measures are outlined in Section 0, while conclusions are provided in Section 5.

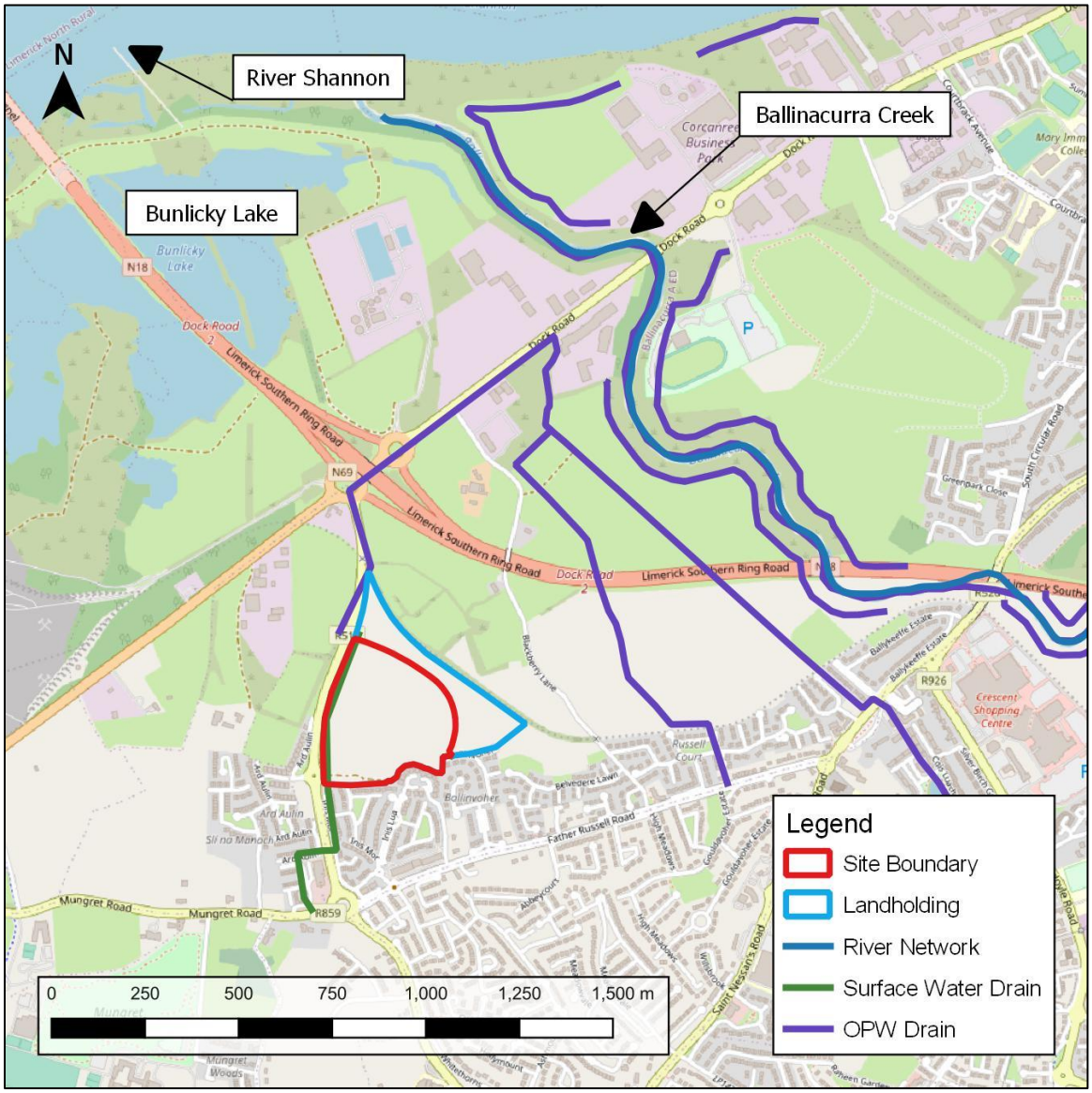
2 Site Background

This section describes the proposed residential development site in Raheen, Co. Limerick, including watercourses, geology and wider geographical area.

2.1 Location

The proposed development site is located in Raheen to the west of Limerick City, refer to Figure 2-1. Access to the site is via the R510 which also defines the western boundary of the site. A disused railway line defines the eastern boundary of the site while residential developments are adjacent to the southern boundary. The area surrounding the site is characterised by a mixture of agricultural, residential and commercial land use.

Figure 2-1 Site Location



2.2 Site Visit

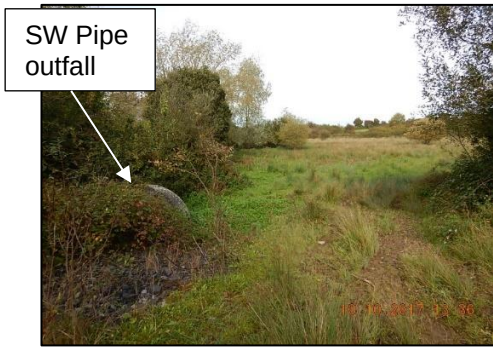
A site visit was undertaken by JBA Consulting on 10/10/2017, refer to Figure 2-2 for site photographs.

The general profile of the site is sloping towards the north, with an isolated high point to the east of the site (10.75mOD). There is a drop in slope at the northern triangle which is very boggy in comparison to the rest of the site (Figure 2-2 C). A 2.1m surface water pipe has an outfall in the northern corner which exacerbates the wet ground conditions. A submerged headwall was observed directly south of the dis-used railway line which indicates a possible culvert providing an outfall for the surface water on site. An inlet for an OPW channel was found in a field west of the site (Figure 2-2 D), and a double culvert was observed directly north of the dis-used railway line. The surface water collected at the north of the site connects with the OPW channel at this double culvert. Surface water of the site is discussed further in Section 2.3.2.

Figure 2-2 Site Photographs

A) Site, looking north

B) Surface water drain outlet, looking south



C) Marshy area to the north of site

D) Inlet for OPW drainage channel (red circle)

2.3 Watercourses

2.3.1 Fluvial

The main fluvial watercourses are identified as the River Shannon/Estuary located c.1.5km to the north and the Ballinacurra Creek located c. 1km to the east, as seen in Figure 2-1. Bunlicky Lake which is a man-made lake is located c.400m to the north. Both the River Shannon and Ballinacurra Creek have flood protection embankments which will be discussed further in Section 2.4.

2.3.2 Surface Water

As discussed in Section 2.2, the 2.1m surface water pipe running through the site discharges to the northern triangle of the site. As the R510 and the railway line are at much higher levels compared to the northern section of the site, the surface water is contained within this marshy section, which is utilised as an attenuation area for Raheen (see hatched green area in Figure 2-3). An OPW Scheme Channel, C1/1/1, runs along the north west corner of the site in a north easterly direction where it discharges into the Ballinacurra Creek via sluice (Refer to Figure 2-4). The surface water from the site, including the outfall from the 2.1m pipe, drains into this OPW channel at a double culvert directly north of the dis-used railway line, a separate connection is also provided, closer to the 2.1m outfall. There is a possible junction along the C1/1/1 channel which diverts some of the flow into the Bunlicky Lake.

Figure 2-3 Schematic 1 of Surface Water Drainage

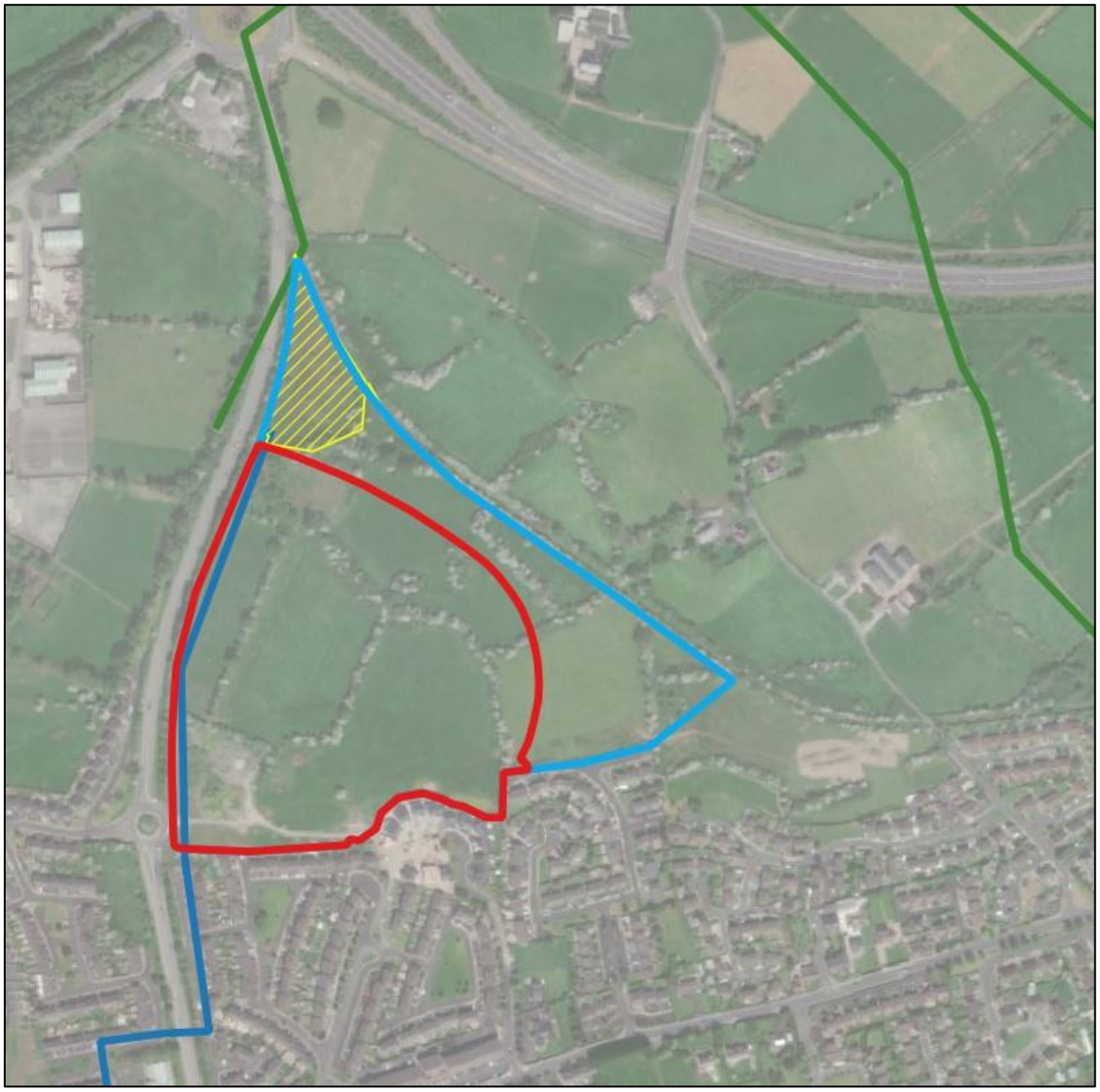
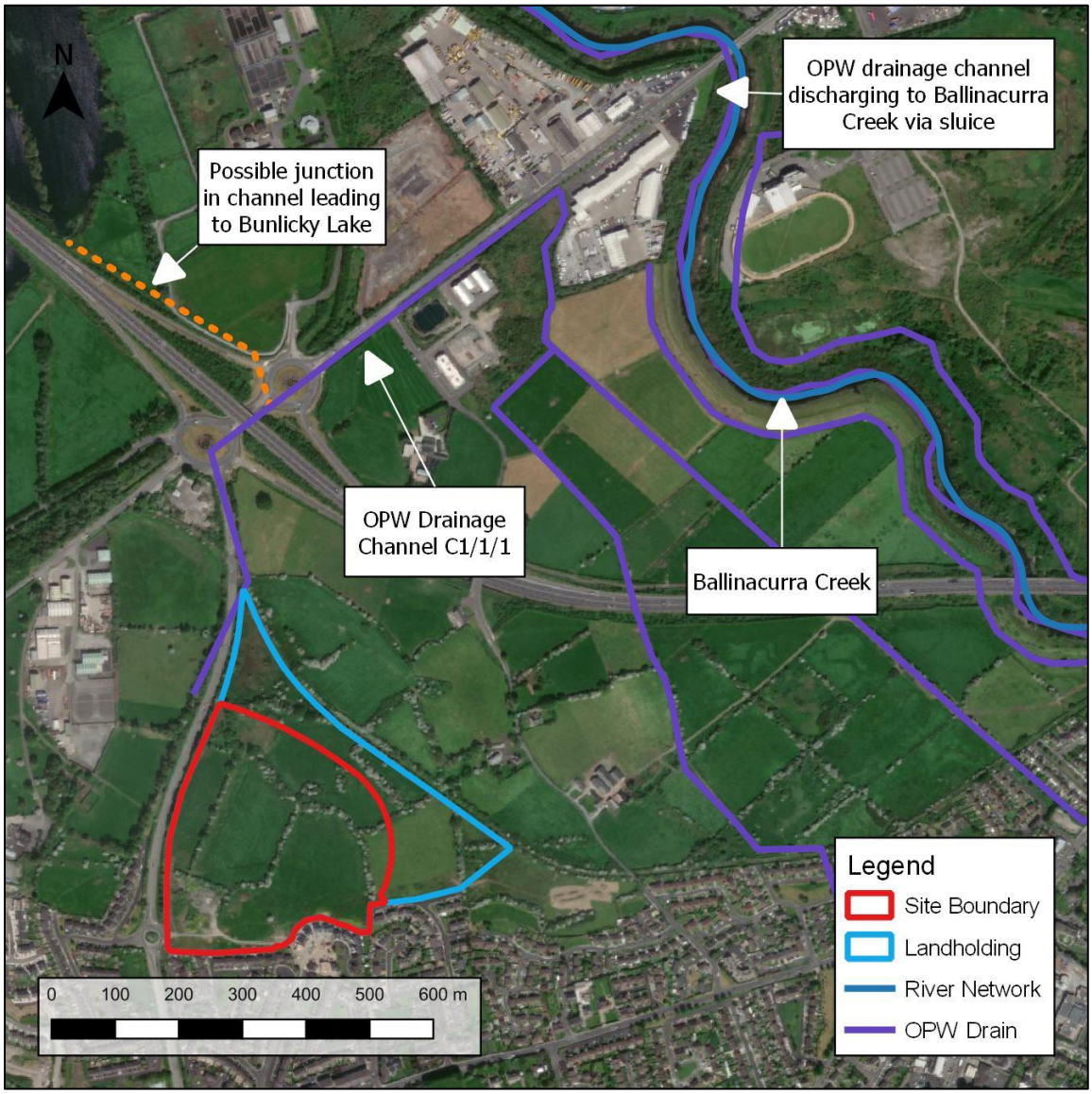


Figure 2-4 Schematic 2 of Surface Water Drainage



Schematics based on Mungret Surface Water Drainage (Appendix B), OPW Arterial Drainage (Appendix C), Limerick Tunnel PPP Scheme - Drainage Layout (Appendix D) and site visit.)

2.4 River Embankments

In recognition of the risks presented from fluvial and tidal flooding in the area, a system of flood embankments has been constructed to offer protection from potential flooding.

Flood defence embankments extend along the Ballinacurra Creek from Rossbrien to its mouth at the Shannon and continue along the River Shannon, protecting properties on the N69 Dock Road. Up to the 1960s, these defences were maintained to a level of 3.9mOD along the Shannon. Following an extreme flood event in 1961, when a recorded tide level of 4.2mOD (note that this level was recorded at Ball's Bridge upstream of the city centre) caused widespread flooding, the embankments were raised.

The flood defences consist of earthen embankments that are maintained by the Office of Public Works (OPW), although some lands are in third party ownership i.e. Irish Cement. The embankments protect an area of Limerick that is bound by both the Ballinacurra Creek and River Shannon, and contain significant investments such as the Toll Road, and the surface water pumping station. It is anticipated that these embankments are maintained on a regular frequency.

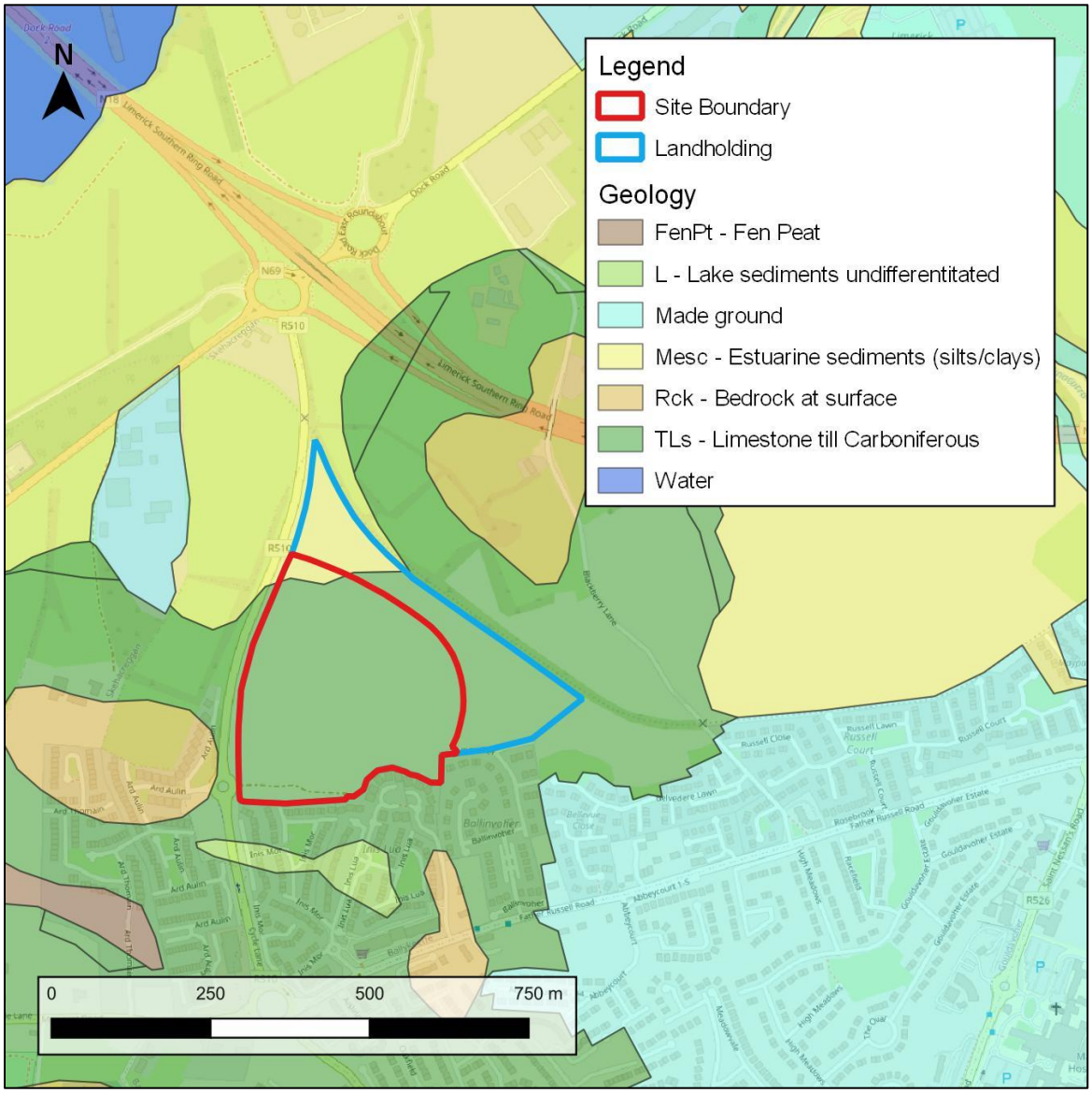
Even though the site is defended, there is still a risk of flooding to the site in the event that the defences fail, either through overtopping or breach; this is termed residual risk. The flood risk associated with sites behind a flood embankment is assessed by carrying out a residual risk analysis, which is explained in more detail in the following sections of the report.

2.5 Site Geology

The groundwater and geological maps of the site, provided by the Geological Survey of Ireland (GSI), have been studied.

The underlying rock is Visean Limestones. The subsoil of the area is mainly Limestone till (Carboniferous) with marine/estuarine silts and clays in the low lying northern section of the site, as seen in Figure 2-5). There are no karst features located within the site or immediate surrounding area. The nearest karst feature is located c.1.5km southwest of the site.

Figure 2-5 Site Subsoils



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. Further detail on the Planning Guidelines and technical concepts are provided in Appendix A.

3.1 Flood History

A number of 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.

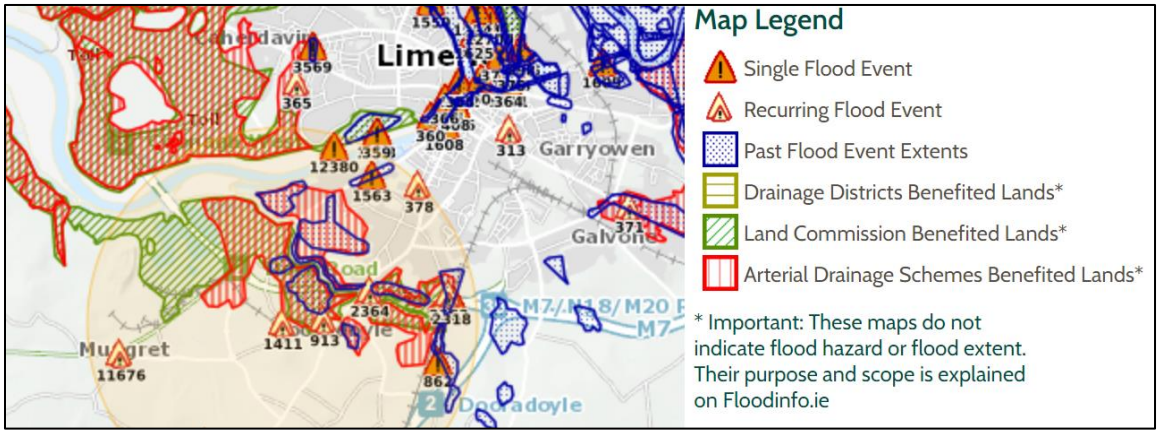
3.1.1 Floodinfo.ie

The Floodinfo.ie website contains no information about historic flooding within the site boundary, however, the following flooding events have been identified within 2km of the site (Figure 3-1), which are as follows:

- Shannon Adjacent Dock Road Limerick Dec 1999
- Ballynaclough River Limerick Dec 1999
- Raheen Dooradoyle, Limerick Feb 1999
- Dooradoyle Limerick Recurring
- Dooradoyle - St Nessans/Fr Russel recurring

It should be noted that the site is partially located within an area defined as benefitting lands from arterial drainage.

Figure 3-1 Floodinfo.ie



3.2 Internet Search

An internet search was conducted to gather information about whether the site was affected by flooding previously. No flooding incidents were recorded at the site.

3.3 Predictive Flood Mapping

The subject area has been a subject of three predicative flood mapping or modelling studies in addition to the LAP:

- OPW Preliminary Flood Risk Analysis (PFRA)
- Shannon Catchment Flood Risk Assessment and Management Study (Shannon CFRAM)
- Irish Coastal Protection Strategy Study (ICPSS)
- Southern Environs Local Area Plan 20121-20127

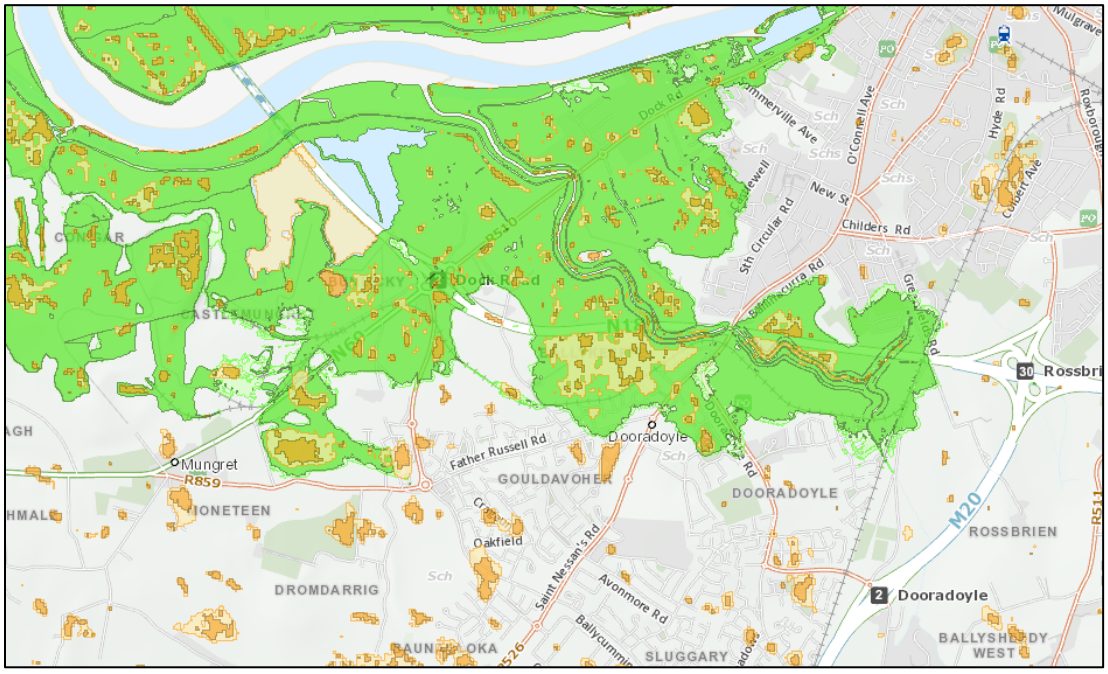
The level of detail presented by each method varies according to the quality of the information used and the approaches involved. The CFRAM is the most detailed assessment of flood extent and supersedes the fluvial flood outlines presented by the OPW PRFA study.

3.3.1 OPW Preliminary Flood Risk Assessment (PFRA)

The preliminary Flood Risk Assessment (PFRA) is a requirement of the EU Flood Directive (2007/60/EC). One of the PFRA deliverables is flood probability mapping for various sources: pluvial (surface water), groundwater, fluvial and tidal. The PFRA is a preliminary or 'indicative' assessment and analysis has been undertaken to identify areas potentially prone to flooding. The OPW PFRA study has been superseded by the latest CFRAM mapping however the PFRA flood map still provides valuable information regarding pluvial and groundwater flooding. See Figure 3-2 for OPW PFRA surface water and coastal flood extents at the site and surrounding area.

Review of the OPW PFRA flood maps highlights no groundwater or fluvial flooding at the site however some coastal flooding is located to the north of the site along with some pluvial flooding to sections to the north and south of the site.

Figure 3-2 OPW PFRA Flood Map



(Source: myplan.ie)

3.3.2 Shannon Catchment Flood Risk Assessment and Management Study (Shannon CFRAM)

The primary source of data with which to identify coastal flood risk is the Shannon CFRAM Study. This study involved detailed hydraulic modelling of the Shannon and its tributaries along with coastal flooding. Raheen is within Unit of Management 24 of the Shannon CFRAM.

Final coastal flood maps for the 10%, 0.5% and 0.1% AEP events for tidal sources are publicly available through the CFRAM Study website, along with fluvial maps for the 10%, 1% and 0.1% AEP events.

Figure 3-3 shows the flood mapping for the Shannon Estuary along with the tidal flood levels. The Flood Maps indicate the site is not at risk of flooding under the current situation However, it is identified as residing in a defended area i.e. protected from flooding due to existing flood defence embankment, therefore the site may be at risk of flooding if failure of the defence embankment occurs. This is discussed further in Section 3.3.2.1 over page. The modelled flood levels and flows for the nearest 'nodes' to the site (01BLN01400, 01BLN01486, 01BLN01813) are presented in Table 3-1.

The fluvial flood maps for the area, provided by the CFRAM, suggest that the area is not at risk of fluvial flooding.

Figure 3-3 Tidal CFRAM Flood Map

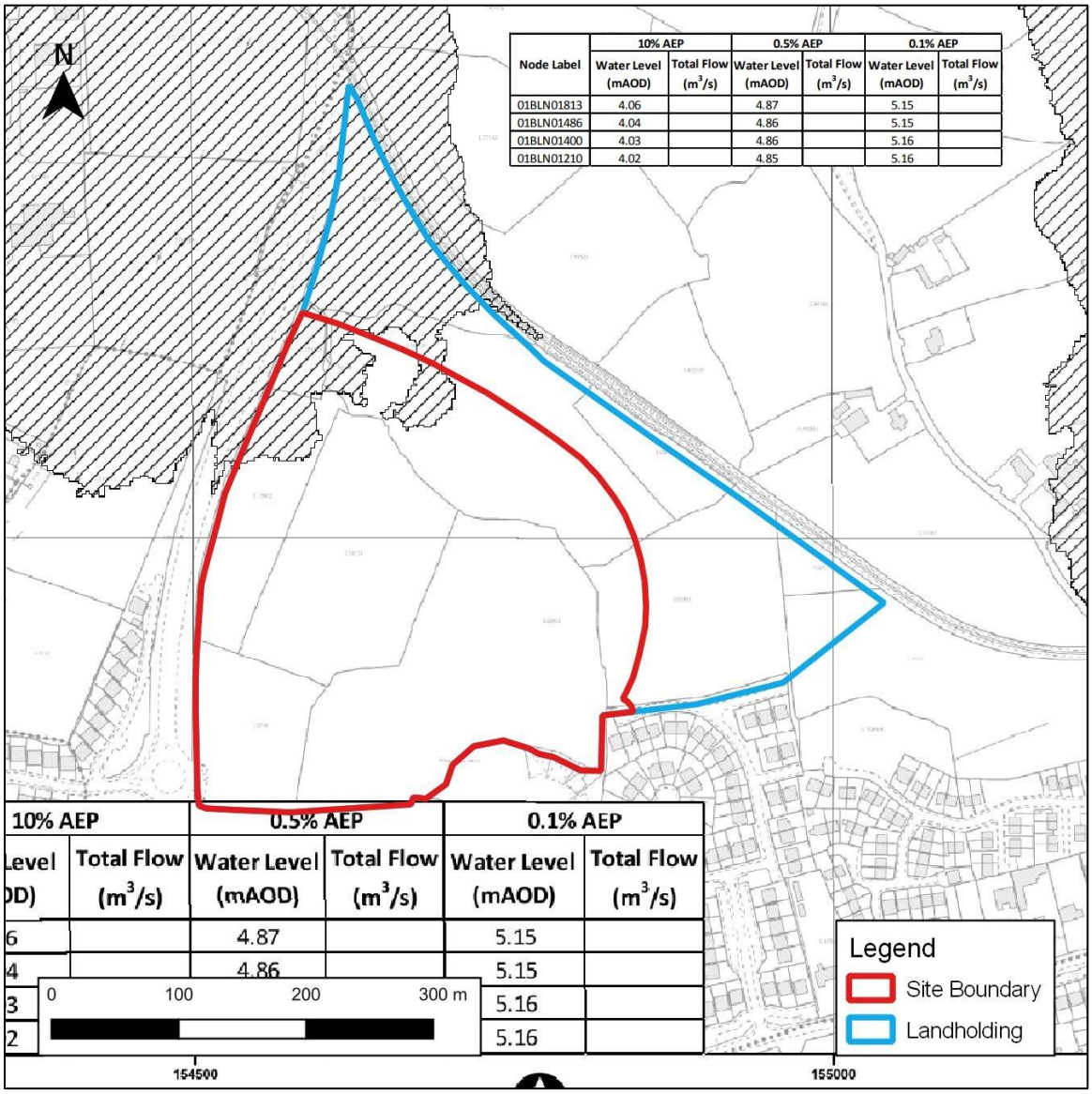


Table 3-1 Modelled Flood Levels

Node Label	Water Level (mAOD)		
	10% AEP	0.5% AEP	0.1% AEP
01BLN01400	4.03	4.86	5.16
01BLN01486	4.04	4.86	5.15
01BLN01813	4.06	4.87	5.15

3.3.2.1 CFRAM Defence Breach and Residual Risk

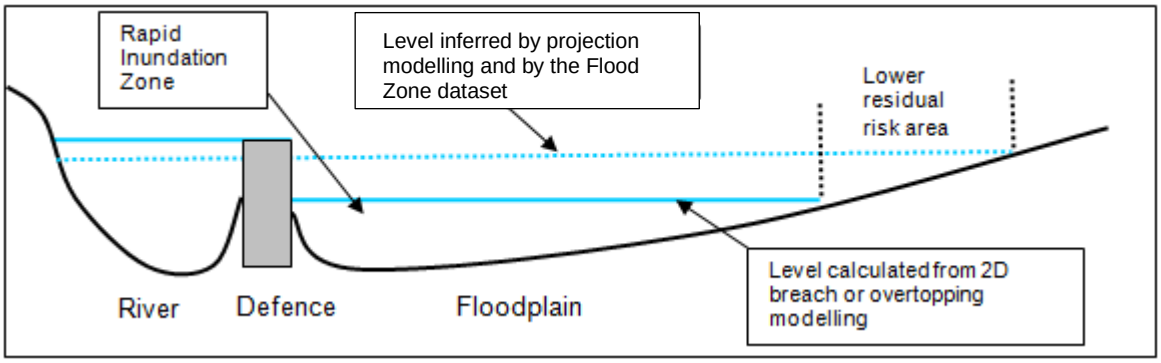
The embankments protecting the site are of earth construction, and however well maintained retain an element of residual flood risk should they fail.

Overtopping of earth embankments generally leads to a catastrophic failure, as the rear face is eroded by the force of water. From the Shannon CFRAM information it was determined that the levels of the flood embankment vary from >4.85mOD to the west of its junction with the Limerick Tunnel to a maximum level of 5.4mOD where the berm intersects the N69 (Dock Road). West of the tunnel the embankment varies from c.4m-5.5mOD.

Considering a tide level of 4.86mOD for a 200-year tide (0.5%AEP) and 5.16mOD for a 1000-year tide (0.1%AEP) overtopping is not anticipated under current conditions for the 200-year event. However, overtopping would be anticipated for the 1000-year event and this is supported by the Shannon CFRAM mapping. As previously stated the site is not impacted from overtopping during the 0.1% flood event.

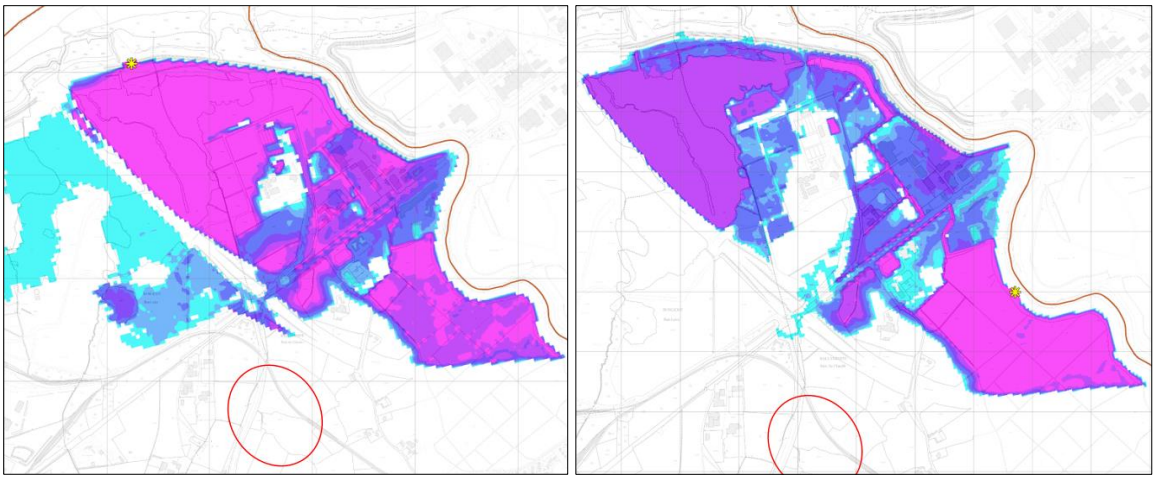
The presence of the Shannon flood embankments, by their very nature, will hinder the movement of flood water across the floodplain (refer to Figure 3-4). The embankments will prevent flooding of the floodplain unless water levels rise above the embankment crest or a breach occurs. Whilst it is possible to quote the return period of an extreme sea level/tidal event on the Shannon Estuary the probability of this impacting the proposed site is controlled by the likelihood of the embankment overtopping and/or failing.

Figure 3-4 Illustration of Residual Risk behind Fluvial / Tidal Defences



CFRAM Coastal Defence Failure mapping has modelled coastal failure scenarios with discrete breach points (50m long) in the River Shannon and Ballincurra Creek defences and spilled a tidal surge through the gap. These models give a realistic representation of what would happen if the defences fail. As seen in Figure 3-5, in the event of a breach, it is predicted the site will remain unaffected by a tidal surge, this is the best representation of actual risk that we have for the site.

Figure 3-5 0.5% AEP Coastal Failure Scenario



3.3.2.2 Climate Change

The effects of climate change will result in increased sea level and subsequently increased flood levels. Climate change could increase the flooding depth around the site as well as the frequency of the defences being overtopped, making them more vulnerable to breach. By designing to accommodate the breach scenario, there is additional protection against climate change.

3.3.2.3 Culvert Blockage

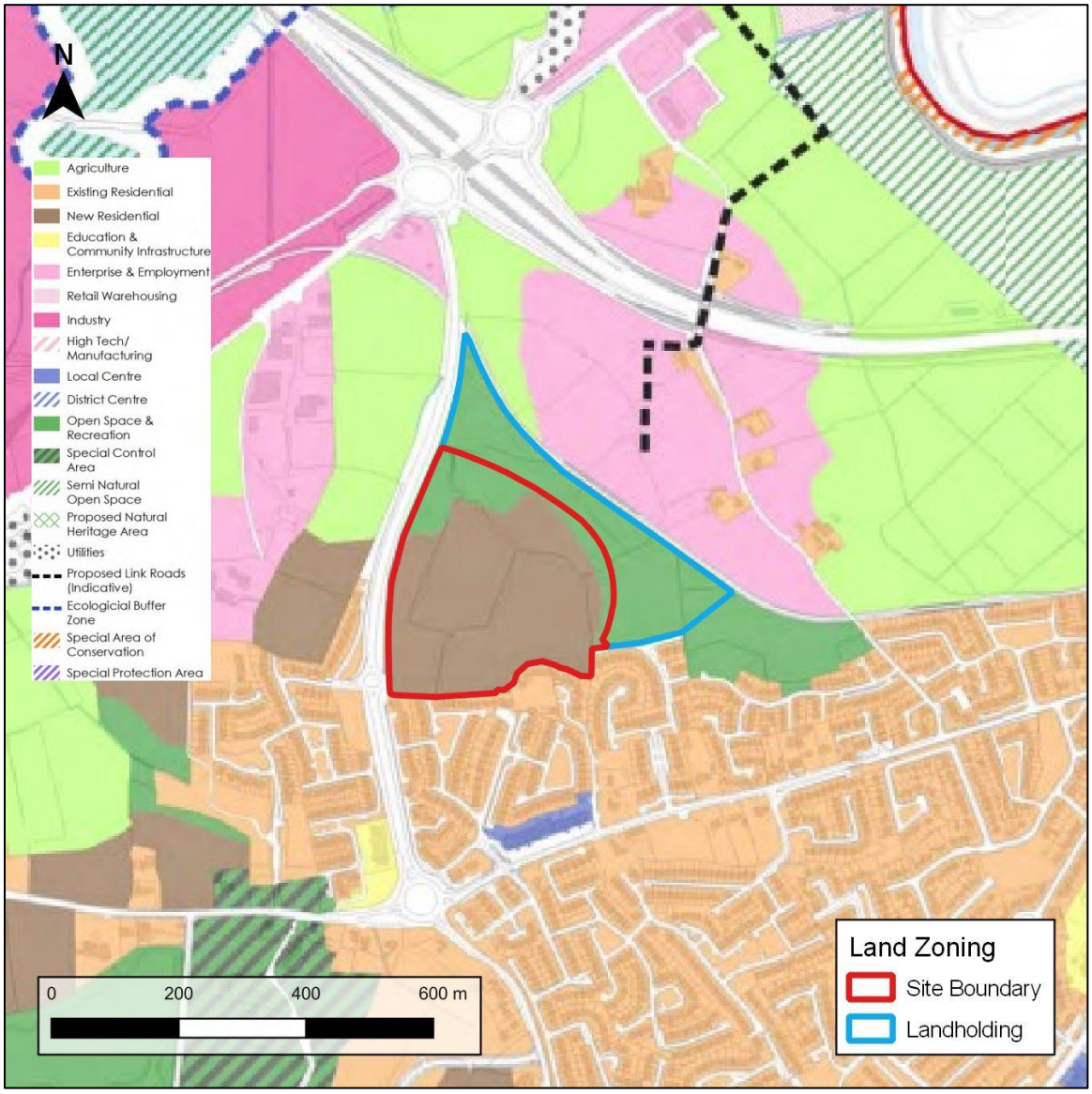
The culvert located to the north of the site is at risk of overflowing due to excessive flow or blockage. Setting the FFL levels of the developments to a suitable level would ensure that any overflow would be directed to the north away from the site.

3.3.3 Southern Environs Local Area Plan 2021-2027

The Local Area Plan (LAP) is a legal document consisting of a public statement of Limerick County Council's planning policies for the Southern Environs area. The aim of the LAP is to establish a framework for the planned, coordinated and sustainable development of the Southern Environs and for the conservation and enhancement of its natural and built environment over the next six years and beyond. The LAP provides guidance as to how this development can be achieved, what new developments are needed, where public and private resource inputs are required, and guidance for development proposed in the LAP area.

As seen in Figure 3-6, the site has been zoned for Residential Development in the south west and Open Space and Recreational along the north eastern boundary of the site. It is noted that the site will be subject to Masterplanning and this report will inform its preparation on the overall landholding.

Figure 3-6 Land Use Zoning

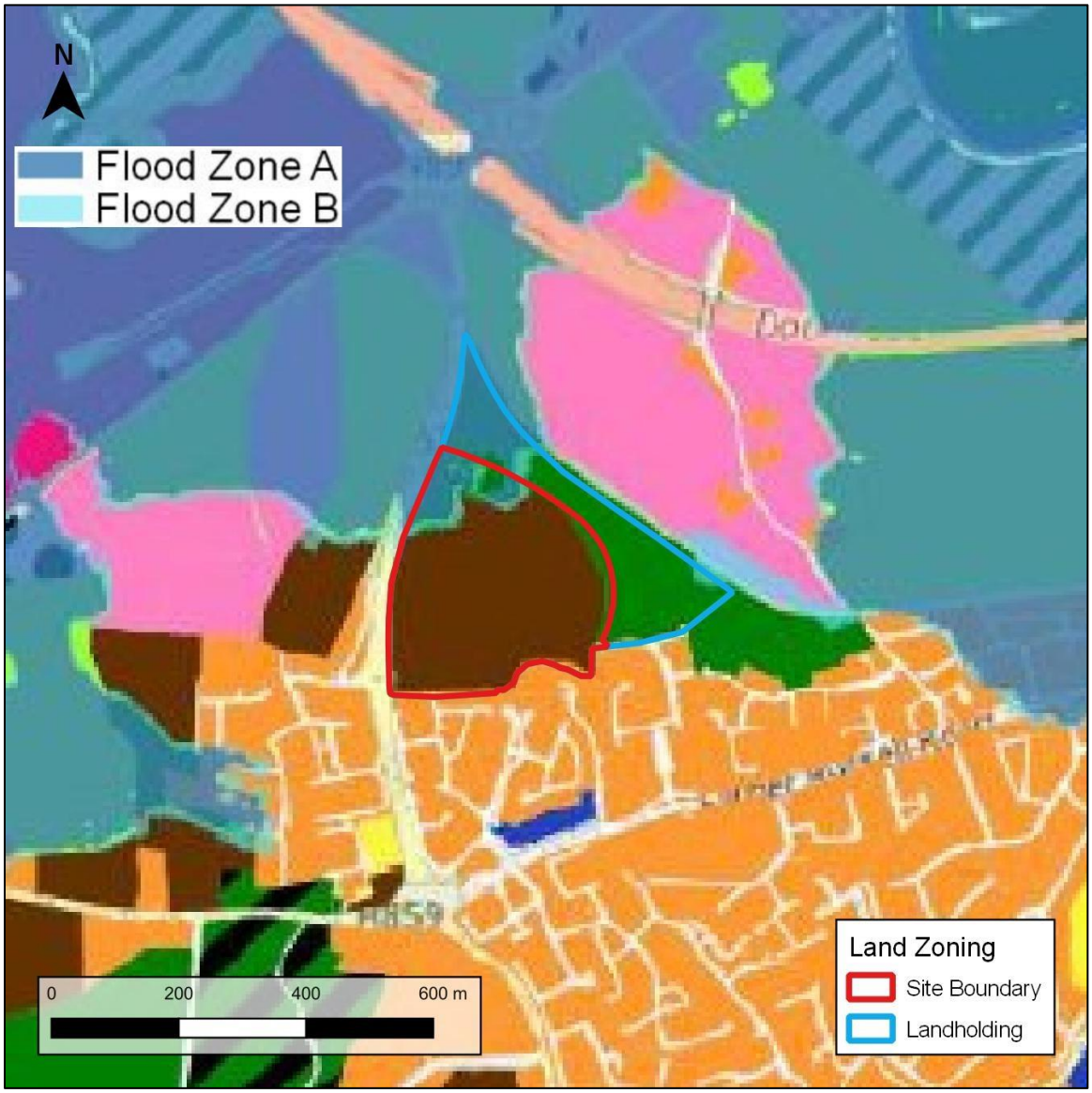


3.3.4 Draft Limerick Development Plan 2022-2028 SFRA

The Draft Limerick Development Plan 2022-2028 Strategic Flood Risk Assessment was available for review, however, it is not yet adopted. Flood mapping is provided from the CFRAM using Flood Zone data that is not available in floodinfo.ie. It is noted that the extent of Flood Zone A is slightly adjusted along the northern triangle of the site. Flood Zone B is also introduced along the northern triangle, and extends along the railway line at the boundary. Flood Zone B encroaches onto the site in two more locations to the east, however, the land use zoning remains as Open Space and Recreation in these areas, it is an appropriate use within Flood Zone B.

These areas will be defended Flood Zone A and Flood Zone B. The embankments along the Ballinacurra Creek and River Shannon will defend Flood Zone A, but technically the embankments do not extend to cover the 0.1% AEP standard, so Flood Zone B is not referred to as defended. Refer to Figure 3-7.

Figure 3-7 Draft Limerick Development Plan 2022-2028 SFRA - Flood Zones



3.4 Sources of Flooding

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.

3.4.1 Fluvial

As part of this report all possible sources of fluvial flooding have been investigated. The OPW PFRA flood Map and the CFRAM mapping does not highlight any fluvial flooding within the site boundary. The drains within the site are considered a surface water issue and are discussed in Section 3.4.4 below.

3.4.2 Tidal

Historically, Limerick has been naturally susceptible to tidal flooding from the River Shannon and this has the potential to inundate the low lying northern corner of the proposed site - but only under a condition where the defences are removed entirely.

Under the current scenario the defence embankment offers protection up to the 0.5% AEP (1:200 year) standard with some overtopping occurring during a 0.1% AEP (1:1000 year) event. This overtopping does not impact on the proposed development and the site is not at risk of flooding up to the 0.1% AEP flood event as indicated in the CFRAM flood maps.

As part of the Shannon CFRAM Management Plan Limerick was highlighted as returning a cost beneficial flood relief scheme and subsequently in May 2018 it was confirmed by Minister Moran that the Limerick Scheme would be progressed in the short term. The Limerick Flood Relief Scheme is likely to rely on existing defences in the Raheen area and the standard of protection is unlikely to increase from what is in place now. However, the existing embankments would be investigated and maintained/upgraded, as necessary. As of December 2021, engineering and environmental consultants have been appointed for the Limerick scheme.

It should be noted that the FRA guidelines state that flood defences should not be taken into account when determining Flood Zones A, B and C due to possible failure. Therefore, according to the FRA guidelines the low lying northern part of the site resides within Flood Zone A, albeit defended, with additional areas within Flood Zone B. This approach completely removes the entirety of the defence, which is a hugely conservative approach, which is helpful in some respects but the full picture should be made clear.

The risk of overtopping and embankment failure is known as residual risk and this is explained within Section 3.3.2.1. This is the most accurate assessment of risk to the site. It is clear that the remote location (from the breach source) and the higher topographic levels mean that the risk from the Flood Zone extents is a large overestimation and this view should be balanced by Figure 3-5.

3.4.3 Pluvial

Pluvial flooding is the result of rainfall-generated flows that arise before run-off can enter a watercourse or sewer. The OPW PFRA mapping indicates two areas of the site which could potentially be subject to pluvial flooding. The first of these is to the centre of the site and is due to an isolated depression. The second is within the low lying/marshy northern extent of the site which is a natural collection point for surface water and is also bound by the higher ground upon which the R151 and dis-used railway line are situated. There may also be a freshwater spring issuing within this area, this was not located during the site visit but would be expected given the drop in elevation and potential interaction with the water table. The road and railway line present a barrier to the onward conveyance of surface water to the lands north of the site. There are culverts located in this area and these are discussed further in Section 3.4.4 below.

3.4.4 Surface Water Drainage

The key flood risk management challenge for the site relates to the outfall of the 2.1m surface water drain in the northern part of the site. The pipe conveys surface water flow from the area surrounding Quinn's Cross Roundabout. JBA is not aware of the direct inputs from the local residential development, however it seems that the northern part of the site was formally intended to act as an attenuation basin; scheme drawings from the Mungret Surface Water Drainage Option 2A suggest this is the case and these are provided in Appendix B. It therefore raises questions in respect to water quality and the ability to use this area of the site as a surface water attenuation pond for additional runoff from the proposed development. The northern end of the site appears to be connected to the OPW drainage channel C1/1/1 which discharges into the Ballinacurra Creek, and possibly to Bunlicky Lake (Appendix D). However the site itself does not contain any OPW drains. Further comment on potential mitigation solutions to facilitate development of the wider site are discussed in Section 0.

3.4.5 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. The OPW PFRA were reviewed and do not indicate groundwater flooding at the site or sounding area. The GSI groundwater vulnerability for the site ranges from 'High' to 'Moderate' which indicates a groundwater depth of greater than 3m.

High groundwater levels are likely in the northern extent of the site. During the site visit the ground here was noted to be waterlogged and marshy, however this could partly be because of the outfall from the 2.1m surface water drain.

4 Flood Risk Assessment

The proposed site is situated behind flood defence embankments. The residual risk of defence failure was discussed under Section 3.3.2.1 and the evidence presented by the OPW CFRAM mapping confirms that the risk to the site is low - it is unaffected if there is a breach in either the Shannon or Ballinacurra defences and this should remain forefront in any consideration of risk.

Despite confirmation of low residual risk, the northern part of the site is still defined as Flood Zone A. This is as a result of the technical definition of the Flood Zone requiring that the defences are removed in their entirety, it will restrict the area of the site that can be used for residential dwellings. There are additional areas to the north of the site within Flood Zone B.

4.1 Mitigation

The site layout strategy has employed the sequential approach in accordance with the Planning System and Flood Risk Management Guidelines. Further details are provided below on the specific elements of the proposals.

4.1.1 Site Layout / Masterplan

Flood Zones A and B are reserved for open space/water compatible uses - the attenuation of stormwater and associated infrastructure. The area of the site within Flood Zone C is suitable for all uses and the residential properties and roads are located within this zone. Figure 4-1 highlights the layout and superimposes the defended Flood Zone A and Flood Zone B, again it is noted that Section 3.3.2.1 discusses the residual risk and the depiction of Flood Zones in this location is with compete removal of the Shannon flood defences.

Figure 4-1 Site Layout

4.1.2 Finished Floor Levels

The minimum FFL of the residential dwellings is 5.70mOD. This figure provides protection from a 0.5% AEP event (4.87mOD) including the impacts of climate change (0.5m) and 0.33m freeboard.

There should be a minimum offset of 150mm between FFL and surrounding hardstanding/landscaping. This is to mitigate potential exceedance of surface water flow.

The combined approach of avoiding highly vulnerable development within Flood Zones A/B and ensuring that all development has FFLs in excess of future climate change levels ensures that the residual risk of flooding from extreme events and embankment breach are managed.

4.1.3 Surface Water Drainage Strategy

The stormwater design has been completed by Hutch O'Malley Consulting Engineers and follows the general principle (as set by Limerick City & County Council (LCCC) and the GDSDS) that runoff from the development is restricted to greenfield rates. The surface water system shall consist of front, middle and rear systems for 3no. catchments with hydro-brake restricted flow rates matching the contributing areas and return periods. The following outlines the key points of the design:

- Greenfield runoff rate of 6.41 l/s/ha for the mean annual flood, increased to 12.5 l/s/ha for the 1:100 year flood (Based on Soil Type 4, indicating poor ground conditions);The system has been designed in compliance with the GDSDS as far as possible;
- Stormtech attenuation tanks for each catchment with outflow controlled by Hydro-Brakes. Attenuation is sized for the 1:100 year 6-hour storm event. The variable head-discharge curve for the Hydro-Brakes has been captured in the drainage model;
- The outfall has been modelled as a surcharged outfall for the 1:100 year event against the 1:200 year tidal event;
- Exceedance flows discharge from the high level overflow upstream of the tank in Catchment 2 to the wider low-lying marsh-attenuation area to the north of the proposed dwellings. This occurs only during blockage or surcharge due to downstream flooding, and does not occur during the 1:100 year event.

A review of the proposed drainage layout and civil engineering report from Hutch O'Malley Consulting Engineers shows the proposed design follows the general principles of the GDSDS and LCCC relating to the appropriate management of surface water runoff for the proposed development. Refer to Figure 4-2 for the proposed surface water layout.

Figure 4-2 Proposed Surface Water Systems Layout (Source: HOM Civil Engineering Report)

4.1.4 Existing Attenuation Area Levels

A drawing provided by Hutch O'Malley (18112 - ExistingSurface-C14_Current Levels _ Cut-Fill_A0) shows that lands within the northern triangle of the site, which acts as an attenuation area and also within defended Flood Zone A and Flood Zone B, have been infilled in excess of 3m in some areas when compared to site levels from c.2000. The infill material is mainly composed of rubble stockpiles and comprises an area of c.9113m2. The increase in site levels within the floodplain would divert potential floodwaters to other areas of the site. However, the risk of coastal inundation of the site is deemed to be low as it would require failure of the defences along the River Shannon and Ballinacurra creek. Figure 3-5 also confirms that the risk of coastal inundation due to failure / breach of the coastal flood defences is low.

4.1.5 Access

Access to the site is via the south west corner of the site which is located in Flood Zone C so there will be no impediment to access during flood events.

4.1.6 Climate Change

The site FFLs take into account climate change and are adequately protected against the residual risk.

The attenuation systems have been initially sized with a 10% increase in rainfall depths as per GDSDS climate change requirements. Full simulation of the network and attenuation systems has been carried out with a 20% increase for the 100-year 6-hour storm event, which is in accordance with the climate change requirements of the Southern Environs Local Area Plan 2021-2027 Strategic Flood Risk Assessment.

4.2 Residual Risk

Residual risks are the risks remaining after all risk avoidance, substitution and mitigation measures have been taken. The flood risk assessment identifies the following as the main source of residual risk to the proposed development:

4.2.1 Stormwater System Exceedance

The stormwater system has a high level overflow upstream of the attenuation tank for Catchment 2 which will alleviate exceedance flooding during blockage or surcharge of the outfall due to flooding and discharge into the green space/attenuation area to the north of the site.

4.2.2 Culvert Blockage

The area to the north of the proposed dwellings is low lying and attenuates flow from the site and the wider Raheen area. In the far northern corner of the site the ground level is circa 1.8mOD. There are two outflowing culverts from the attenuation area and should these both be subject to blockage, water levels will rise and potentially inundate the low lying area until water can overtop the R510 and re-join the OPW channel to the north. Since levels on the R510 adjacent to the low lying area are between 3.3-3.4mOD, the road will overtop prior to any of the properties being inundated (FFL 5.7mOD).

5 Conclusion

JBA Consulting has undertaken a detailed Flood Risk Assessment for the proposed site development in Raheen, Co. Limerick. The site is a greenfield site currently under agricultural use. It is proposed to develop residential properties, retirement properties and a creche within the site boundary.

The site is located behind flood embankments and is protected from direct tidal inundation to beyond the 0.5% AEP storm surge tide levels and there is a low risk of flooding to the site in an embankment breach scenario. There is also no history of tidal inundation since the embankments were raised following the 1961 flood. Overtopping is predicted to occur from the CFRAM mapping along a section of the defences during a 0.1% AEP event, however the overtopping flood extent does not impact the proposed site. The Shannon defences currently protect significant areas of the city, are actively managed and are promoted within the Shannon CFRAM as the (single) preferred defence option. Despite the above assessment of risk, the Planning Guidelines require that the northern area of the site, where levels drop below 5mOD Malin, is considered as Flood Zone A/B. As such the site layout has applied the sequential approach and all dwellings and roads are located in Flood Zone C, only stormwater attenuation is located within the defended Flood Zone A and Flood Zone B.

The stormwater system has been designed according to the GDSDS with discharge limited to a maximum of 6.41 l/s/ha under the mean annual flood, increasing to 12.5 l/s/ha for the 100yr flood. The attenuation area accommodates the 1:100yr 6-hour rainfall event. During an exceedance event, overland flow from the attenuation tank from Catchment 2 will be directed to the north of the site and away from the proposed development. This occurs only during blockage or due to a surcharged outfall, and does not occur during the 1:100 year storm event. The outfall has been modelled as a surcharged outfall for the 1:100 year storm event against the 1:200 year tidal event. The variable head-discharge curve of the Hydro-Brakes has been captured in the drainage model. The stormwater attenuation systems have been initially sized with a 10% increase in rainfall depths as per GDSDS climate change requirements. Full simulation of the network and attenuation systems has been carried out with a 20% increase for the 100-year 6-hour storm event, which is in accordance with the climate change requirements of the Southern Environs LAP 2021-2027 SFRA.

The development proposal is adequately protected against the residual risk of climate change (coastal), stormwater exceedance and culvert blockage.

The minimum FFL is 5.70mOD. This level will protect the dwellings from the 0.5% AEP tidal flood event, including climate change and 330mm freeboard.

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

Appendices

A 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

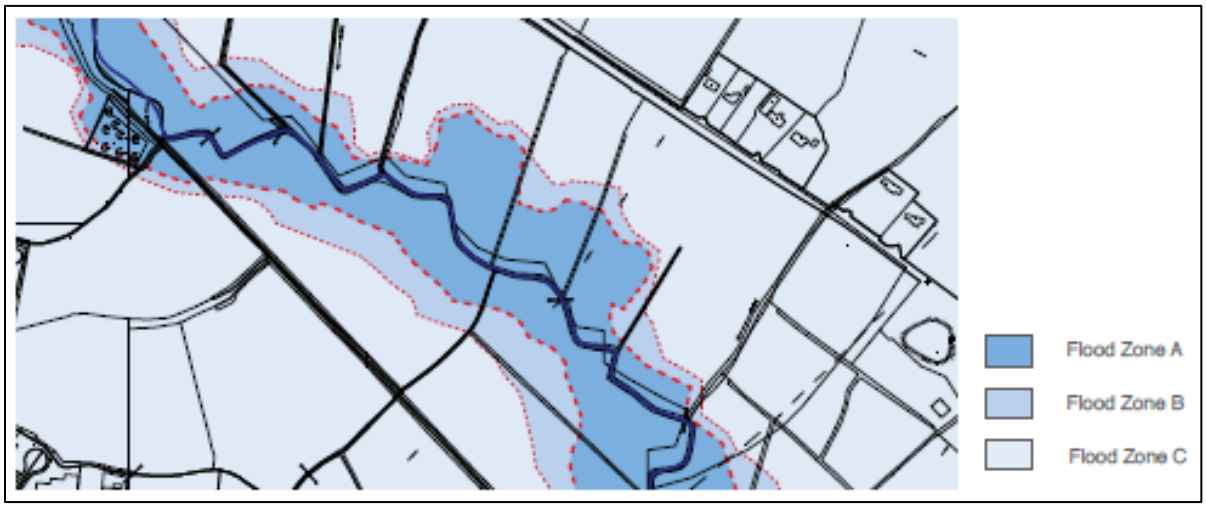
Return period (years)	Annual exceedance probability (%)
2	50
10	10
50	2
100	1
200	0.5
1000	0.1

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

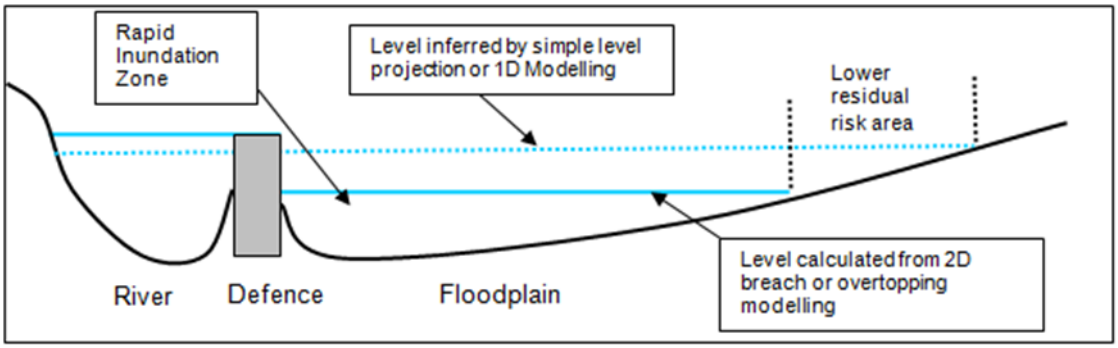
Consequences of flooding depend on the Hazards caused by flooding (depth of water, speed of flow. Rate of onset, duration, wave-action effects, water quality) and the vulnerability of receptors (type of development, nature, e.g. age-structure of the population, presence and reliability of mitigation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

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

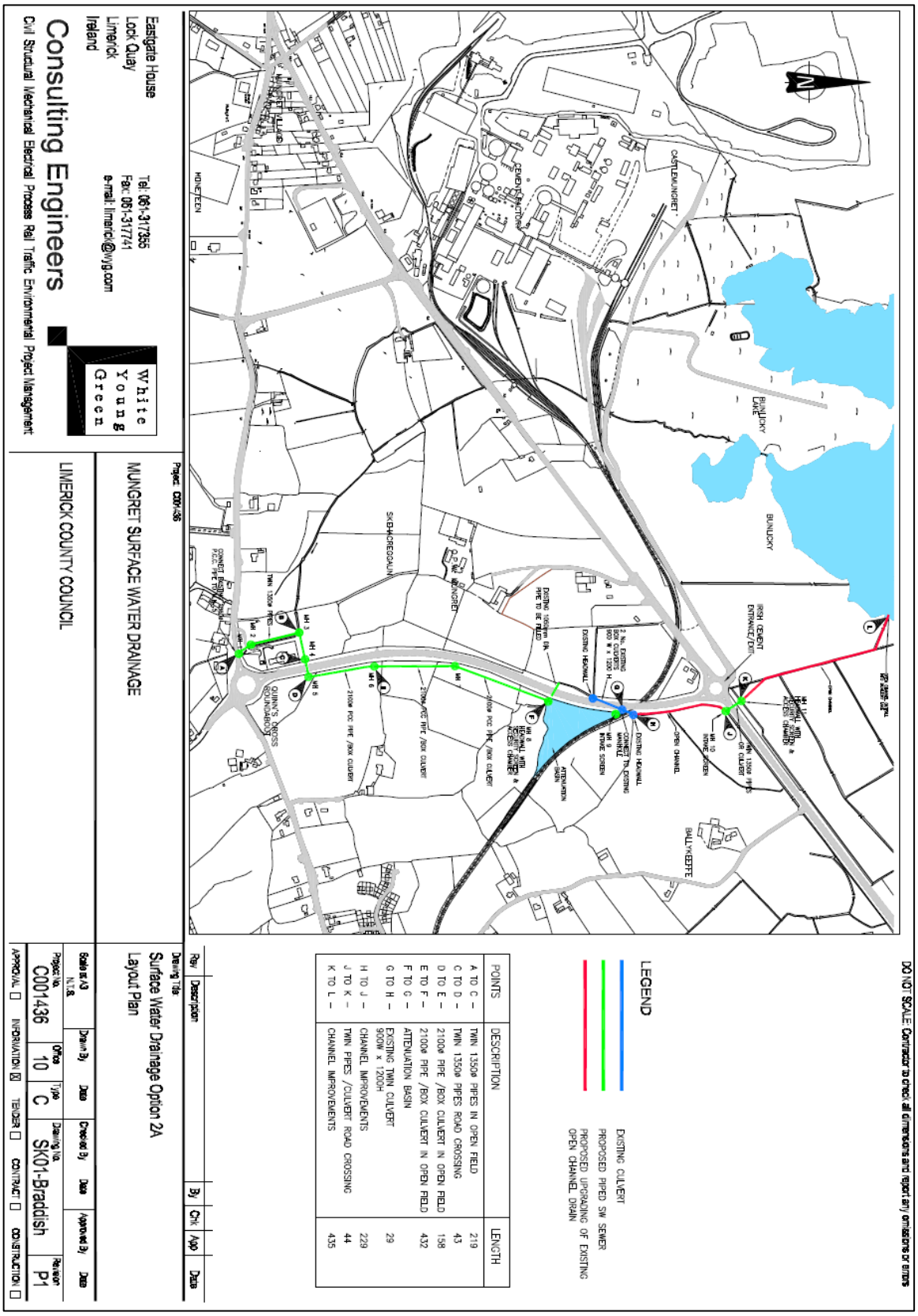
- **Highly vulnerable**, including residential properties, essential infrastructure and emergency service facilities.
- **Less vulnerable**, such as retail and commercial and local transport infrastructure, such as changing rooms.
- **Water compatible**, including open space, outdoor recreation and associated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

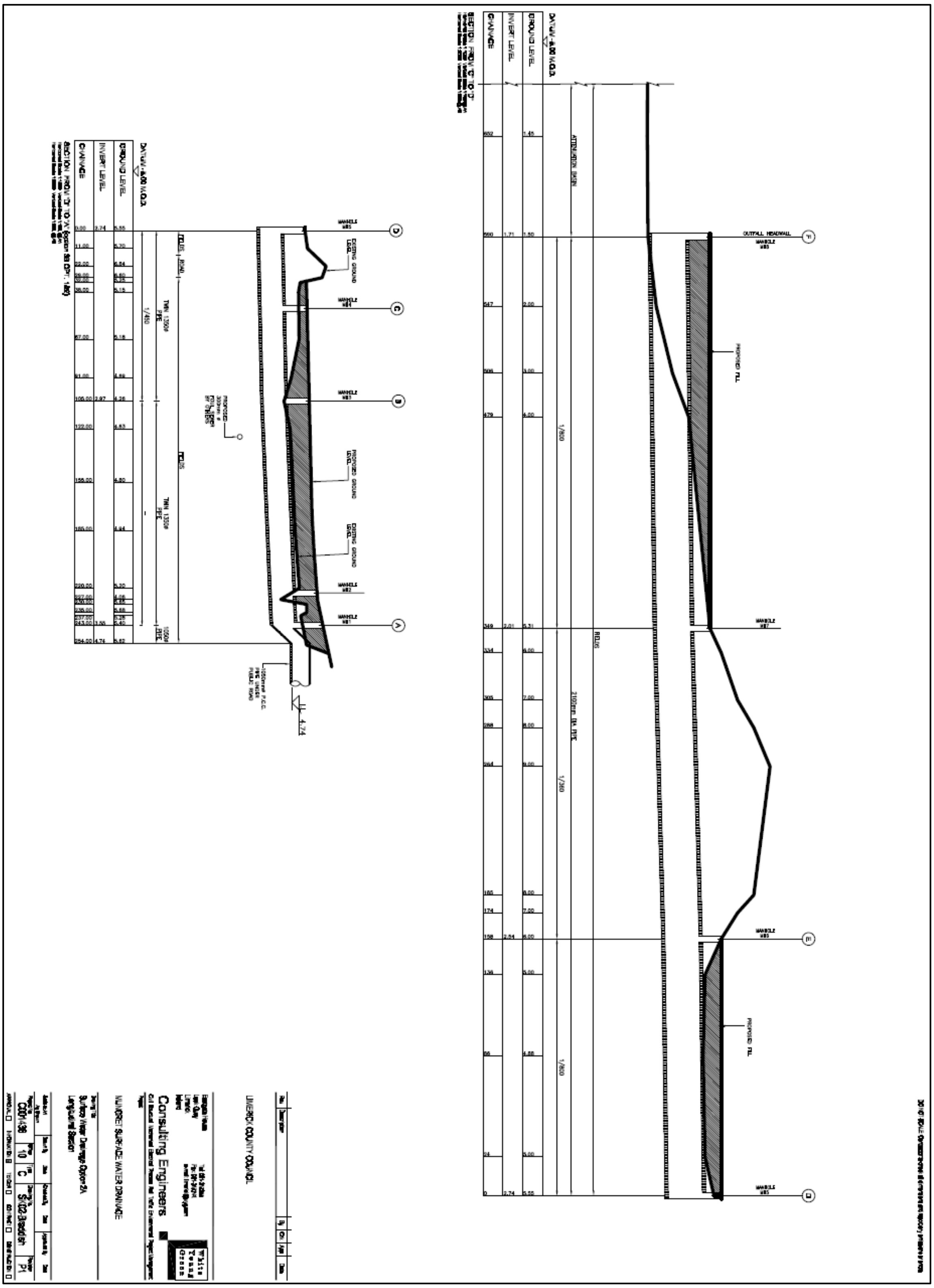
A.4 Residual Risk

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 is known as residual risk:

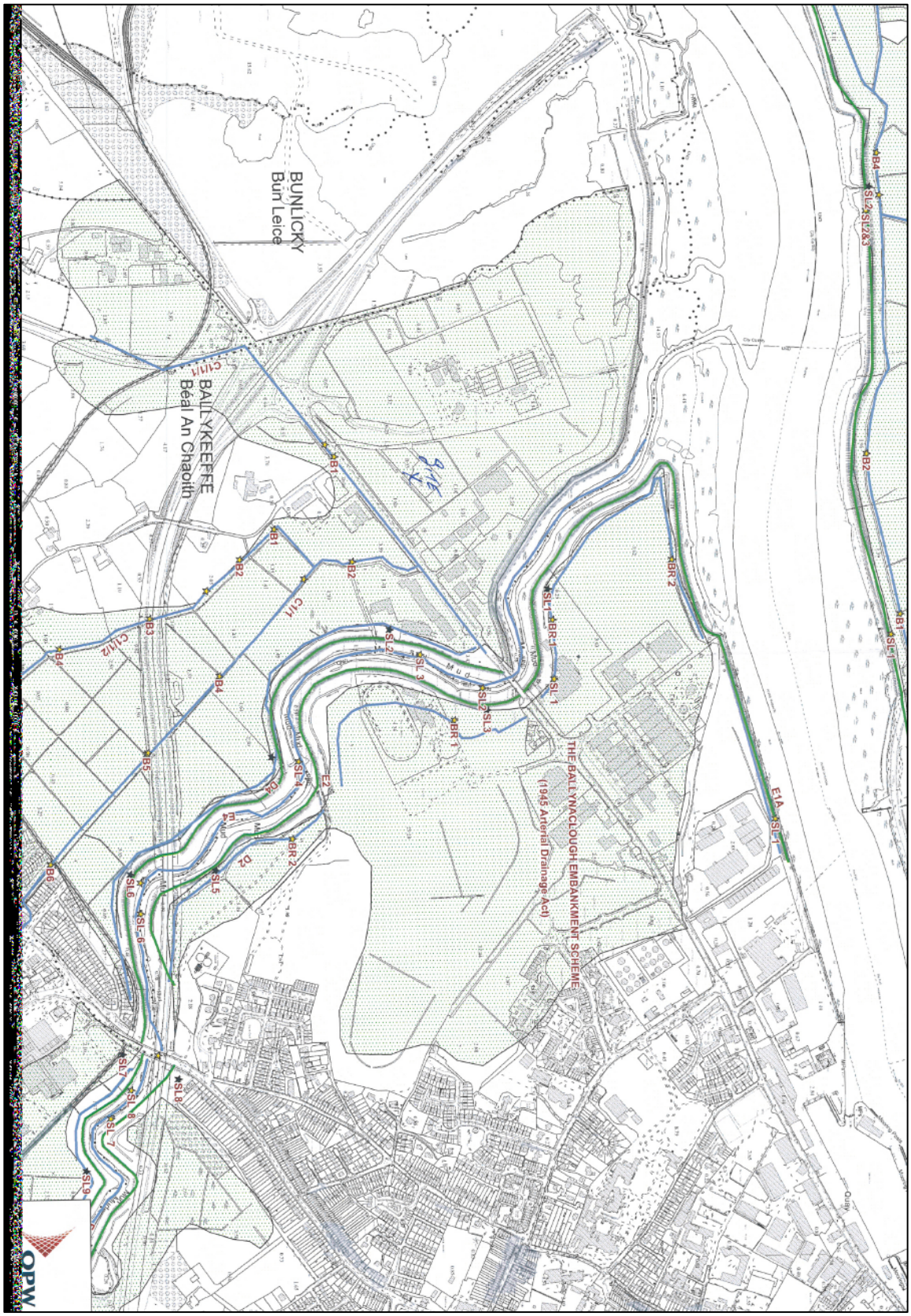


B Mungret Surface Water Drainage

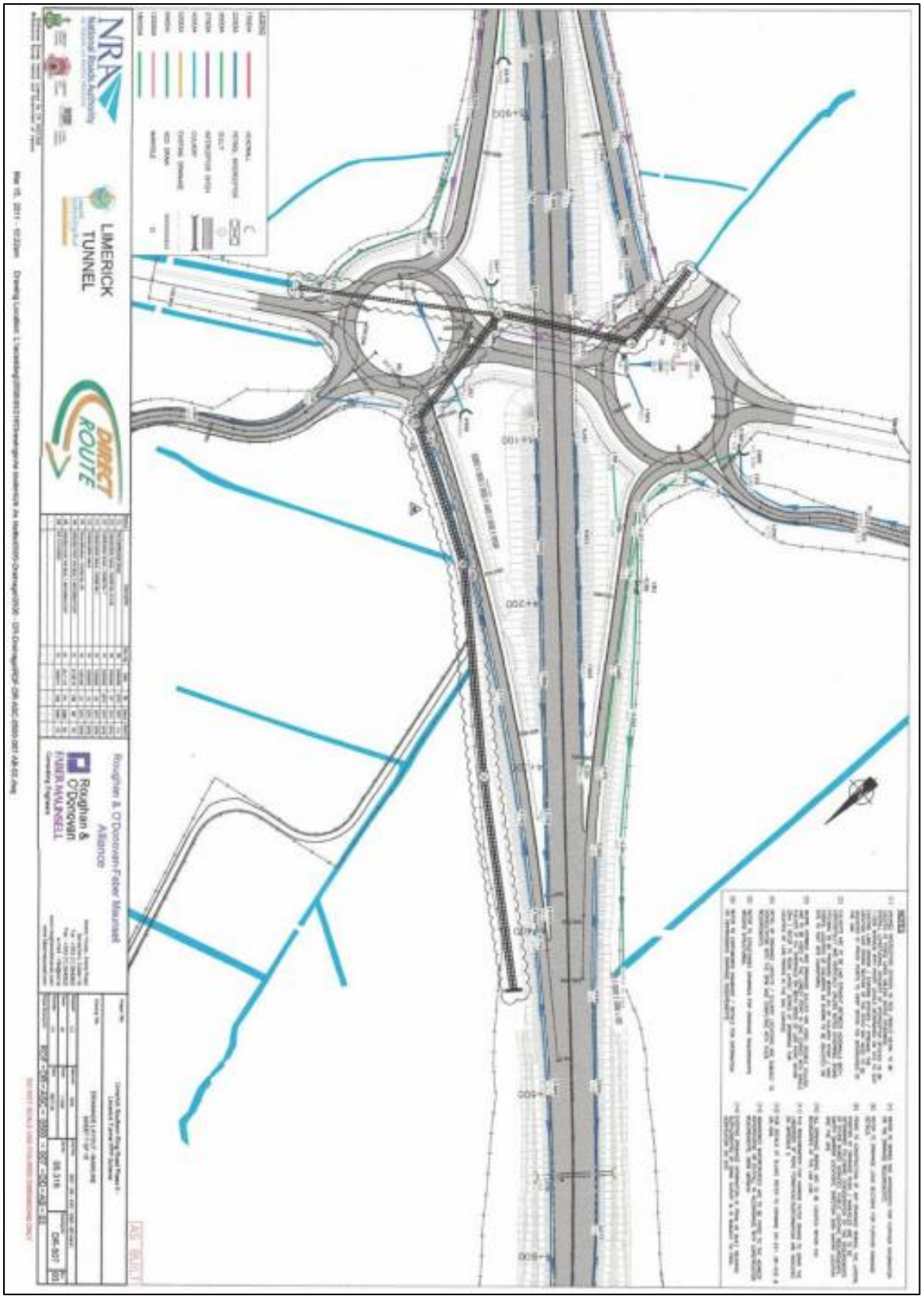




C OPW Arterial Drainage Information



D Limerick Tunnel PPP Scheme - Drainage Layout



Offices at
Dublin
Limerick

Registered Office
24 Grove Island
Corbally
Limerick
Ireland

t: +353 (0) 61 345463
e:info@jbaconsulting.ie

JBA Consulting Engineers and Scientists Limited
Registration number 444752

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ISO 9001:2015
ISO 14001:2015
OHSAS 18001:2007

Visit our website
www.jbaconsulting.ie