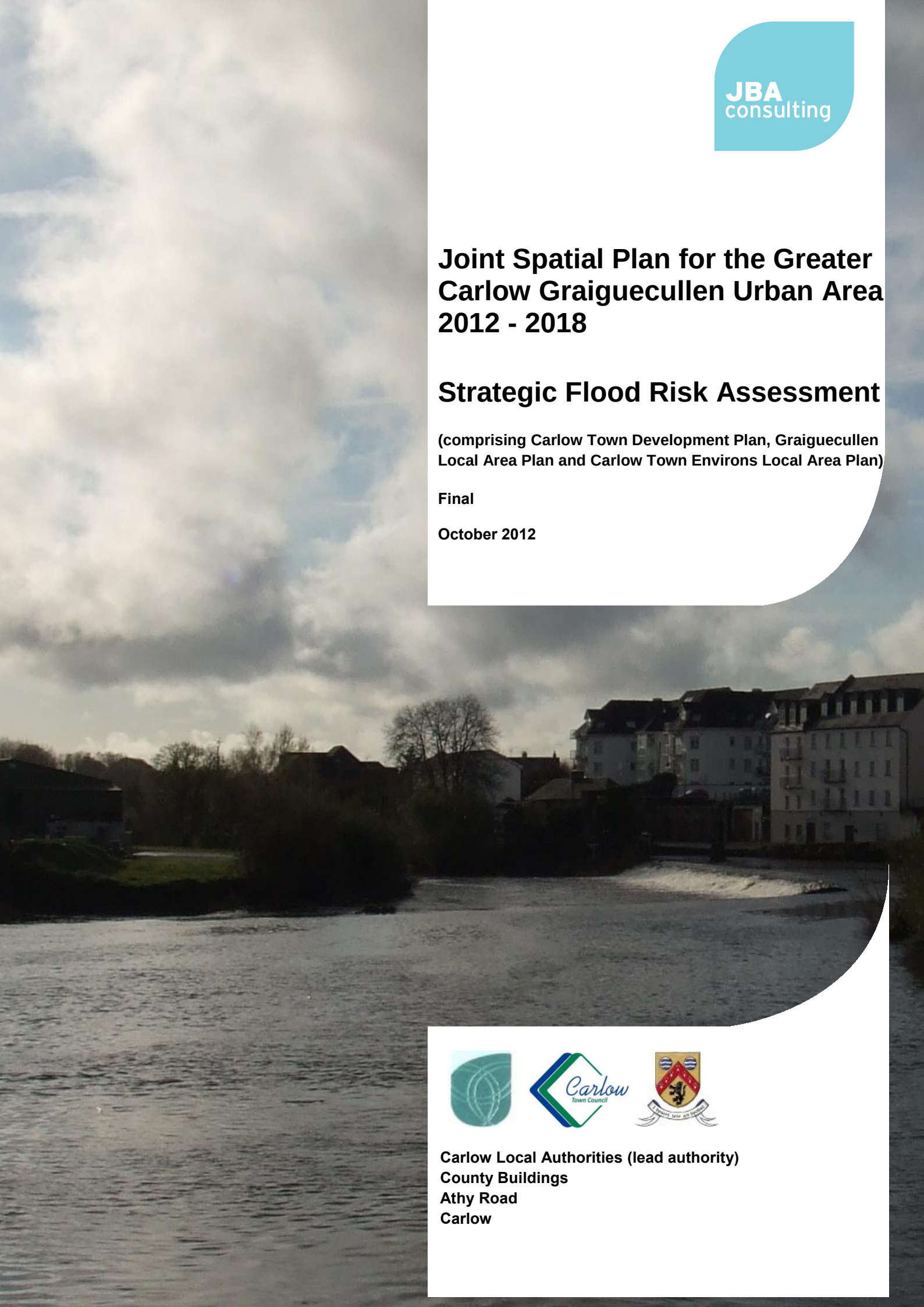

Joint Spatial Plan for the Greater Carlow Graiguecullen Urban Area 2012 - 2018

Strategic Flood Risk Assessment

(comprising Carlow Town Development Plan, Graiguecullen Local Area Plan and Carlow Town Environs Local Area Plan)

Final

October 2012

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Revision History

Revision Ref / Date Issued	Amendments	Issued to
Initial Draft v2 / 6 Dec 2011	Initial Issue covering CARLOW TOWN ONLY	Fiona O'Neill, SEO, Planning Department, Carlow Local Authorities
Draft v3 / 14 Feb 2012	Interim issue covering CARLOW TOWN ONLY	Fiona O'Neill, SEO, Planning Department, Carlow Local Authorities
Draft v4 / 13 March 2012	Draft Issue	Fiona O'Neill, SEO, Planning Department, Carlow Local Authorities
Final v5 / 30 May 2012	Final Issue	Fiona O'Neill, SEO, Planning Department, Carlow Local Authorities
Final v6 / 25 October 2012	Final Issue including responses to amendments	Fiona O'Neill, SEO, Planning Department, Carlow Local Authorities

Contract

This report describes work commissioned by Carlow Local Authorities by a letter dated 19th August 2011. Carlow Local Authorities' representative for the contract was Fiona O'Neill. Rosalie Scanlon of JBA Consulting carried out this work.

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Purpose

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JBA Consulting has no liability regarding the use of this report except to Carlow Local Authorities.

Acknowledgements

Acknowledgement is made here to the engineers and planners in Carlow Local Authorities and Laois County Council for their input; RPS Consulting for information on the Carlow Flood Relief Scheme and the OPW for information on historic flooding in the area.

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Abbreviations

2D	Two Dimensional (modelling)
ABD	Area Benefiting from Defences
AEP	Annual Exceedance Probability
AFA	Area for Further Assessment
DoEHLG	Department of the Environment, Heritage and Local Government
CFRAM	Catchment Flood Risk Assessment and Management
DTM	Digital Terrain Model
EPA	Environmental Protection Agency
FEH	Flood Estimation Handbook
FRA	Flood Risk Assessment
FRR	Flood Risk Review
FSU	Flood Studies Update
GIS	Geographical Information System
GSI	Geological Survey of Ireland
HEFS	High End Future Scenario
JBA	JBA Consulting – Engineers & Scientists
JFLOW	2-D hydraulic modelling package developed by JBA
LA	Local Authority
MRFS	Medium Range Future Scenario
NHA	Natural Heritage Area
OPW	Office of Public Works
OS	Ordnance Survey
PFRA	Preliminary Flood Risk Assessment
RPG	Regional Planning Guidelines
SAC	Special Area of Conservation, protected under the EU Habitats Directive
SEA	Strategic Environmental Assessment
SECFRAM	South Eastern Catchment Flood Risk Assessment and Management
SFRA	Strategic Flood Risk Assessment
SPA	Special Protection Area for birds, protected under the EU Habitats Directive
SPR	Standard percentage runoff
SUDS	Sustainable Urban Drainage Systems

1 Study Background

1.1 Commission

JBA Consulting was commissioned by Carlow Local Authorities (lead authority) in September 2011 to undertake a Strategic Flood Risk Assessment (SFRA). This study is to inform the Joint Spatial Plan that is currently being developed for the Greater Carlow Graiguecullen Urban Area for 2012 - 2018.

This report details the SFRA for this area and has been prepared in accordance with the requirements of the DoEHLG and OPW Planning Guidelines, The Planning System and Flood Risk Management[1].

1.2 Scope and Objectives

Under the "Planning System and Flood Risk Management" guidelines, the purpose for the SFRA is detailed as being *"to provide a broad (wide area) assessment of all types of flood risk to inform strategic land-use planning decisions. SFRAs enable the LA to undertake the sequential approach, including the Justification Test, allocate appropriate sites for development and identify how flood risk can be reduced as part of the development plan process".*

The objectives of the SFRA as set out by the local authorities are to:

- To supplement existing datasets, identifying the extent of floodplains (1 in 100 and 1 in 1000) that should be safeguarded from inappropriate development;
- To carry out a flood risk assessment based on existing datasets and survey work, as appropriate, leading to a suite of flood risk maps that support the application of the sequential approach, in areas within the development envelope, where there may be tension between development pressures and avoidance of flood risk;
- To apply the Justification Test to proposed land use zonings, in consultation with the Planning Authorities, as set out in DoEHLG guidelines;
- To propose mitigation measures to deal with flood risk to the area proposed for development and assess whether these measures can satisfactorily reduce the risks to an acceptable level while not increasing flood risk elsewhere; and
- To produce guidance on how surface water should be managed

In addition, the SFRA and resulting policies contained in the development plan will provide a guide for subsequent studies which deal with flood risk, including site specific flood risk assessments.

1.3 Report Structure

The SFRA considers the broader settlement strategy of the Midlands and South East Regional Planning Guidelines and the countywide policies and objectives of the County Carlow and County Laois development plans.

On a more local level, this study considers the development strategy that will form part of the Joint Spatial Plan for the Greater Carlow Graiguecullen Urban Area. The context of flood risk in the Carlow Graiguecullen area is considered with specific reference to people, property, infrastructure and the environment. A range of flood sources are considered including fluvial, pluvial, groundwater, sewer and artificial reservoirs and canals.

A two stage assessment of flood risk was undertaken, as recommended in 'The Planning System and Flood Risk Management' guidelines, for the area that lies within the development boundary of the Joint Spatial Plan. The first stage is to identify flood risk. Historical records and recent events indicate that the Carlow Graiguecullen area has a history of flooding and confirms that a proportion of zoned lands are at flood risk. The second stage and the main purpose of this SFRA report is to appraise the adequacy of existing information, to prepare

[1] DoHELG and OPW (2009) The Planning System and Flood Risk Management: Guidelines for Planning Authorities

indicative flood zone maps, based on available data, and to highlight potential development areas that require more detailed assessment on a site specific level.

Section 2 of this report, provides an introduction to the study area and Section 3 discusses the concepts of flooding, Flood Zones and flood risk.

In Section 4, the available data related to flooding, is summarised and appraised and Section 5 outlines the sources of flooding to be considered. Section 6 looks at the flood management assets that are in place including the Carlow Flood Relief Scheme and this leads into a discussion of residual risk in Section 7.

Following this, Section 8 presents indicative flood mapping for the area and discusses how it has been developed and validated.

Flooding impact and the management of flood risk are discussed in Sections 9 and 10.

Sections 11 and 12 look at the specific zoned lands highlighted in the plan as areas for new development and details the issues that arise relating to flood risk and planning, including the application of the Justification Test.

Finally, triggers for the ongoing monitoring and future review of the SFRA are detailed in Section 13.

2 The Study Area

2.1 Introduction

The area of interest comprises the urban area of Carlow Town and its surrounds, including Graiguecullen which lies within the Laois County border.

This section will provide an overview of the study area, the drainage catchment, the population and the nature of settlement, to give context to the study.

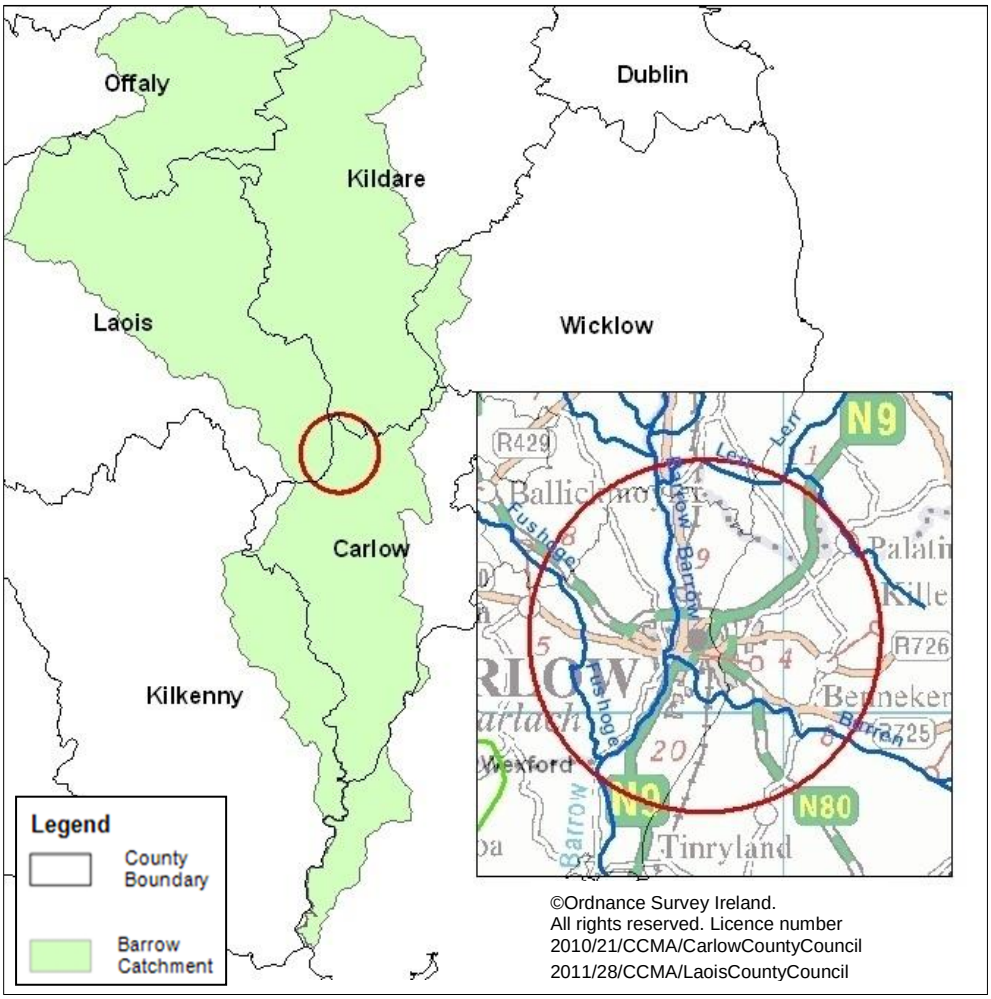
2.2 Drainage Catchment

Carlow Town lies within the Barrow River catchment which covers approximately 3,000 km^2 and lies within counties Carlow, Laois, Kildare, Offaly, Wexford and Kilkenny.

The main rivers that flow through the town are the Barrow River and its tributary the Burrin River. Further north, where the three county borders of Carlow, Kildare and Laois meet, the Lerr River joins the Barrow. The Barrow flows from north to south through Carlow town, under Graiguecullen Bridge and over the Carlow Weir. The River Burrin flows from a southeast direction to its confluence with the Barrow immediately downstream of Carlow Weir.

The extent of the Barrow catchment and the rivers that flow through Carlow Town are illustrated in Figure 2-1 below.

Figure 2-1 Barrow River Catchment[2]



[2] Catchment boundary from www.floodmaps.ie

2.3 People, Property and Infrastructure

County Carlow has a population of 50,349 based on the 2006 census. Preliminary figures from the 2011 census indicate that this figure increased to 54,532 in recent years. The population of Carlow Town is 20,724.

The census statistics are based on political boundaries and according to the published 2006 census results and the 2011 preliminary results, the population of the Carlow Town electoral division, saw a small increase from 13,623 in 2006 and to 13,693 in 2011. The electoral area of Graigue (rural) population increased from 3,120 (2006) to 4,539 (2011). A proportion of this electoral division would be included under the study area. The published 2011 census results for the study area as a whole will not be published until April 2012.

The population change of the Greater Graiguecullen urban area as a whole, demonstrates a modest level of growth, and indicates that development pressures may be balanced against flood management and planning.

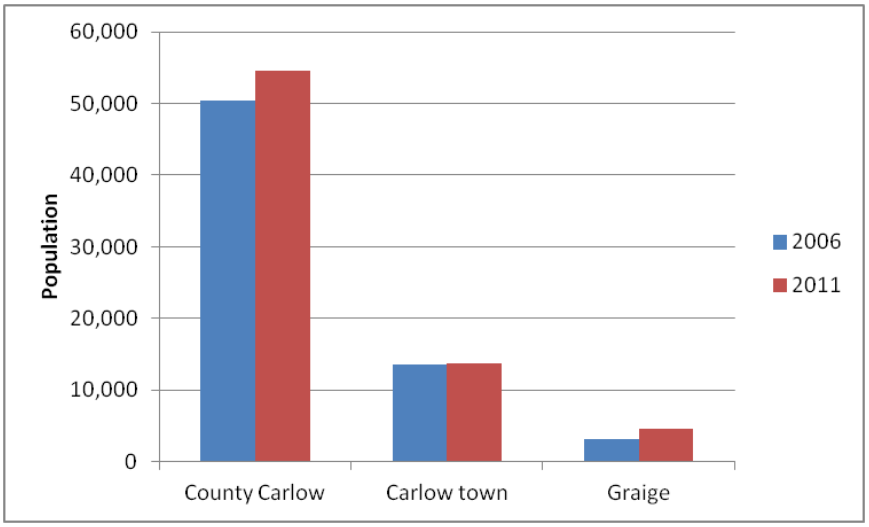


Figure 2-2 Population change based on 2006 and preliminary 2011 Census figures

The study area is an established urban centre and settlement in Carlow is thousands of years old, predating written Irish history. The town has a number of buildings of historic importance including the courthouse and the remains of Carlow Castle. Traditionally, Carlow has grown as a market town with its location on the banks of the River Barrow. Today, it is also a vibrant college town with the Carlow IT campus located on the Kilkenny Road.

Being an urban centre the physical infrastructure includes services to the town with public sewerage collection networks and treatment facilities, water distribution networks, roads and public transport networks.

Construction is currently underway as part of the Carlow Surface Water Drainage, Flood Relief and Water Supply Improvement Scheme. This project, with an allocated budget of €20 million, is funded by Central Government through the DoEHLG and by Carlow County Council and the OPW. The project is expected to take two years to complete and is divided into 5 sections:

- Surface Water Drainage - work includes over 20kms of pipework including combined storm overflows (CSO), pumping stations and pressure lines to upgrade the existing surface water network.
- Flood Relief Works - the first phase of this scheme includes flood defences along the east bank of the Barrow and north bank of the Burrin. Subsequent phases of work once completed will offer a 1% AEP standard of protection to the town centre. More detail on the scheme is given in Section 6.
- Water Mains Rehabilitation - work includes the replacement of mains that are in poor condition and prone to leakage, to help conserve water.
- Urban Relief Road - a relief road and associated landscaping along the Barrow Track between Montgomery Street and Cox's Lane.

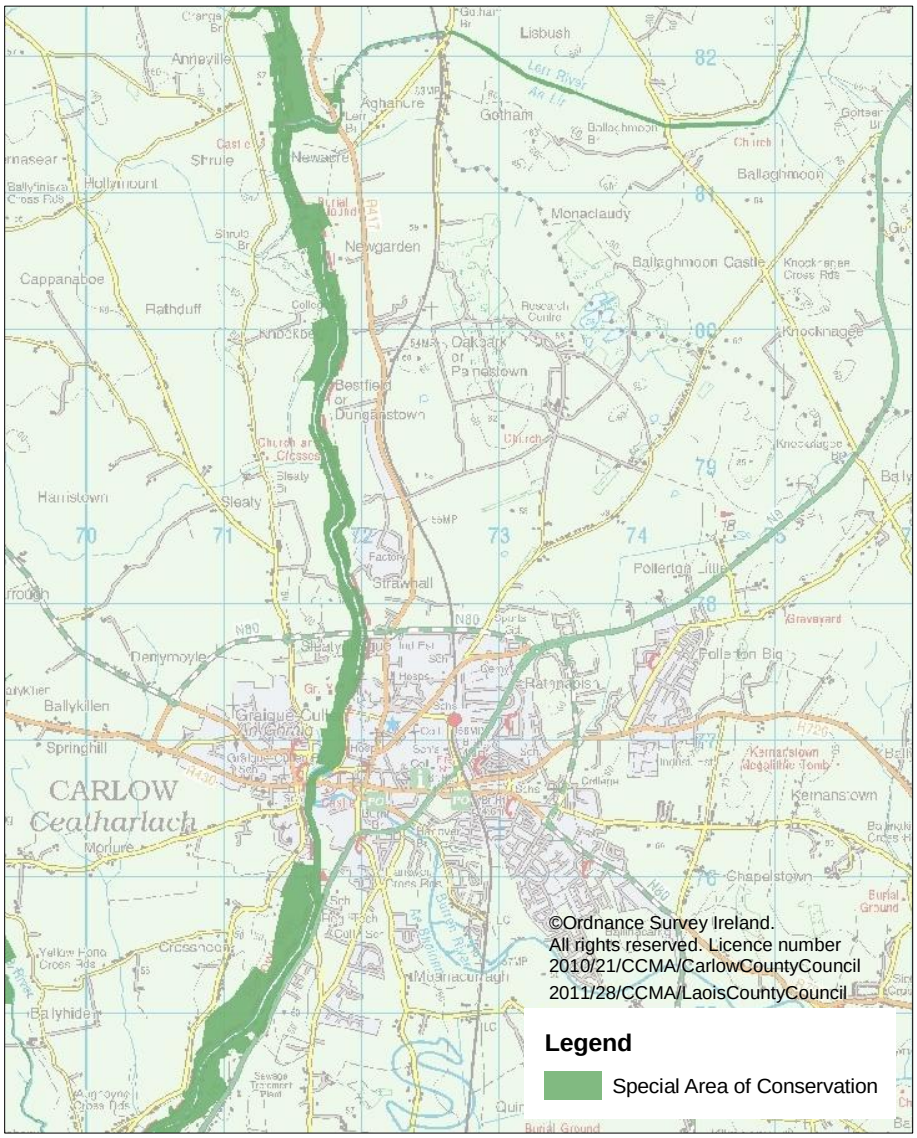
- Kernanstown SLI - essential infrastructure funded under the Serviced Land Initiative to facilitate existing and future development in this area.

Figure 2-3 Flood Defences built into the landscaping of the Town Park

2.4 Environment

The River Barrow forms part of the *River Barrow and River Nore* SAC. There are no other environmentally sensitive sites (such as SPA, NHA) within the study area.

Figure 2-4 Barrow Special Area of Conservation



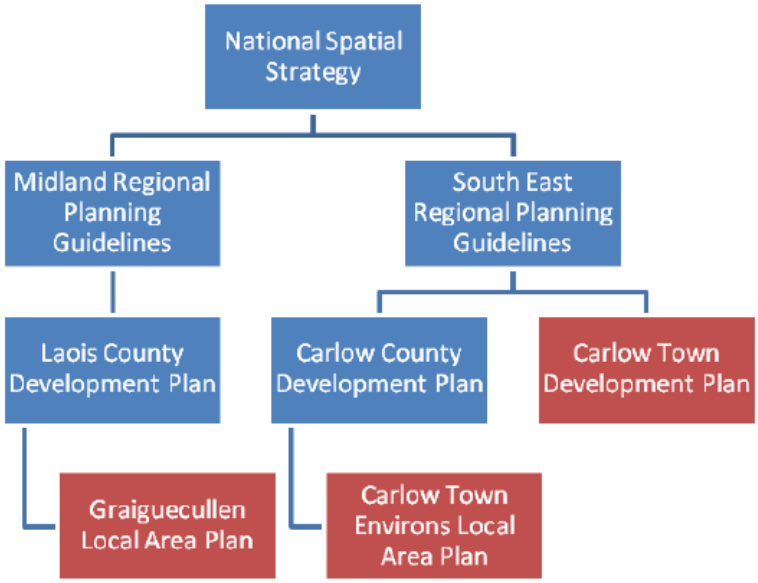
The SEA Report being compiled by Laois County Council and the AA undertaken by RPS Consulting details the environmental issues to development in the Greater Carlow Graiguecullen Urban Area.

2.5 Relevant Planning Authorities

The study area lies across two counties; Carlow and Laois. County Carlow is governed by the South East Regional Planning Authority and County Laois falls within the Midlands Regional Planning Authority.

Figure 2-5 illustrates the various planning documents that govern the local area under consideration.

Figure 2-5 Planning Policy



Source: Greater Carlow Graiguecullen Urban Area Spatial Plan

2.6 Development Plan Areas

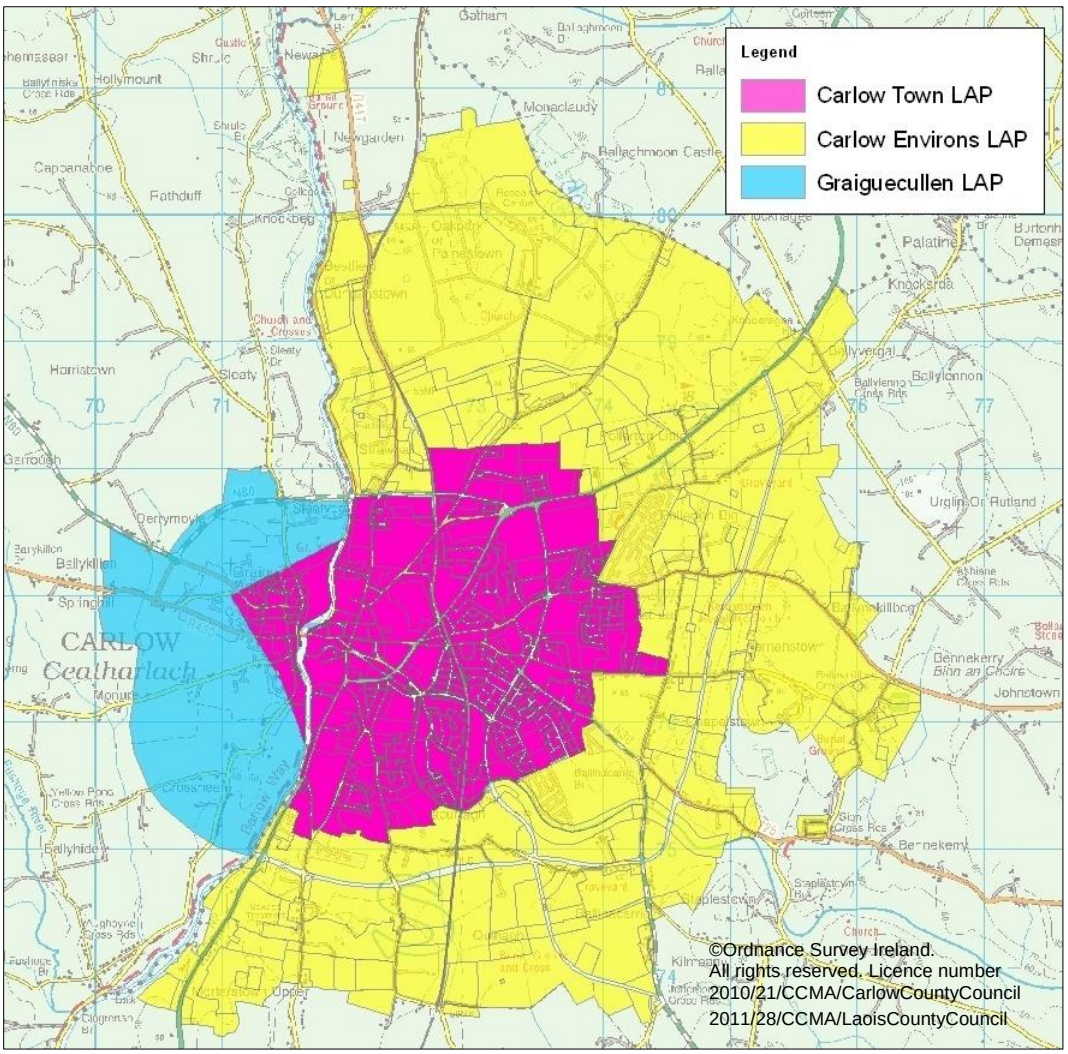
The Joint Spatial Plan will set out the overall strategy for the proper planning and sustainable development of the Greater Carlow Graiguecullen Urban Area. It is a joint project between Carlow Local Authorities and Laois County Council and will replace the following three local area plans:

- Carlow Town Development Plan (last plan period 2009 to 2015)
- Carlow Town Environs Local Area Plan (last plan period 2008 to 2014)
- Graiguecullen Local Area Plan (last plan period 2007 to 2013)

This integrated approach ties in with the objectives of the Regional Flood Risk Appraisal (RFRA) and the Planning Guidelines to consider flood risk in an overall context with the co-operation of neighbouring authorities.

The current development areas are illustrated below in Figure 2-6. (It should be noted that the boundary of these areas have been edited in the joint spatial plan 2012 - 2018).

Figure 2-6 Current Development Plan Areas



3 The Planning System and Flood Risk Management Guidelines

3.1 Introduction

Prior to discussing the management of flood risk, it is helpful to understand what is meant by the term. It is also important to define the components of flood risk in order to apply the principles of the Planning System and Flood Risk Management in a consistent manner.

The Planning System and Flood Risk Management: Guidelines for Planning Authorities, published in November 2009, describe flooding as a natural process that can occur at any time and in a wide variety of locations. Flooding can often be beneficial, and many habitats rely on periodic inundation. However, when flooding interacts with human development, it can threaten people, their property and the environment.

This Section (3) will firstly outline the definitions of flood risk and the Flood Zones used as a planning tool; a discussion of the principles of the Planning Guidelines and the management of flood risk in the planning system follows.

3.2 Definition of 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

The assessment of flood risk requires an understanding of the sources, the flow path of floodwater and the people and property that can be affected. The *source - pathway - receptor model,* shown below in Figure 3-1, illustrates this and is a widely used environmental model to assess and inform the management of risk.

Figure 3-1 Source Pathway Receptor Model

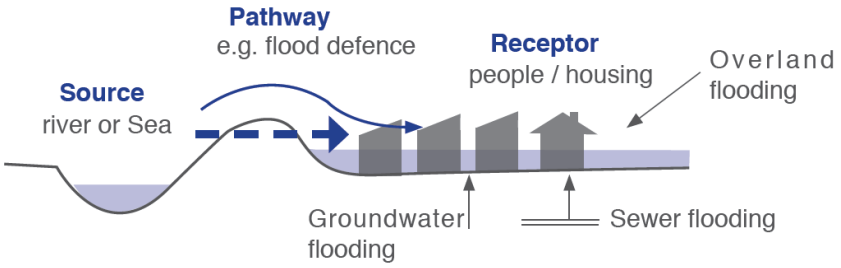


Fig. A1: Sources, pathways and receptors of flooding

Source: Figure A1 The Planning System and Flood Risk Management Guidelines Technical Appendices

Principal sources of flooding are rainfall or higher than normal sea levels while the most common pathways are rivers, drains, sewers, overland flow and river and coastal floodplains and their defence assets. Receptors can include people, their property and the environment. All three elements must be present for flood risk to arise. Mitigation measures, such as defences or flood resilient construction, have little or no effect on sources of flooding but they can block or impede pathways or remove receptors.

The planning process is primarily concerned with the location of receptors, taking appropriate account of potential sources and pathways that might put those receptors at risk.

3.2.1 Likelihood of Flooding

Likelihood or probability of flooding or a particular flood event is classified by its annual exceedance probability (AEP) or return period (in years). A 1% AEP flood indicates the flood event that will occur or be exceeded on average once every 100 years and has a 1 in 100 chance of occurring in any given year.

Return period is often misunderstood to be the period between large flood events rather than an average recurrence interval. Annual exceedance probability is the inverse of return period as shown in Table 3-1.

Table 3-1 Probability of Flooding

Return Period (Years)	Annual Exceedance Probability (%)
2	50
100	1
200	0.5
1000	0.1

Considered over the lifetime of development, an apparently low-frequency or rare flood has a significant probability of occurring. For example:

- A 1% flood has a 22% (1 in 5) chance of occurring at least once in a 25-year period - the period of a typical residential mortgage;
- And a 53% (1 in 2) chance of occurring in a 75-year period - a typical human lifetime.

3.2.2 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 the type of development, 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;
- **Water compatible**, including open space, outdoor recreation and associated essential infrastructure, such as changing rooms.

3.3 Definition of Flood Zones

In the 'Planning System and Flood Risk Management', Flood Zones are used to indicate the likelihood of a flood occurring. These Zones indicate a high, moderate or low risk of flooding from fluvial or tidal sources and are defined below in Table 3-2.

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 due to overtopping or breach and that there may be no guarantee that the defences will be maintained in perpetuity.

It is also important to note that the Flood Zones indicate flooding from fluvial and tidal sources and do not take other sources, such as groundwater or pluvial, into account, so an assessment of risk arising from such sources should also be made.

Table 3-2 Definition of Flood Zones

Zone	Description
Zone A High probability of flooding.	This zone defines areas with the highest risk of flooding from rivers (i.e. more than 1% probability or more than 1 in 100) and the coast (i.e. more than 0.5% probability or more than 1 in 200).
Zone B Moderate probability of flooding.	This zone defines areas with a moderate risk of flooding from rivers (i.e. 0.1% to 1% probability or between 1 in 100 and 1 in 1000) and the coast (i.e. 0.1% to 0.5% probability or between 1 in 200 and 1 in 1000).
Zone C Low probability of flooding.	This zone defines areas with a low risk of flooding from rivers and the coast (i.e. less than 0.1% probability or less than 1 in 1000).

3.4 Objectives and Principles of the Planning Guidelines

The 'Planning System and Flood Risk Management' describes good flood risk practice in planning and development management. Planning authorities are directed to have regard to the guidelines in the preparation of Development Plans and Local Area Plans, and for development control purposes.

The objective of the 'Planning System and Flood Risk Management' is to integrate flood risk management into the planning process, thereby assisting in the delivery of sustainable development. For this to be achieved, flood risk must be assessed as early as possible in the planning process. Paragraph 1.6 of the Guidelines states that the core objectives are to:

- "*avoid inappropriate development in areas at risk of flooding;*
- *avoid new developments increasing flood risk elsewhere, including that which may arise from surface run-off;*
- *ensure effective management of residual risks for development permitted in floodplains;*
- *avoid unnecessary restriction of national, regional or local economic and social growth;*
- *improve the understanding of flood risk among relevant stakeholders; and*
- *ensure that the requirements of EU and national law in relation to the natural environment and nature conservation are complied with at all stages of flood risk management".*

The guidelines aim to facilitate '*the transparent consideration of flood risk at all levels of the planning process, ensuring a consistency of approach throughout the country.*' SFRAs therefore become a key evidence base in meeting these objectives.

The 'Planning System and Flood Risk Management' works on a number of key principles, including:

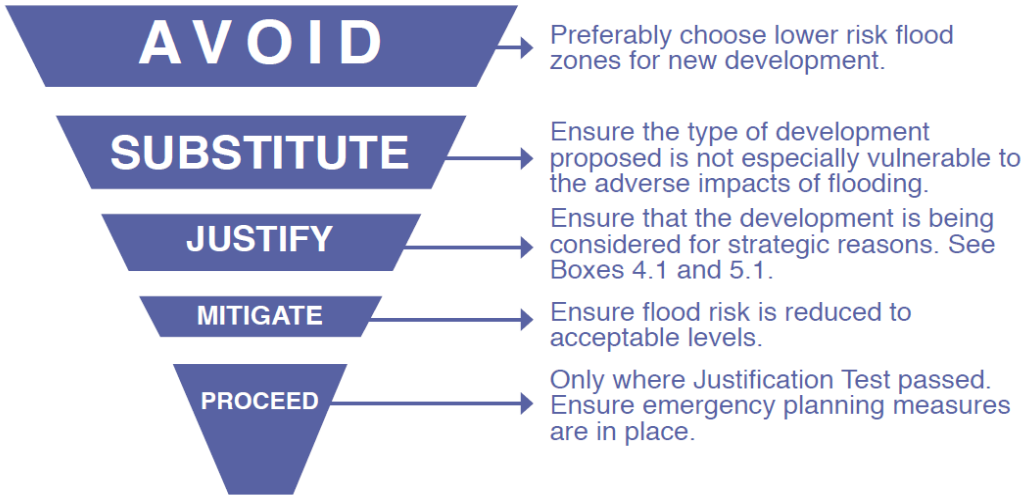
- Adopting a staged and hierarchical approach to the assessment of flood risk;
- Adopting a sequential approach to the management of flood risk, based on the frequency of flooding (identified through Flood Zones) and the vulnerability of the proposed land use.

3.5 The Sequential Approach and Justification Test

Each stage of the FRA process aims to adopt a sequential approach to management of flood risk in the planning process.

Where possible, development in areas identified as being at flood risk should be avoided; this may necessitate de-zoning lands within the development plan. If de-zoning is not possible, then rezoning from a higher vulnerability land use, such as residential, to a less vulnerable use, such as open space may be required.

Figure 3-2 Sequential Approach Principles in Flood Risk Management



Source: The Planning System and Flood Risk Management (Figure 3.1)

Where rezoning is not possible, exceptions to the development restrictions are provided for through the Justification Test. Many towns and cities have central areas that are affected by flood risk and have been targeted for growth. To allow the sustainable and compact development of these urban centres, development in areas of flood risk may be considered necessary. For development in such areas to be allowed, the Justification Test must be passed.

The Justification Test has been designed to rigorously asses the appropriateness, or otherwise, of such developments. The test is comprised of two processes; the Plan-making Justification Test, which is undertaken for a number of development opportunity sites in Section 0 of this SFRA, and the Development Management Justification Test. The latter is used at the planning application stage where it is intended to develop land that is at moderate or high risk of flooding for uses or development vulnerable to flooding that would generally be considered inappropriate for that land.

Table 3-3 shows which types of development, based on vulnerability to flood risk, are appropriate land uses for each of the Flood Zones. The aim of the SFRA is to guide development zonings to those which are 'appropriate' and thereby avoid the need to apply the Justification Test.

Table 3-3 Matrix of Vulnerability versus Flood Zone

	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

Source: Table 3.2 of The Planning System and Flood Risk Management

The application of the Justification Test in the context of land zoning objectives in the Greater Carlow Graiguecullen Urban Area SFRA is discussed in Section 0.

3.6 Scales and Stages of Flood Risk Assessment

Within the hierarchy of regional, strategic and site-specific flood-risk assessments, a tiered approach ensures that the level of information is appropriate to the scale and nature of the flood-risk issues and the location and type of development proposed, avoiding expensive flood modelling and development of mitigation measures where it is not necessary. The stages and scales of flood risk assessment are shown in Table 3-4 and comprise:

- **Regional Flood Risk Appraisal (RFRA)** – a broad overview of flood risk issues across a region to influence spatial allocations for growth in housing and employment as well as to identify where flood risk management measures may be required at a regional level to support the proposed growth. This should be based on readily derivable information and undertaken to inform the Regional Planning Guidelines. The studies that cover the Greater Carlow Graiguecullen Urban Area are the Midlands and South East RFRA (see Section 0).
- **Strategic Flood Risk Assessment (SFRA)** – an assessment of all types of flood risk informing land use planning decisions. This will enable the Planning Authority to allocate appropriate sites for development, whilst identifying opportunities for reducing flood risk. This SFRA will revisit and develop the flood risk identification undertaken in the RFRA, and give consideration to a range of potential sources of flooding. An initial flood risk assessment, based on the identification of Flood Zones, will also be carried out for those areas, which will be zoned for development. Where the initial flood risk assessment highlights the potential for a significant level of flood risk, or there is conflict with the proposed vulnerability of development, then a site specific FRA will be recommended, which will necessitate a detailed flood risk assessment.
- **Site Specific Flood Risk Assessment (FRA)** – site or project specific flood risk assessment to consider all types of flood risk associated with the site and propose appropriate site management and mitigation measures to reduce flood risk to and from the site to an acceptable level. If the previous tiers of study have been undertaken to appropriate levels of detail, it is highly likely that the site specific FRA will require detailed channel and site survey, and hydraulic modelling. .

Table 3-4 Flood risk stages required per scale of study undertaken

Scale of Assessment	Flood Risk Identification	Initial Flood Risk Assessment	Detailed Flood Risk Assessment
Regional Flood Risk Appraisal	✓	U	U
Strategic Flood Risk Assessment - County	✓	P	U
Strategic Flood Risk Assessment - City / town	✓	✓	P
Site Specific Flood Risk Assessment	✓	✓	✓

Key:
P = Probably needed to meet the requirements of the Justification Test
U = Unlikely to be needed
✓ = Required to be undertaken

Source: The Planning System and Flood Risk Management (Table A3)

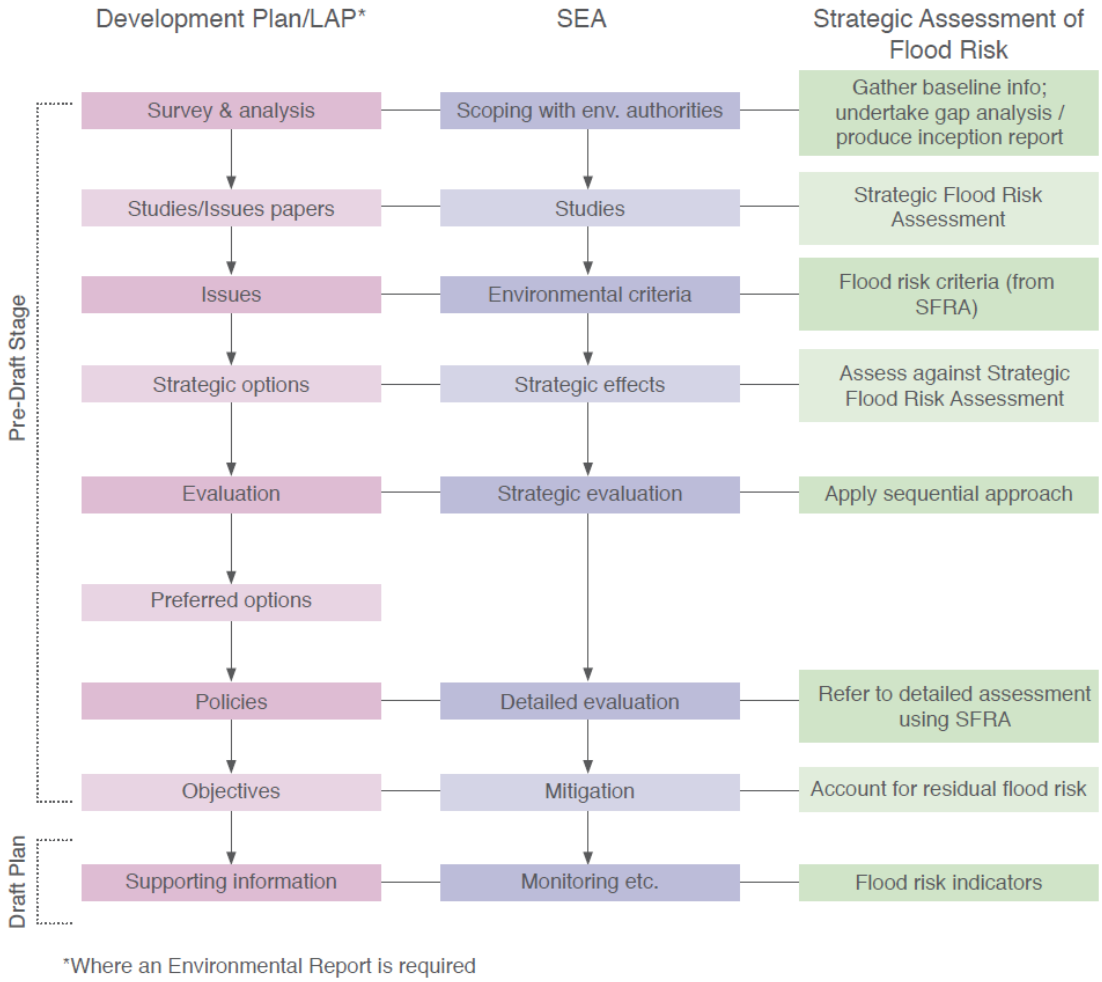
3.7 SFRA and SEA

As detailed in the 'Planning System and Flood Risk Management', the steps in the development plan process and its Strategic Environmental Assessment (SEA) need to be supported by appropriate analysis of flood risk. The SEA process addresses any likely significant effects on the environment and their amelioration, from the implementation of development plans through all stages of the plan-making process.

The SEA report will consider the environmental effects of the Development Plan, including flood management policies and recommendations. These will be assessed against environmental criteria for the plan area and the SEA will detail mitigation measures and future monitoring requirements.

A summary of the likely effects of the plan on the environment, through exposing new development and their occupants to potential flood risks and any adverse impacts as a result, will be addressed in the SEA process and summarised in the environmental report element of the overall development plan. The integration of the SFRA with the SEA and wider Development Plan process is shown in Figure 3-3.

Figure 3-3 Development Plan Preparation where flood risk is scoped as an issue



Source: Fig 4.2 of the Planning Guidelines and Flood Risk Management

4 Data Collection and Availability

4.1 Overview

This section of the SFRA will review the availability of data relating to flood risk in the Greater Carlow Graiguecullen Urban Area. Firstly, the aim is to identify flood risk based on the data available, including historical records, considering all sources of flooding. Table 4-1 summarises the data available and its quality; includes an assessment of confidence in its accuracy (when attempting to incorporate it into the flood zone maps) and gives an indication of how it was used in the SFRA study.

Table 4-1 Available Data

Description	Coverage	Quality	Confidence	Used
Regional Flood Risk Appraisal	Midlands and South East Region	Moderate (but broadscale)	Low	Reviewed
JFLOW® flood zones based on OSi National Height Model	Full Study Area	Moderate	Moderate	Yes; base data (refined using other available data)
OPW PFRA flood extent maps	Full Study Area	Moderate	Moderate	Yes
Alluvial Soil Maps	Full Study Area	Moderate	Low	Used in the RFRA to provide indicative assessment
Historic Flood Outlines	Carlow Town 2008 event 1947 event	Unknown	Unknown	Yes indirectly to validate Flood Zones
Historic Flood Records including photos, aerial photos and reports.	Broad, spot coverage	Various	Various	Yes indirectly to validate Flood Zones & identify other flood sources
RPS Flood Relief Scheme 1% AEP flood levels	Majority of study area	High	High	Yes
Localised Survey Spot Levels	Selected locations	High	High	Yes
Walkover Survey	Selected locations	Moderate	Low	Yes to validate outlines at key locations

A wide range of data was collected and reviewed for completeness, quality and confidence in its accuracy. One of the key outcomes of the SFRA is to produce a flood zoning map which, along with other planning considerations, will inform land zoning decisions. The quality of outline may vary across the study area depending on the origin and quality of available data. Each dataset and its use are detailed in the following sections.

4.2 Regional Flood Risk Appraisal

The RFRA for the Midlands was undertaken as part of the development of the Midland Regional Planning Guidelines 2010-2022[3]. This document includes the county of Laois. Similarly, a RFRA for the South East was undertaken as part of the South East Regional Planning Guidelines and includes the county of Carlow.

The following two sub-sections give an overview of the Midlands and South East Regional Flood Risk Assessment.

Midlands RFRA

The core of the Midlands RFRA was a GIS analysis, which was undertaken on the basis of the following datasets, and resulted in the mapping of flood extents, and surrogate data sets.

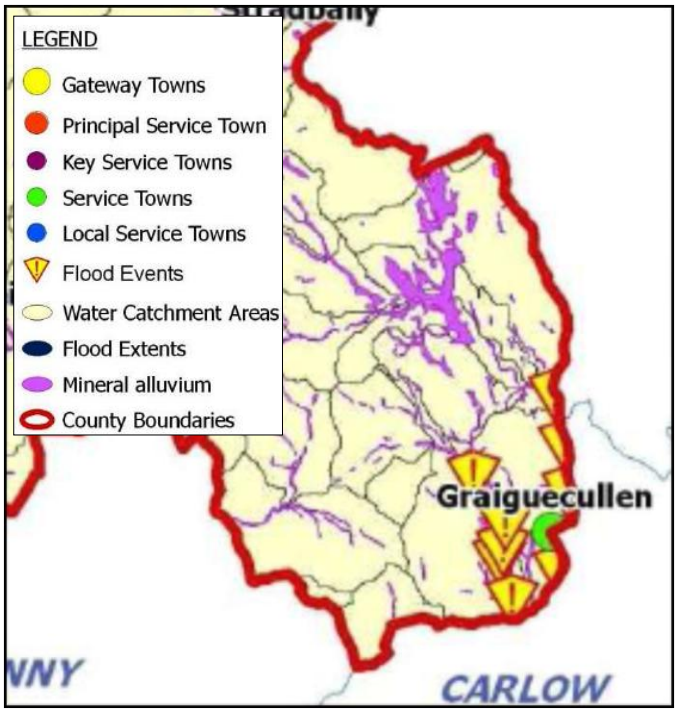
- Recorded flood extents
- Historic flood events
- Mineral alluvial soils mapping

Flood events were identified through the region with multiple events in Graiguecullen in Laois. Flood extent records were not recorded in Laois. However, it is noted that since the RFRA was carried out, a flood extent record has been added to the OPW hazard mapping website and is now available for the 1947 flood event.

The mineral alluvial soils mapping provides a source of flood risk information. Analysis of the location of deposits provides information on the location of historical flood events. The most predominant deposits in Laois were found along the Barrow, Nore and Timahoe Rivers and their tributaries.

Figure 4-1 indicates the datasets mentioned that are located in and around the study area.

Figure 4-1 Occurrence Specified Flood Risk factors through the Report



Source: Extract from Regional Flood Risk Appraisal Figure 1.

The need for specific flood risk assessments of settlements through the region was prioritised, taking account of the findings of the RFRA, the hierarchy of settlements in RPG and whether flood management studies have been carried out for areas that are at risk.

[3] Available at http://www.midlands.ie/Files/Doc%205RFRA.pdf

Graiguecullen was awarded a prioritisation score of 2 (the highest score was 6) indicating a relatively low need for the completion of flood risk assessment and management studies in comparison to the overall Midlands area. In contrast, Portlaoise was awarded a prioritisation score of 5, this is primarily a reflection of its position in the settlement hierarchy, and the fact that it has not been subject to any previous flood studies.

The resulting policies relating to flooding in the RPG are:

- The identification of detailed priorities for area where more detailed evidence needs to be gathered. This includes Graiguecullen in County Laois.
- The coordination of authorities to address flood risk.

South East RFRA

The South East RFRA follows a similar albeit less detailed approach. The RFRA is presented in Appendix 3 of the Environmental Report & Habitats Directive Assessment Report prepared for the Regional Planning Guidelines for the South-East Region 2010-2022. The RFRA gives an overview of the main river catchments in the region, including the Barrow. The resulting recommendation was for an integrated approach to catchment management across all relevant local authorities.

4.3 JFLOW® Flood Mapping

JBA developed software, known as JFLOW®[4] to undertake multi-scale two dimensional hydraulic fluvial and tidal flood modelling. More detail on the modelling methodology is provided in Section 8.

These JFLOW® flood extents are used as the base dataset for defining flood risk in the study area. The base JFLOW® outlines have been reviewed against available data and have been refined where appropriate. In particular the datasets that have been used for this purpose are the draft OPW PFRA flood outlines, records of historic flood events including extents, RPS design flood levels, local surveyed ground levels, walkover survey and consultation with local area engineers. The resultant verified Flood Zones for the Carlow Graiguecullen area are presented in Section 8.

In addition, JBA have completed broad scale pluvial modelling based on a 10m national OSi DTM. This was reviewed and compared with the PFRA pluvial maps to identify development areas at particular risk of surface water and pluvial flooding.

4.4 OPW PFRA Flood Mapping

The Preliminary Flood Risk Assessment (PFRA) is a national screening exercise that was undertaken to identify areas at potential flood risk. The PFRA is a requirement of the EU Floods Directive. The publication of this work will lead to, and inform, more detailed assessment that will be undertaken as part of the Catchment Flood Risk Assessment and Management (CFRAM) studies.

The draft PFRA flood outlines consider fluvial, tidal, pluvial and groundwater sources of flooding. Public consultation on the PFRA flood outlines closed on November 2011. More detail on the methodology behind the PFRA fluvial flood maps is provided in Section 8. The South East CFRAM study reviewed the PFRA fluvial (and tidal) outlines at each of its study sites, including Carlow Town.

It is noted that, as stated in the OPW User Notes and Guidance, the PFRA maps *"are indicative only and are intended to give a broad, strategic indication of areas that might be prone to flooding."* There are a number of limitations to the PFRA methodology as outlined in Chapter 8.

The PFRA maps have been used to inform the SFRA and have been validated based on other available information including historic flood records and anecdotal evidence, local and site specific studies, site walkovers, consultation with local authorities.

[4] JFLOW® is a registered UK trade mark in the name of Jeremy Benn Associates Limited

4.5 South East CFRAM Study

Following on from the PFRA study, the OPW commenced appointment of consultants to carry out a more detailed flood risk assessment on key flood risk areas. This work will be undertaken under the national CFRAM programme across seven river basin districts in Ireland. Carlow Graiguecullen located in the Barrow catchment falls under the South Eastern CFRAM study being undertaken by RPS Consulting Engineers. This study is at an early stage with the consultant appointed in August 2011. The initial Flood Risk Review (FRR) stage has been completed and the FRR report was made available, for the purposes of this SFRA study. In this report Carlow Town was recommended as an Area for Further Assessment (AFA) meaning that more detailed assessment including hydraulic river modelling will be carried out in subsequent stages of the CFRAM study. Detailed flood risk and hazard maps will be produced for all AFAs and under the EU Floods Directive, will be available by the end of 2015.

4.6 Carlow Town Surface Water Drainage Scheme

This scheme is divided into five projects, including surface water drainage upgrade and flood relief scheme. The surface water drainage upgrade incorporates a number of pumping stations and considers the flood relief works.

The flood relief scheme includes defences along the River Barrow and River Burrin. These defences consist of flood walls and flood embankments. The proposal also included some weir alterations and channel improvement works. This scheme is discussed in more detail in Section 6.

Although a hydraulic model was built as part of the flood relief study, information is not readily available on residual risk and the comparison of defended and undefended scenarios. This residual risk must be taken into consideration for future planning in the area (see Section 7.)

Design flood levels for the 1% AEP event and model cross sections were available. These were used to estimate flood extents and compare with PFRA and JFLOW® indicative flood outlines.

4.7 Historic Flood Review

Records of past flooding are useful for looking at the sources, seasonality, frequency and intensity of flooding. Historical records are mostly anecdotal and incomplete, but are useful for providing background information. The flood history of Carlow Town will be summarised in this section, and referred to in the assessment of flood risk to individual settlements.

The OPW hosts a National Flood Hazard Mapping website[5] that makes available information on areas potentially at risk from flooding. This website provides information on historical flood events across the country and formed the basis of the RFRA.

Information is provided in the form of reports and newspaper articles which generally relate to rare and extreme events. Since the establishment of the hazard mapping website, more records are available which identify more frequent and often recurring events. These tend to include memos and meeting records from local authority area engineers, often relating to road flooding. The location of records available on www.floodmaps.ie for Carlow Town is shown in Figure 4-2.

Recorded recurring flood events are listed in Table 4-2. Significant events are summarised in Table 4-3 and include details of the areas affected and the peak flood levels recorded.

[5] www.floodmaps.ie

Figure 4-2 Historical Flood Records

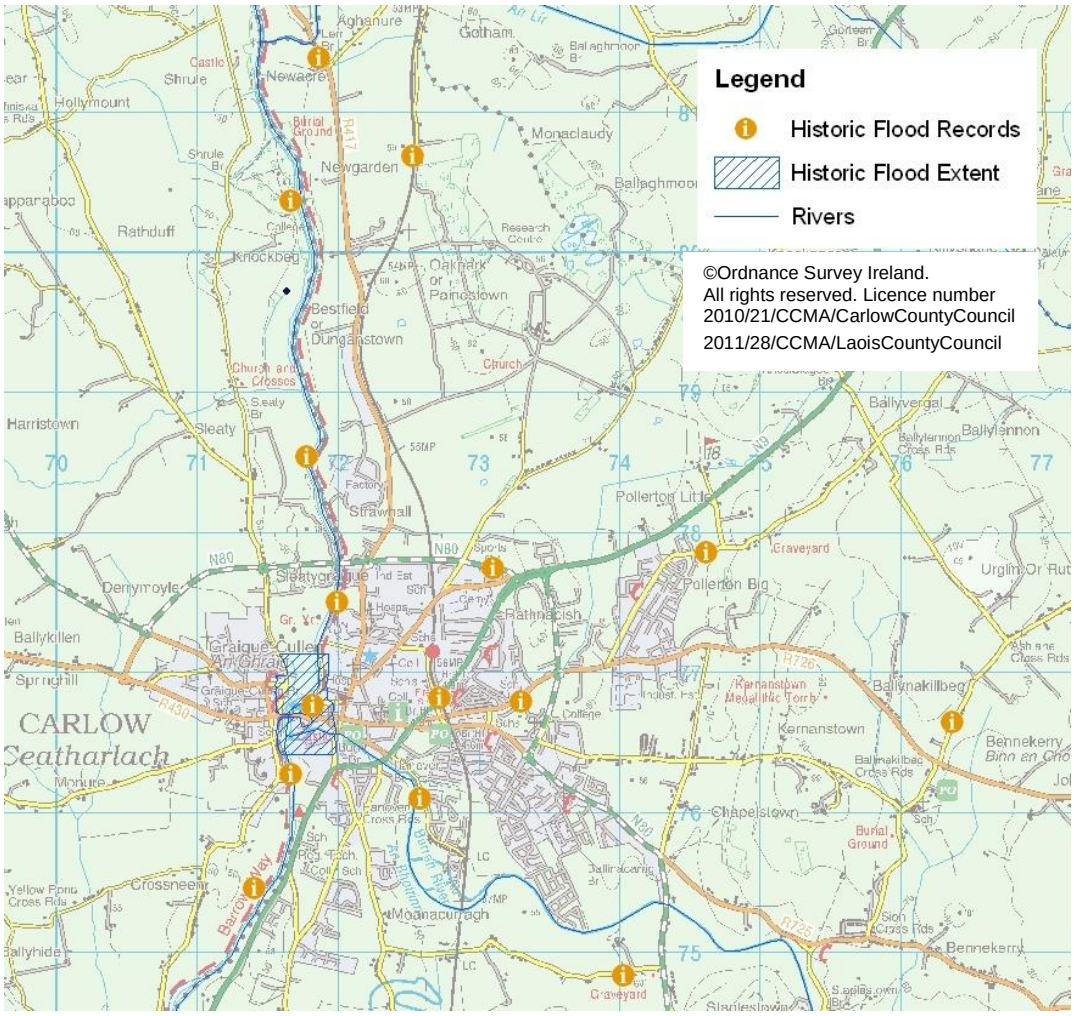


Table 4-2 Recurring Flood Events

Location	Source	Details (from Floodmaps.ie)
Knockbeg	Barrow	River Barrow overflows its banks every year after heavy rain
Paupish Lane	Burrin	Flooding due to Burrin alleviated by recent local works, including land raising as part of development
Crossneen	Barrow	River Barrow overflows its banks every year after heavy rain
Sleaty	Barrow	River Barrow overflows its banks every year after heavy rain
Green Lane	Surface Water	Low dip in road under railway line; potential to floods when pumps fail
Dr Cullen Road	Surface Water	SW flooding due to insufficient capacity in SW network capacity
Askagh Drive	Surface Water	SW flooding due to insufficient capacity in SW network capacity
Pollerton Big	Surface Water	SW flooding due to insufficient capacity in SW network capacity
Ballincarrig	Unknown	Cause not identified
Oak Park Entrance	Unknown	Cause not identified

Table 4-3 Significant Flood Events

Date: 19 - 26 November 2009	Source: Barrow
Description: Rainfall levels recorded at Oak Park indicated that 158% and 300% of mean monthly rainfall fell in October and November respectively. River levels remained high for two weeks causing surface water drainage backed up. Mobile pumps were used to discharge water into the river and alleviate surface water flooding. Wastewater pumping stations at Maryborough St, Carlow Castle and Pembroke were also inundated with surface water. On the 19th November water overflowed into low-lying streets at Barrow Track, Maryborough St, Centaur St and was followed by flooding at Pembroke and Kennedy St. Floodwaters did not recede until Friday 27th November. The peak recorded flood level was 46.965mOD which was just below the 1947 peak flood level of 47.08mOD, the highest ever recorded in Carlow Town. A number of properties were affected including 33 residential, 6 shops, 5 public houses, 3 restaurants, 1 garage and 1 leisure facility.[6] High water levels in the Barrow also caused backing up of the Lerr River and 3 properties were affected at New Acre, Athy Road, to the North of Carlow Town.	
Date: November 2009	**Source: Lerr**
Description: River Lerr backed up due to high levels in the River Barrow, causing out of channel flow. 3 properties were affected at New Acre, Athy Road, to the North of Carlow Town.	
Date: March 1947	**Source: Barrow**
Description: The peak flood level during the flood event of 1947 of 47.08mOD is recorded as being the highest in living memory. Digitised flood extents indicate peak flood level and the areas that were affected include Montgomery Street (49.82mOD), Cox's Lane (49.76mOD), Centaur Street (49.78mOD), Kennedy Street (49.82mOD) and Pembroke Road (49.08mOD.)	
Date: January / March 1995	**Source: Barrow / Burrin**
Description: Flooding was reported in January 1995 due to high rainfall and the areas affected include Kennedy St, Centaur St, John St, Maryborough St and Barrow Track. Flood levels in 1995 were 150mm higher than those recorded in 1990 / 1993. On 17th February, the flood level in the Barrow reached 48.95mOD and flooding was reported at the Barrow Track and on Maryborough Street. On the 23rd February, the Barrow reached a level of 48.978mOD and flooding was reported at the Barrow track between Montgomery St and Cox's Lane and a large portion of Maryborough St was affected. Pembroke CSO did not operated at full capacity and foul water backed up through road gullies. On the 10 to 12th March, flood level peaked at 49.3mOD and Pembroke, Kennedy St, Centaur St, Maryborough St were flooded. A section of the N80 National Secondary route, (at Kennedy St) was closed to traffic. It was noted that flooding at Kennedy Street in the past has been the result of the backing up of water levels in the Burrin River.	
Date: January 1996	**Source: Barrow**
Description: Historic reports including photos of flooding at Barrow Track near Montgomery St and adjacent to Carlow weir.	
Date: November 2000	**Source: Barrow**

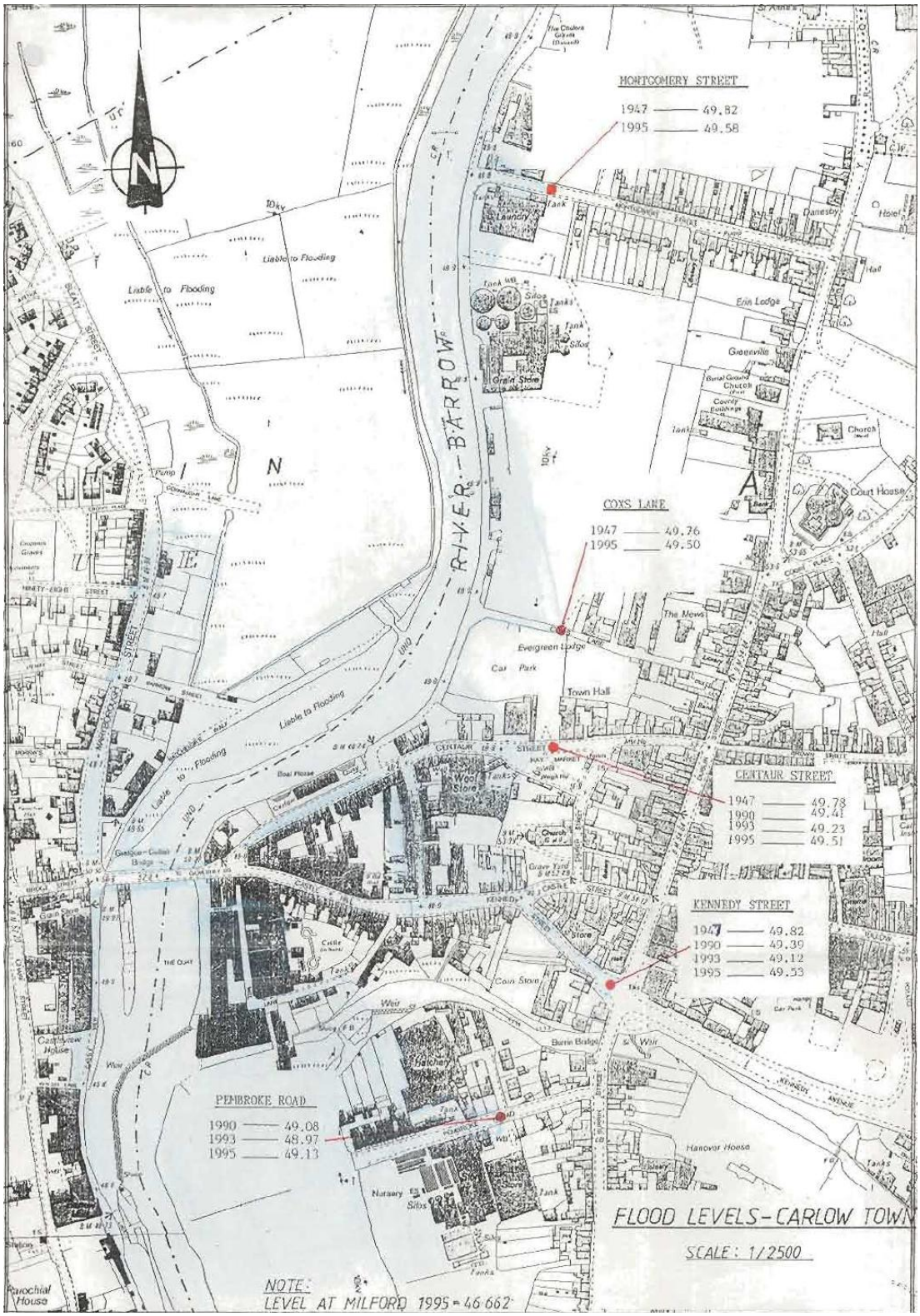
[6] Source: www.floodmaps.ie Flood event report detailing number of properties affected.

Date: November 2000	Source: Barrow
Description: In the early days of November, Council staff were on alert as heavy rain was forecast. Levels on the Barrow were seen to peak at on Tuesday morning, 7th November. Centaur St and Kennedy were closed to traffic. 28 residential properties were affected and 18 people were evacuated from 6 residential properties, 15 commercial properties were also affected.[7]	
Date: February 1990	**Source: Barrow**
Description: Flooding reported in Carlow Town; flood levels recorded at key locations, Centaur St (49.41mOD), Kennedy St (49.39mOD) and Pembroke Road (49.08mOD).	
Date: December 1998	**Source: Burrin**
Description: On the 30th December reaching flooding occurred in the Paupish Lane area with depth of flooding reaching 150mm. A report on the flooding was prepared for the OPW by MCOS in June 2001, entitled "Flooding at Paupish Lane, Carlow Town"	
Date: June 1993	**Source: Barrow**
Description: Flooding reported in Carlow Town; flood levels recorded at key locations, Centaur St (49.23mOD), Kennedy St (49.12mOD) and Pembroke Road (48.97mOD).	
Date: 18th August 2008	**Source: Barrow**
Description: Reports of flooding including photos of flood extents. Flood levels recorded at key locations are Cox's lane (46.495mOD), Centaur St (46.578mOD) and Kennedy St (46.443mOD).	
Date: January 2008	**Source: Barrow**
Description: Reports of flooding with photos of flood extents at Barrow Track, Cox's Lane (46.514mOD), Centaur St (46.416mOD), Kennedy St (46.332mOD), John St, Maryborough St, Town Park, Pembroke and Montgomery St.	

Extracts from various documents, to illustrate the extent of previous flooding in the town are presented below, in Figure 4-3 and Figure 4-4. These are available for download from www.floodmaps.ie.

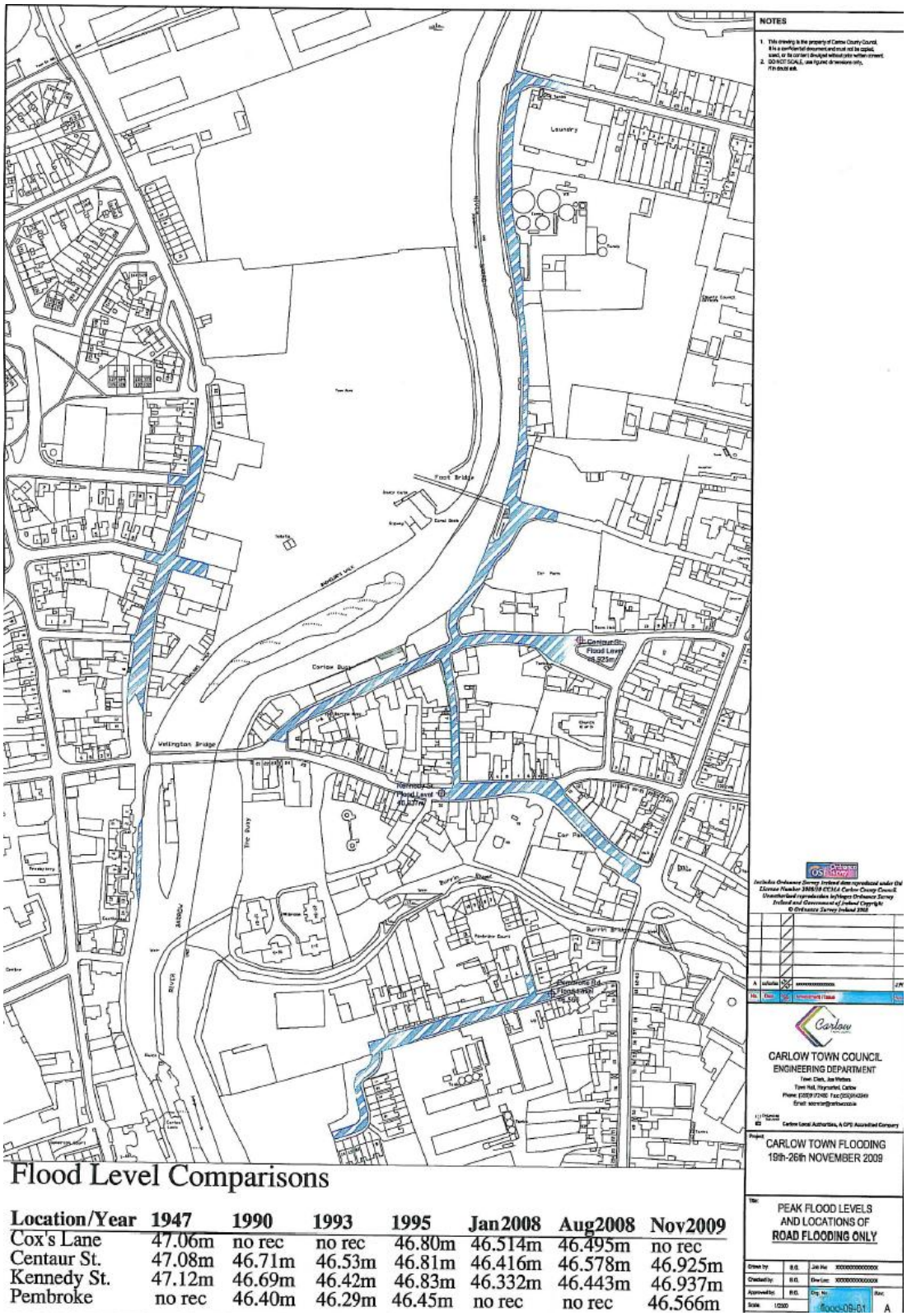
7 Source: www.floodmap.ie Carlow County Council letter dated 10th November 2000

Figure 4-3 1947 Historic Flood Extent and Recorded Flood Levels up to 1993 [8]



[8] Source: www.floodmaps.ie Report ID 2973

Figure 4-4 2009 Flood Extent and Recorded Flood Levels up to 2009[9]



Flood Level Comparisons

Location/Year	1947	1990	1993	1995	Jan 2008	Aug 2008	Nov 2009
Cox's Lane	47.06m	no rec	no rec	46.80m	46.514m	46.495m	no rec
Centaur St.	47.08m	46.71m	46.53m	46.81m	46.416m	46.578m	46.925m
Kennedy St.	47.12m	46.69m	46.42m	46.83m	46.332m	46.443m	46.937m
Pembroke	no rec	46.40m	46.29m	46.45m	no rec	no rec	46.566m

9 Source: www.floodmaps.ie Report ID 11120

4.8 Specific Local Data (including walkover survey)

A walkover survey was carried out, involving consultation with local authority personnel and taking into account the local topography. This allowed validation and, where justified, amendment of the flood outlines. For example, although the base flood maps indicate the main Kilkenny Road into Carlow is at flood risk, a visual inspection, backed up by local reports indicated that the is sited on high ground and is not considered to be at flood risk in a 1% or 0.1% AEP event.

Carlow Town Council provided ground levels at a number of locations in the town to help refine the JFLOW® flood zones. These ground levels were compared with 1% AEP (100 year) flood levels from the RPS flood relief study. This allowed a refinement to the flood zones in the following locations: Kennedy Avenue, Paupish Lane and Rivercourt. The survey carried out at Paupish Lane confirmed reports of raised ground associated with recent development placing it above 1% AEP (100 year) flood levels.

5 Sources of Flooding

This SFRA has reviewed flood risk from fluvial, pluvial and groundwater sources. It also considers flooding from drainage systems, reservoirs and canals and other artificial or man-made systems. The study has also considered residual risk associated with the Carlow Flood relief scheme.

The focus of the study is on risk from fluvial flooding. There are two main reasons for this decision. Firstly, the review of historical floods shows rivers to be the most common and most damaging. Secondly, Flood Zones in the 'Planning System and Flood Risk Management' are defined on the basis of fluvial, and where appropriate, tidal flood risk. In addition, the SFRA should be based on readily derivable information, and records and indicators for fluvial flood risk are generally more abundant than for other sources of flooding.

5.1 Fluvial Flooding

Flooding of watercourses is associated with the exceedance of channel capacity during higher flows. The process of flooding on watercourses depends on a number of characteristics associated with the catchment including; geographical location and variation in rainfall, steepness of the channel and surrounding floodplain and infiltration and rate of runoff associated with urban and rural catchments. Generally there are two main types of catchments; large and relatively flat or small and steep, both giving two very different responses during large rainfall events.

In a large, relatively flat catchment, flood levels will rise slowly and natural floodplains may remain flooded for several days, acting as the natural regulator of the flow. In small, steep catchments, local intense rainfall can result in the rapid onset of deep and fast-flowing flooding with little warning. Such “flash” flooding, which may only last a few hours, can cause considerable damage and possible threat to life.

The form of the floodplain, either natural or urbanised, can influence flooding along watercourses. The location of buildings and roads can significantly influence flood depths and velocities by altering flow directions and reducing the volume of storage within the floodplain. Critical structures such as bridge and culverts can also significantly reduce capacity creating pinch points within the floodplain. These structures are also vulnerable to blockage by natural debris within the channel or by fly tipping and waste.

In Carlow town the main source of flooding is the River Barrow as can be seen from historical records. The River Burrin also contributes to fluvial flood risk in Carlow town and is influenced by water levels in the Barrow. The Barrow catchment is large covering approximately 3,000km^2 and is relatively slow responding. This allows adequate time for flood response once a suitable management plan is put in place. The Burrin River however is quite flashy and river levels peak in a matter of hours, this poses challenges for adequate flood warning and successful flood management.

Flood risk to specific potential development sites is discussed in Section 12, and has been used to inform the zoning objectives for the Joint Spatial Plan. Where development is proposed within Flood Zones A or B, the Justification Test must be applied, and passed.

5.2 Flooding from Flood Defence Overtopping or Breach

The flood defence works along the River Barrow and Burrin are designed to a 1% AEP (100 year) standard of protection (See Section 6 for more detail on the scheme). There is a residual risk associated with failure of these defences due to overtopping or breach. The areas benefiting from defences are presented in MAP A (in Section 8 and in Appendix A) and indicate the areas of residual risk.

With climate change, the frequency, pattern and severity of flooding are expected to change and become more damaging. Climate change and increased river flows will impact on the level of protection of the scheme in future years.

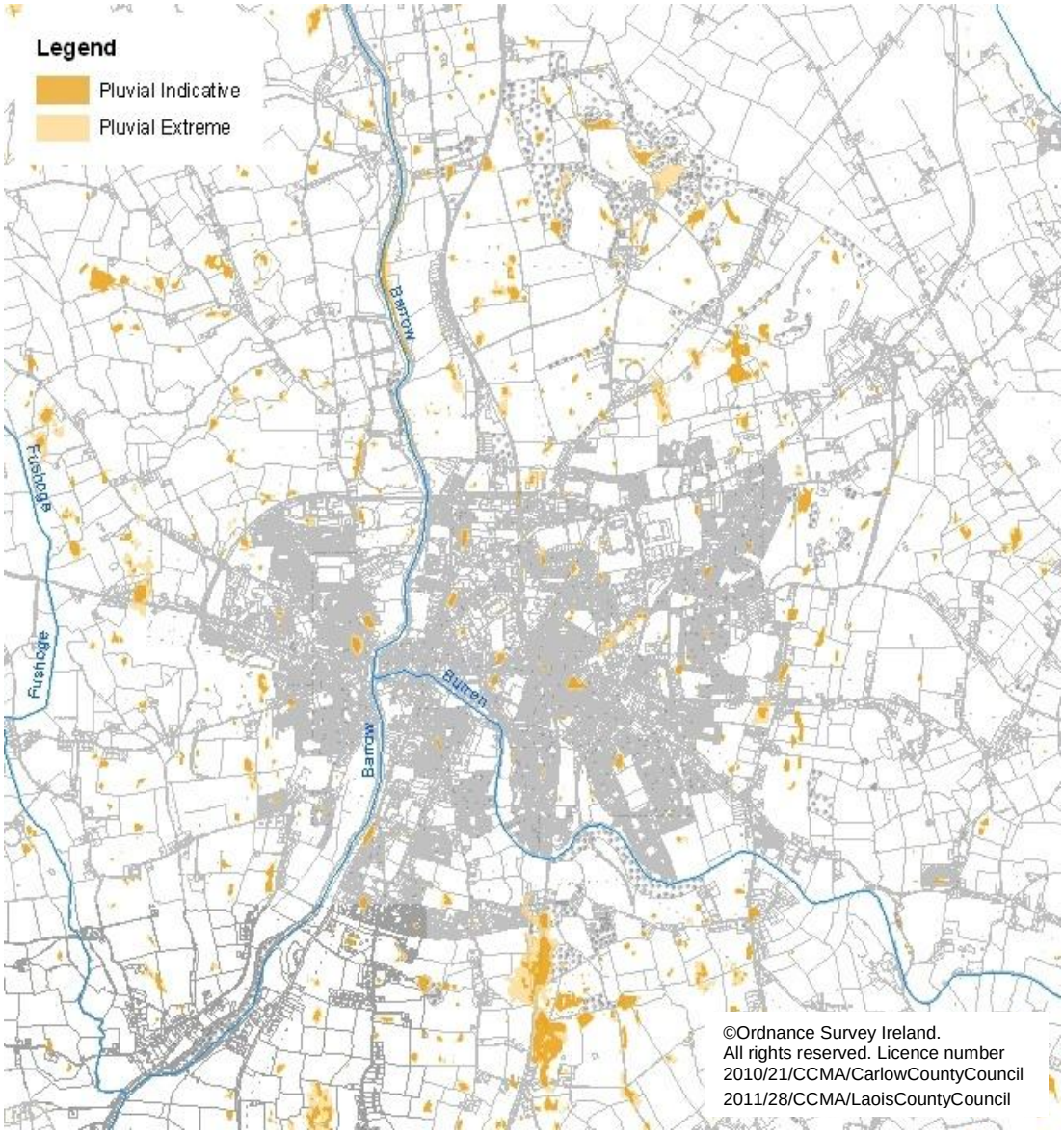
The Planning Guidelines require that an initial assessment of risk is made without consideration of flood defences when defining Flood Zones A and B. Residual risk and its impact are discussed in more detail in Section 7.

5.3 Pluvial Flooding

Flooding of land from surface water runoff is usually caused by intense rainfall that may only last a few hours. The resulting water follows natural valley lines, creating flow paths along roads and through and around developments and ponding in low spots, which often coincide with fluvial floodplains. Any areas at risk from fluvial flooding will almost certainly be at risk from surface water flooding.

The PFRA study considered pluvial flood risk and produced a national set of pluvial flood maps. The indicative pluvial map from the PFRA study is presented in Figure 5-1 below.

Figure 5-1 PFRA Indicative Pluvial Flood Map[10]



SFRAs require a strategic assessment of the likelihood of surface water flooding for which overland routing is suitable and appropriate. This includes consideration of the following:

[10] Source: OPW, PFRA Study Draft Data, licensed to Carlow Local Authorities

- Are there zoned lands which may need to accommodate and retain surface water flow routes?
- Are there zoned lands which might discharge upstream of an area vulnerable to surface water flooding?

Whilst the potential for surface water flow paths or ponding should not necessarily impede or restrict development, applications in such areas need to consider drainage thoroughly to ensure risks do not increase in the future. Any development proposals must not impact negatively on flood risk elsewhere. A detailed drainage assessment should be undertaken for specific applications. Using the available datasets a preliminary assessment of the potential for specific zoned lands to contribute, or be vulnerable to surface water flooding, should be undertaken based on local ground topography on a site by site basis.

A preliminary assessment of the potential for specific zoned lands i.e. opportunity sites, to contribute or to be vulnerable to surface water flooding has been undertaken (see Sections 11 and 12).

5.4 Flooding from Drainage Systems

Flooding from artificial drainage systems occurs when flow entering a system, such as an urban storm water drainage system, exceeds its discharge capacity, it becomes blocked or it cannot discharge due to a high water level in the receiving watercourse.

Flooding in urban areas can also be attributed to sewers. Sewers have a finite capacity which, during certain load conditions, will be exceeded. In addition, design standards vary and changes within the catchment areas draining to the system, in particular planned growth and urban creep, will reduce the level of service provided by the asset. Sewer flooding problems will often be associated with regularly occurring storm events during which sewers and associated infrastructure can become blocked or fail. This problem is exacerbated in areas with under-capacity systems. In the larger events that are less frequent but have a higher consequence, surface water will exceed the sewer system and flow across the surface of the land, often following the same flow paths and ponding in the same areas as overland flow.

Foul sewers and surface water drainage systems are spread extensively across the urban areas with various interconnected systems discharging to treatment works and into local watercourses.

The surface water drainage network is currently being upgraded to improve the capacity of the underground drainage network. This work includes the construction of combined storm overflows at a number of locations.

Maintenance activities, i.e. cleaning gullies, repairing pipes, clearing debris, are vital in order to manage this risk. Recent works in the town as part of the Carlow Surface Water Drainage Scheme have upgraded the surface water drainage network in conjunction with the other flood relief works on the Rivers Barrow and Burrin.

5.5 Groundwater Flooding

Groundwater flooding is caused by the emergence of water originating from underground, and is particularly common in karst landscapes. This can emerge from either point or diffuse locations. The occurrence of groundwater flooding is usually very local and unlike flooding from rivers and the sea, does not generally pose a significant risk to life due to the slow rate at which the water level rises. However, groundwater flooding can cause significant damage to property, especially in urban areas and pose further risks to the environment and ground stability.

Groundwater flooding can persist over a number of weeks and poses a significant but localised issue that has attracted an increasing amount of public concern in recent years. In most cases groundwater flooding cannot be easily managed or lasting solutions engineered although the impact on buildings can be mitigated against through various measures.

Groundwater vulnerability, derived by the Geological Survey of Ireland (GSI), shown below in Figure 5-2 is based on a number of parameters including:

- Sub-soils that overlie the groundwater;
- Type of recharge - whether point or diffuse;
- Thickness of the unsaturated zone through which the contaminant moves.

The more vulnerable the groundwater is to contamination (i.e. passage of contaminants down through the soil), the more chance there is of the groundwater rising to the surface and causing flooding.

Figure 5-2 Groundwater Vulnerability[11]

The GSI mapping indicates that the Carlow Graiguecullen Urban Area mainly over lies groundwater of 'high' vulnerability, with pockets of moderate or extreme vulnerability to the outskirts of the town centre.

The National PFRA Study considered flooding from groundwater sources. The draft PFRA groundwater flood maps, which provide an indication of vulnerability to groundwater flooding, did not show any significant risk in the Carlow urban area. These maps are based on an appraisal of groundwater vulnerability and correlation to reports of historic groundwater flooding. Although there are no flood records listing 'groundwater' as a source of flooding, it is often difficult to distinguish groundwater and surface water in the historical records. It is recommended that future flooding events are monitored for source. Based on the findings of the PFRA study, the risk of groundwater flooding is not considered significant enough to warrant further investigation in this SFRA.

5.6 Flooding from Reservoirs and other Artificial Sources

Reservoirs can be a major source of flood risk, as demonstrated in the 2009 flooding, when waters released from the Inniscarra dam flooded significant sections of Cork. Whilst the probability of dam failure or breach occurring is very small, the consequences of such an event can be devastating thereby presenting a risk of flooding which has to be considered.

11 Source: Department of Communications, Marine and Natural Resources. Copyright DCMNR and Government of Ireland.

However Carlow Graiguecullen does not have any large reservoirs or artificial detention basins.

Barrow Navigation is a river navigation system which is under the control of Waterways Ireland. It runs from Athy in Co. Kildare to St. Mullins in Co. Carlow and passes through Carlow Town. Features of the navigation system include the Barrow Track which functioned as a tow path and Carlow Lock which dates back to the 18th century was constructed to allow navigation past the weir downstream of Graiguecullen Bridge. Built in 1569, the bridge was originally named Carlow Bridge, it was widened in the early 19th century and was renamed Wellington Bridge, today it is known as Graiguecullen Bridge. The bridge and weir act as flow controls structure and their influence on river flow would need to be considered in any detailed assessment of the River Barrow.

6 Flood Risk Management Assets

The condition of existing flood management assets is an important consideration for local authority planners when allocating new development. The 'Planning System and Flood Risk Management' define Flood Zones without the benefit of defences acknowledging that defended areas (i.e. those areas that are protected to some degree against flooding by the presence of a formalised flood defence) are still at risk of flooding due to the risk of overtopping or breach. Sites within these areas must be assessed with respect to the adequacy of the defences.

In Carlow town, the Carlow Flood Relief Scheme which is currently under construction consists of flood defences along the River Barrow and River Burrin and is detailed below in Section 6.1.

There are a number of Drainage Districts in the outskirts of Carlow Town which are discussed below in Section 6.2.

6.1 Carlow Flood Relief Scheme

The flood relief scheme includes defences along the River Barrow and River Burrin. These defences consist of flood walls and flood embankments. The proposal also included some weir alterations and channel improvement works. Based on the original design proposal, the flood relief scheme work was divided into the following three phases:

- Phase A included works along east bank of the Barrow upstream of Graiguecullen Bridge and the north bank of the River Burrin;
- Phase B included works along the right bank of the Barrow in the town park area and works along the southern bank of the River Burrin;
- Phase C included works in the Paupish Lane area

Where possible, the works have been incorporated into the planning conditions laid out for individual site developments. Work proposed along the River Burrin in the Paupish Lane area (originally part of Phase C) is no longer required, largely due to land raising carried out as part of local development.

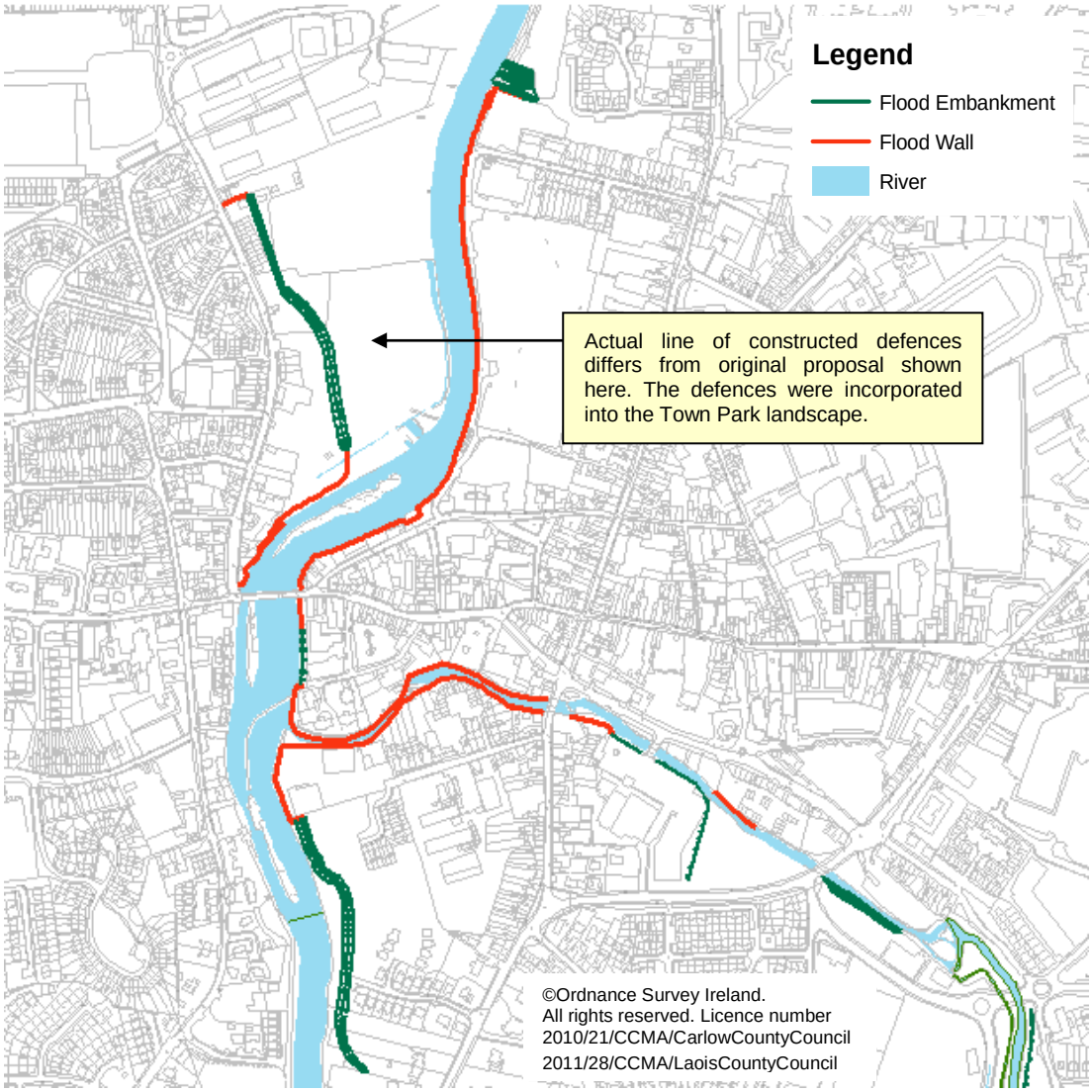
The works completed to date are those along the right and left bank of the River Barrow upstream of Graiguecullen Bridge and the north bank of the River Burrin (Phase A and part of Phase B).

The scheme was designed to a 1% AEP (100 year) level of protection and did not take into account the effects of climate change. A freeboard of 150mm or 300mm was applied to hard (i.e concrete flood wall) and soft defences (i.e. earthen embankments) respectively.

Figure 6-1 below outlines the original design proposal for the Carlow Flood Relief Scheme.

The consideration of residual risk i.e. the likelihood of flooding occurring as a result of breach or overtopping of defences, is discussed in Section 7.

Figure 6-1 Carlow Flood Relief Scheme - as proposed



6.2 Drainage Districts

Several hundred minor drainage improvement schemes, on localised stretches of river, were first established under the 1842 Arterial Drainage Act. Some of these schemes were then subsumed into Arterial Drainage Schemes under the 1945 Arterial Drainage Act, but circa 172 schemes remain standalone and are known as Drainage Districts (DD).

The Act deals with the improvement of lands by drainage and preventing or substantially reducing the flooding of lands. The 1945 Act set up the process of Arterial Drainage Schemes and provides for the maintenance of these works. It also implements a number of drainage and flood reduction related measures such as approval procedures for bridges and weirs and iterates reporting requirements for Drainage Districts.

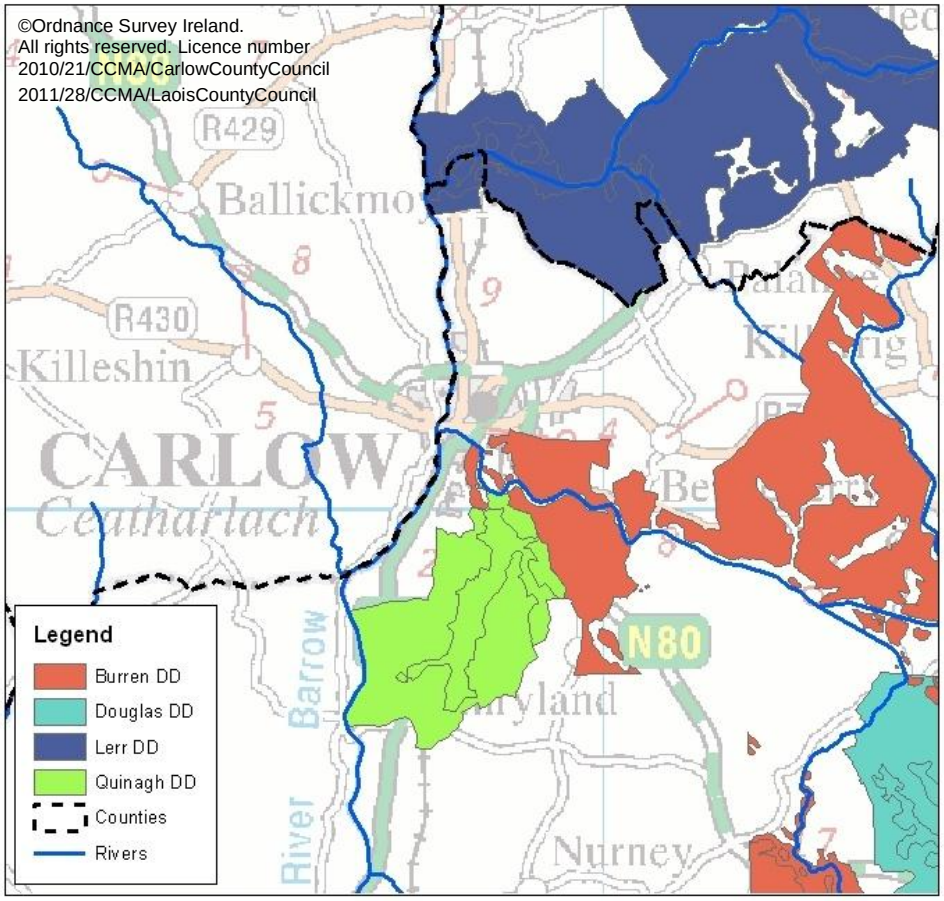
The Arterial Drainage Act was originally established to deal with land drainage issues and by definition focused on agricultural land in rural areas. In 1995, in response to serious urban flooding the Act was amended to allow for the provision of flood relief schemes in urban areas. The Drainage Districts in and around Carlow Town are illustrated in Figure 6-2 below.

Associated with the River Barrow catchment is the Barrow Drainage District which covers an area upstream of Athy, Co. Kildare and does not extend as far as Carlow town. The Burren Drainage District and the Quinagh Drainage District to the south of the town extend into the study area.

The key maintenance activities carried out within drainage districts are:

- Placement of rock armour in locations of bank collapse and erosion, particularly on bends (as required, with respect to ecological constraints, and constitutes a full time programme of works);
- Removal of rock and gravel deposits from below bridges. This work is undertaken as required, with respect to ecological and water level constraints. It is noted that in previous years clearance may have been undertaken every two or three years, but has been required annually for the last two or three years;
- Vegetation clearance along bank tops (October to March).

Figure 6-2 Drainage Districts



7 Residual Risk

Residual risk is the risk that remains after measures to control flood risk have been carried out. Residual risk can arise from overtopping of flood defences and / or from the breach from structural failure of the defences.

The concept of residual risk is explained in the Planning System and Flood Risk Management guidelines as follows:

"*Although flood defences may reduce the risk of flooding, they cannot eliminate it. A flood defence may be overtopped by a flood that is higher than that for which it was designed, or be breached and allow flood water to rapidly inundate the area behind the defence. In addition, no guarantee can be given that flood defence will be maintained in perpetuity. As well as the actual risk, which may be reduced as a result of the flood defence, there will remain a residual risk that must be considered in determining the appropriateness of particular land uses and development. For these reasons, flooding will still remain a consideration behind flood defences and the flood zones deliberately ignore the presence of flood defences*."

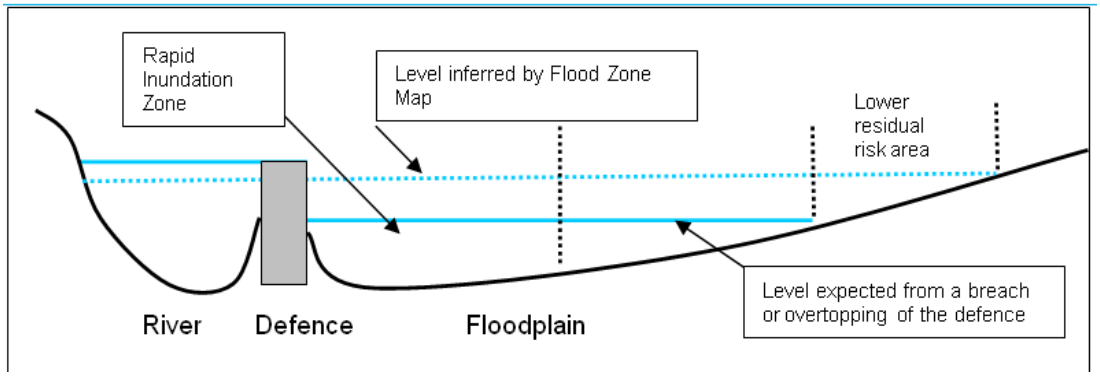
7.1 Types of Residual Risk

7.1.1 Residual Risk due to Overtopping

Overtopping of flood defences will occur during flood events greater than the design level of the defences. The defences in Carlow have been designed to a 1% AEP level of protection. During any event greater than a 1% AEP, overtopping will occur. This is likely to cause more limited inundation of the floodplain than if defences had not been built, but the impact will depend on the duration, severity and volume of floodwater. However, and more critically, overtopping can destabilise a flood defence, cause erosion and make it more susceptible to breach or fail.

Overtopping may become more likely in future years due to the impacts of climate change. In Carlow the defences have been designed to a 1% AEP standard of protection without the inclusion of possible climate change impacts, such as more frequent and higher river flows.

Figure 7-1 Illustration of Residual Risk behind Defences



7.1.2 Residual Risk due to Breach or Structural Failure

Breach or structural failure of flood defences is hard to predict and is largely related to the structural condition and type of flood defence. 'Hard' flood defences such as solid concrete walls are less likely to breach than 'soft' defence such as earth embankments.

Breach will usually result in sudden flooding with little or no warning and presents a significant hazard and danger to life. There is likely to be deeper flooding in the event of a breach than due to overtopping. The volume and impact of flooding will depend on a number of factors including:

- Size and number of breaches

- The time that the breach develops; a breach that develops early will allow more floodwater through, however a breach that develops near the peak of the event will be more hazardous.
- How long the breach remains open, leaving those in the floodplain vulnerable to secondary flood peaks on a watercourse or the next high tide cycle for areas on the coast or in estuaries.

7.1.3 Residual Risk due to Operational Failure

A flood defence system may also fail if it is dependent on flow control structures such as sluices, barriers and flap gates since there is always the possibility operational failure. Similarly if a defence system includes temporary or demountable sections it may fail due to human error.

Along with the flood relief works undertaken in Carlow, works were carried out to upgrade the existing surface water drainage network and to allow adequate drainage of the land behind the defences. This includes a number of storm overflow chambers and pumping stations. There is a residual risk associated with the operational failure of these flow control structures. The flood relief scheme does not include for the provision of demountable defences.

7.2 Climate Change

Climate change should be considered when assessing flood risk and in particular residual flood risk. Areas of residual risk are highly sensitive to climate change impacts as an increase in flood levels will increase the likelihood of defence failure.

The 'Planning System and Flood Risk Management' recommends that a precautionary approach to climate change is adopted due to the level of uncertainty involved in the potential effects. A significant amount of research into climate change has been undertaken on both a national and international front. This section will briefly examine some of the key findings of the research to date.

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 and its first report in 1990 justified concern about the effects of climate change on a scientific basis. The more recent IPCC Fourth Assessment Report 2007[12] concludes that climate change is unequivocal. It projects a global average sea level rise of between 0.18m and 0.59m for different SRES emissions scenarios, up to the end of the century. (SRES refers to the IPCC Special Report on Emissions Scenarios, published in 2000. The scenarios explore different demographic, economic and technological forces and resultant greenhouse gas emissions.)

Table 7-1 Allowances for Future Scenarios (100 Year Time Horizon)

Criteria	MRFS	HEFS
Extreme Rainfall Depths	+20%	+30%
Flood Flows	+20%	+30%
Mean Sea Level Rise	+500mm	+1000mm
Land Movement	-0.5mm / year*	-0.5mm / year*
Urbanisation	No General Allowance - Review on Case by Case Basis	No General Allowance - Review on Case by Case Basis
Forestation	-1/6 Tp**	-1/3 Tp** +10% SPR***

Notes:
* Applicable to the southern part of the country only (Dublin - Galway and south of this)
** Reduce the time to peak (Tp) by a third; this allows for potential accelerated runoff that may arise as a result of drainage of afforested land
*** Add 10% to the Standard Percentage Runoff (SPR) rate; this allows for increased runoff rates that may arise following felling of forestry

More specific advice on the expected impacts of climate change and the allowances to be provided for future flood risk management in Ireland is given in the OPW draft guidance13.

[12] Inter-Governmental Panel on Climate Change (IPCC), 4th assessment report. "Climate Change 2007".
[13] OPW Assessment of Potential Future Scenarios, Flood Risk Management Draft Guidance, 2009

Two climate change scenarios are considered. These are the Mid-Range Future Scenario (MRFS) and the High-End Future Scenario (HEFS). The MRFS is intended to represent a "likely" future scenario based on the wide range of future predictions available. The HEFS represents a more "extreme" future scenario at the upper boundaries of future projections. Based on these two scenarios the OPW recommended allowances for climate change are given in Table 7-1.

The Flood Zone maps do not directly take climate change into account, but climate change flood extents can be assessed by using the Flood Zone B outline as a surrogate for 'Flood Zone A with allowance for the possible impacts of climate change', as suggested in the 'Planning System and Flood Risk Management'.

7.3 Scales of Residual Risk

The relief scheme in Carlow is currently under construction, therefore is in good condition and is unlikely to fail due to structural deficiencies. The standard of protection and condition of the defences will be dependent on regular inspection and maintenance over its entire lifetime. The current level of residual risk behind the defences is low due to the fact that the defences have been recently designed and constructed.

The scale of residual risk is difficult to predict and requires detailed modelling to estimate the flood extents from a range of different scenarios, defended and undefended. As part of the South Eastern CFRAM detailed modelling will be carried out and will investigate residual risk. Once complete this data will be available for plan making decisions at local authority level.

Without detailed modelling, the following assumptions can be made to assess residual risk.

- Worst case scenario would be flood extent equal to that of an undefended scenario for a particular return period.
- Flow velocities and hence hazard will be greatest immediately adjacent to flood defences.

Development in areas benefiting from defences must consider long-term flood risk management policies and plans. On a site specific level, emergency response plan should be prepared taking into account the overall plan for the area.

Flood mitigation and management measures to deal with flood risk are discussed in Section 10.

8 Flood Zone Mapping

As discussed in Section 4, JBA software known as JFLOW® was used to undertake multi-scale two dimensional hydraulic flood modelling. These base JFLOW® outlines have been reviewed against available data and have been refined where appropriate.

This section details the process of validation undertaken as part of the creation of the Flood Zone maps, which were developed using available data and the investigations carried out as part of this SFRA. These Flood Zones inform planning decisions leading to the application of the Justification Test where applicable. The application of the Justification Test for specific 'development opportunity sites' is detailed in Section 12.

8.1 Comparison of PFRA, JFLOW® Indicative Flood Mapping

8.1.1 PFRA Indicative Fluvial Flood Mapping & Methodology

Flood flow estimates were calculated at nodes every 500m intervals along the entire river network. (The river network is the EPA 'blue-line' network, which, for the most part, matches the rivers mapped at the 1:50,000 scale Discovery Series OS mapping). This flow estimation was based on the OPW Flood Studies Update research programme. An assumption was made that the in-channel flow equates to the mean annual flood and so the out of bank flow for a particular AEP event was determined by deducting the mean annual flood from the flood flow estimate for that probability event.

Using the OPW's 5m national digital terrain model (DTM) a cross section was determined at 100m spacings. Manning's equation, a hydraulic equation for normal flow was used to calculate a flood level which was then extrapolated across the DTM to determine the flood extent. This exercise was completed for all river catchments greater than 1km^2.

This methodology does not take into account defences, channel structures or channel works. Potential sources of error in the mapping include local errors in the DTM or changes to the watercourse flow route due to an error in mapping or new development.

The PFRA mapping was completed as part of a desk based study and was put on display for public consultation and comment. A site based review of the PFRA, at selected sites, is ongoing as the National CFRAM programme continues. In Carlow town the PFRA outlines have been reviewed by RPS Consulting as part of the Flood Risk Review stage of the South Eastern CFRAM. The flood risk review reported that a minor watercourse shown within the PFRA was not confirmed on site. Consultation, as part of the SFRA, has confirmed that sections of this watercourse have been culverted (See Section 8.2)

8.1.2 JFLOW® Indicative Fluvial Flood Mapping & Methodology

The JFLOW® fluvial flood mapping process involved two stages, hydrology and hydraulic modelling. JBA Consulting developed in-house software tools to interpolate catchment descriptors from a number of environmental datasets and produced an automated method for calculating design flows. The method used to calculate flows was based on the Flood Estimate Handbook (FEH)[14] Statistical Method and is in line with the methods of the Flood Studies Update (FSU) which is currently under development. Index flows were generated at 300m intervals along the entire river network. Annual Maximum flow data from the OPW Hydrodata[15] website were used to adjust the index flows by allocating 'donor' gauges, whereby local gauges are used to compare and adjust index flows for a given catchment. Pooled data was used to generate growth curves and determine flood flows for different return periods.

JFLOW®, a two dimensional hydraulic modelling software, developed in-house by JBA Consulting, was used to simulate overland flooding. Cross sections were generated at each inflow point to define the extent of the area over which to route the flow. A similar assumption was made relating to the channel capacity as for the PFRA study. The flow hydrograph calculated at each estimation point was routed over a digital terrain model and this was the

[14] Flood Estimation Handbook, Institute of Hydrology, 1999

[15] www.opw.ie/hydro

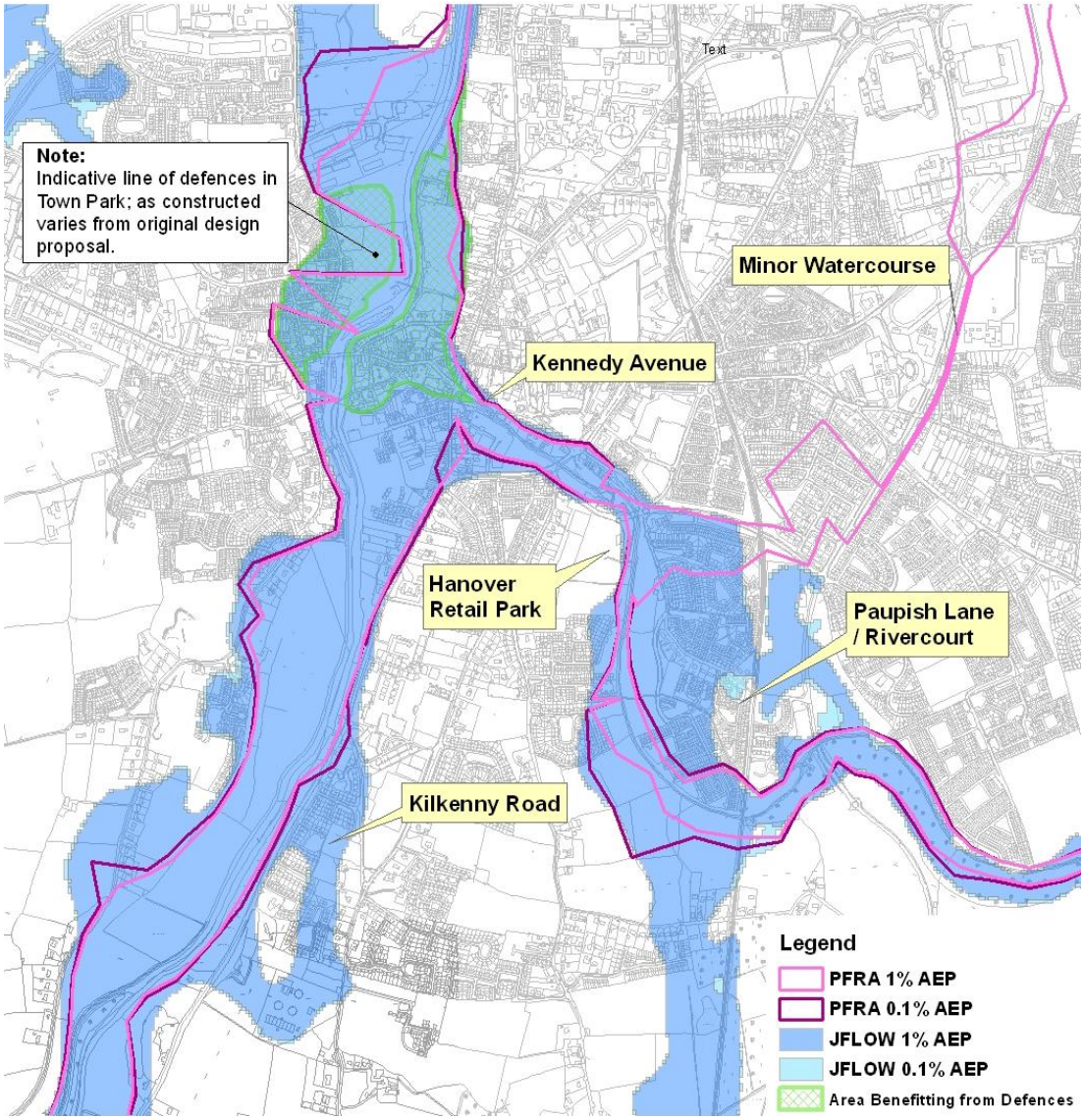
OSi national 10m height model. This process was completed for all river catchments greater than 10km^2.

JFLOW® results were subject to several iterations of manually checking and model re-runs. However the accuracy of the flood mapping is directly correlated to the DTM and individual flow structures such as bridges, culverts, weirs and sluices are not explicitly modelled.

8.1.3 Summary

Both methods are inherently different but have produced indicative flood maps which, in Carlow, correlate very well. One of the main differences is the DTM that was used. The JFLOW® extents are generally more conservative, because it considers flow volume and interconnecting watercourses, however the PFRA mapping includes for an extra watercourse (catchment less than 10km^2) that was not modelled using JFLOW®. The indicative flood outlines for both (before site review) are displayed below in Figure 8-1.

Figure 8-1 PFRA & JFLOW® Indicative Flood Mapping



8.2 Flood Zone Map Improvements

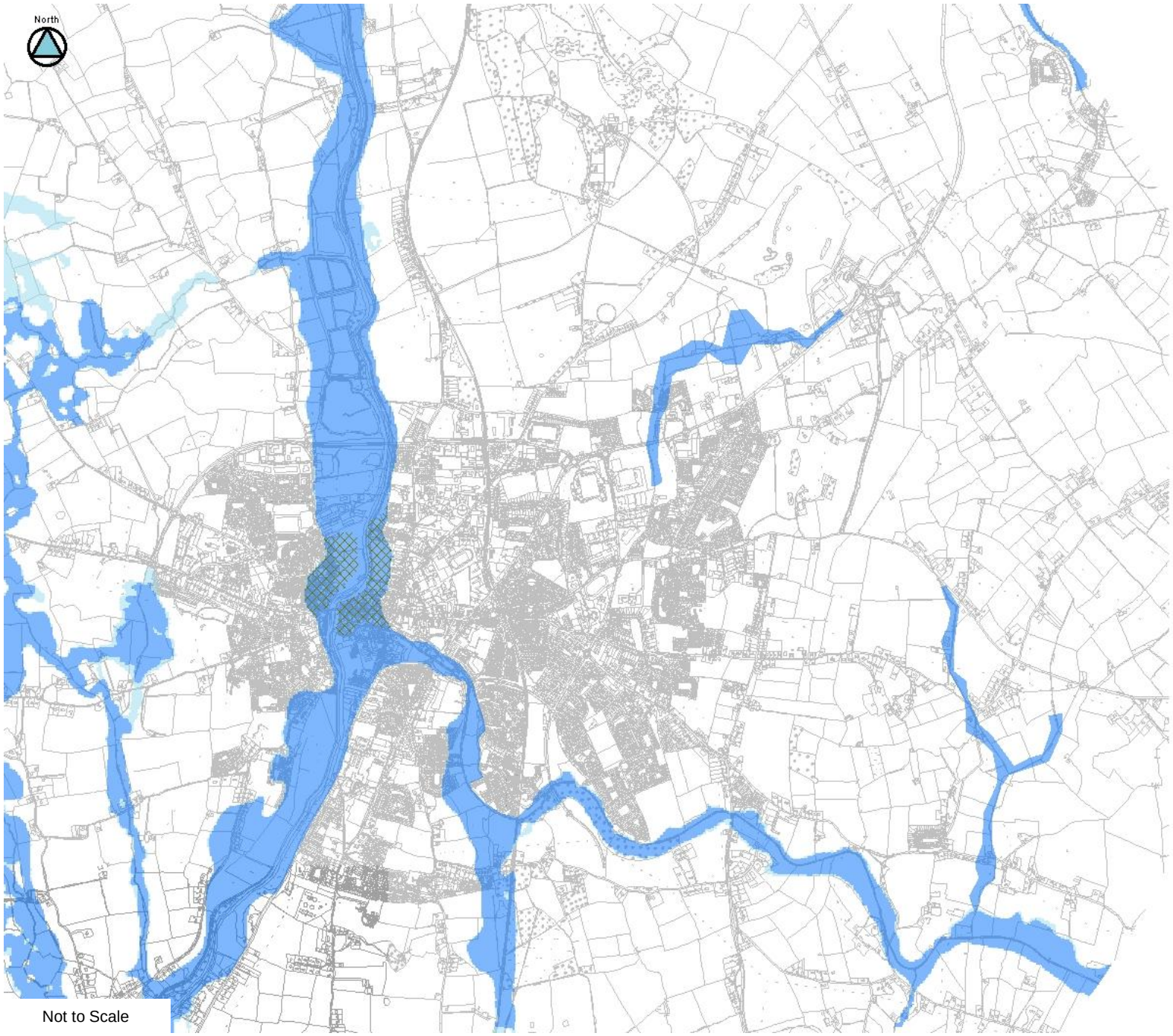
JBA Consulting visited Carlow, consulted with local authority personnel and undertook a site walkover to validate the flood maps. This, including all collated data, (see Section 4) was used to modify the indicative Flood Zone Maps; these modifications are detailed in the following section.

The specific areas that have been refined based on the available local data are outlined below and are illustrated in Figure 8-1. These areas include Kilkenny Road, Kennedy Avenue, the Paupish Lane and Rivercourt area.

- **Kilkenny Road** - site walkover confirmed that the road is at a high level well above the normal river level. Anecdotal and historical evidence suggest that this area is not at flood risk.
- **Kennedy Avenue** - Based on local spot levels and design flows from the Carlow Flood Relief Scheme Design, the area of flood risk has been refined.
- **Paupish Lane Area** - the site walkover and consultation with Carlow Town Council confirmed recent development and land raising. Local spot level survey data and comparison of levels from Carlow Flood Relief Scheme Design allowed a refinement of the indicative maps.
- **Rivercourt Area** - the site walkover confirmed the recent construction of a road embankment as part of housing development. Local spot levels confirmed a lesser flood extent and the indicative flood maps have been modified based on this data.
- **Minor watercourse** - consultation with the Local Authority confirmed that this watercourse has been culverted and eventually discharges into the Burren. This is a minor watercourse and was not originally modelled under JFLOW®, but was included under the PFRA study. The findings of the flood risk review stage of the South East CFRAM reports that this watercourse was not located on site however sufficient flood risk exists in Carlow town to warrant its inclusion as an Area for Further Assessment (AFA) in subsequent detailed modelling stages of the SECFRAM. A site visit by JBA Consulting confirmed the existence of the watercourse upstream of the Dublin Road and concluded that the PFRA outline was reasonable to indicate potential flood risk in the area. A significantly long section of culvert continues from a point downstream of the Dublin Road to its outfall at the Burren River. Upstream of this long culvert, works have been completed on the stream as part of the Castle Oaks development. A submission by Monaco Properties (CTJSP99) and information from planning, confirmed the nature of the works to the Askea Stream within the site. However the information submitted does not include an assessment of flow in the stream and does not provide sufficient evidence to discount flood risk at the site. The flood zones presented in this SFRA, indicate the flood risk associated with the watercourse upstream of where the minor watercourse has been substantially culverted.
- **Hanover Retail Park** - Based on a submission to the draft plan (ref CTJSP84), which included a site specific "Flood Risk Assessment Report for the Extension to Carlow Retail Park, Hanover, Carlow" the Flood Zones in this area have been amended. The submission included a site specific FRA, that presented a flood extent based on a comparison of design flood levels from the Carlow Relief Scheme and surveyed site levels. The Flood Zone adjacent to defences has not been amended as it is unclear how the site specific assessment has considered such defences.

Figure 8-1 also shows the areas that benefit from the flood relief works that have been completed to date in the town, along the Barrow Track and in the Town Park. The Areas Benefitting from Defences (ABD) are overlaid onto the flood zone mapping and indicate areas of residual risk.

The resultant validated Flood Zones along with the ABDs for the Carlow Graiguecullen area are presented below in MAP A and reproduced (at A3 size) in Appendix A.



Not to Scale

NOTES

Flood Zone A defines the area that has a 1% (1 in 100) or greater chance of flooding each year.

Flood Zone B defines the area that has between a 1% (1 in 100) and a 0.1% (1 in 1000) chance of flooding each year.

The flood zones are defined without the influence of defences (as per the Planning Guidelines).

This map also highlights those 'Areas Benefitting from Defences' which takes into account the recently constructed sections of the Carlow Flood Relief Scheme.

Flood Zone C is everywhere that is not in Flood Zones A or B.

LEGEND

- Area Benefitting from Defences
- Flood Zone A
- Flood Zone B

JBA consulting

MAP A

GREATER CARLOW GRAIGUECULLEN URBAN AREA

FLOOD ZONES

9 Flooding Impacts

Flood impacts maybe direct or indirect, immediate or long term and may affect households and communities, individuals as well as the environment, infrastructure and economy of an area. In the following sections, the impacts of flooding to people, property, infrastructure and the environment is discussed, and assessed in the context of Carlow Town.

9.1 Flooding Impacts on People

Flooding has a wide range of social impacts which may be difficult to delineate as they are interconnected, cumulative and often not quantifiable.

In small urban or steep upland catchments, which have a very rapid response to rainfall, or with flooding due to infrastructure failure, flood waters can rise very quickly and put life at risk. Even shallow water flowing at 2m/s can knock children and many adults off their feet and vehicles can be moved by water of 300mm depth. The risks rise if the flood water is carrying debris.

The impact on people as a result of the stress and trauma of being flooded, or even of being under the threat of flooding, can be immense. Long-term impacts can arise due to chronic illnesses and stress. Flood water contaminated by sewage or other pollutants (e.g. chemicals stored in garages or commercial properties) is particularly likely to cause such illnesses, either directly as a result of contact with the polluted flood water or indirectly as a result of sediments left behind.

The degree to which populations are at risk from flooding is not solely dependent upon proximity to the source of the threat or the physical nature of the flooding. Social factors also play a significant role in determining risk. Although people may experience the same flood, in the same area, at the same time, their levels of suffering are likely to differ greatly as a result of basic social differences. These differences will affect vulnerability in a variety of ways, including an individual or community's response to risk communication (flood warning) and physical and psychological recovery in the aftermath of a flood. How individuals and communities experience the impact will also vary depending on their awareness of the risk of flooding, preparedness for the flood event and the existence or lack of coping strategies.

Impacts of flooding on people are difficult to measure and quantify. There is currently no spatially referenced dataset of social vulnerability, although, in time, the census could be adapted into the format of the Social Flood Vulnerability Index, as used in the UK[16].

For the purposes of this SFRA, the impacts of flooding on people must be inferred from the number of properties at risk of flooding.

9.2 Flooding Impacts on Property and Infrastructure

Flooding can cause severe property damage. Flood water is likely to damage internal finishes, contents, electrical and other services and possibly cause structural damage. The physical effects can have significant long-term impacts, with re-occupation sometimes not possible for over a year. The costs of flooding are increasing, partly due to increasing amounts of electrical and other sophisticated equipment within developments.

The damage flooding can cause to businesses and infrastructure, such as transport or utilities like electricity and water supply, can have significant detrimental impacts on local and regional economies. The long-term closure of businesses, for example, can lead to job losses and other economic impacts.

The vulnerability of buildings is important to understand in terms of their occupants and their type. For example, it is much more difficult to evacuate the old and ill from hospitals and care homes than people working in offices or industrial areas. Building types that need to be operational during and post flood, such as ambulance stations and emergency response

[16] Office of Public Works (2008) Flood Risk Assessment Indicators, Methods and Datasets - Scoping Study, Final Report.

centres are also vulnerable; if the services they provide are disrupted by flooding it will place the immediate community at greater risk.

Within the Graiguecullen and Carlow town development area there are 11% of all properties are within Flood Zone A, and approximately 0.6% are within Flood Zone B. The breakdown of property type by Flood Zone is shown in Table 9-1.

There are no schools or hospitals located within the Flood Zones A and B.

Table 9-1 Number and Type of Properties within Flood Zones

	Property Type	Number of Properties	Percentage of Total Properties
	All Properties	***11,623***	
Flood Zone A	Residential	852	7.3%
	Commercial	157	1.4%
	Combined	288	2.5%
	Total	**1,297**	**11.2%**
Flood Zone B	Residential	67	0.6%
	Commercial	3	<0.1%
	Combined	0	
	Total	**70**	**0.6%**

Transport and strategic utilities infrastructure can be particularly vulnerable to flooding because interruption of their function can have widespread effects well beyond the area of flooding. For example, flooding of primary roads or railways can deny access to areas for the duration of the flooding, as well as causing damage to the road or railway. Flooding of water distribution infrastructure, such as pumping stations, or of electricity sub-stations can result in loss of water or power over large areas. This can magnify the impact of flooding beyond the immediate community and reinforces why decisions to locate development in floodplain should be taken very carefully.

Placing new development or regenerating in flood risk areas has additional short and long-term costs. The need to build resistant and resilient properties could significantly increase overall costs of development, whilst ongoing maintenance and insurance increase future expenditure.

9.3 Flooding Impacts on Environment

Environmental impacts can be significant and include soil erosion, bank erosion, land sliding and damage to vegetation as well as the impacts on water quality, habitats and flora and fauna caused by bacteria and other pollutants carried by floodwater.

Flooding can have a beneficial role in natural habitats. Many wetland habitats are dependent on annual flooding for their sustainability and can contribute to the storing of flood waters to reduce flood risk elsewhere. It is important to recognise the value of maintenance or restoration of natural riparian zones such as grasslands which protect the soils from erosion and 'natural' meadows which can tolerate flood inundation. The use of Green Infrastructure throughout the river corridor can also play a vital role in enhancing the river environment as well as safeguarding land from future development, protecting people and buildings from flooding and reducing flood risk downstream.

A natural floodplain can help accommodate climate change and improve the quality of rivers and associated wetlands to help achieve 'good status' by 2015 under the Water Framework Directive (WFD). Meeting WFD objectives involves not only ecosystems, water quality, drought and flood impact considerations but also the physical characteristics and morphology of the river channel, floodplain and associated structures.

10 Flood Management and Mitigation

Following the Planning Guidelines, development should always be located in areas of lowest flood risk first, and only when it has been established that there are no suitable alternative options should development (of the lowest vulnerability) proceed. In such instances, consideration of suitable flood risk mitigation and management measures is necessary. It may be technically feasible to mitigate or manage flood risk at site level, however the potential impacts on the surrounding community must also be considered. A strategic approach to the management of flood risk is particularly important in Carlow due to the presence of the Carlow flood relief scheme.

The detailed assessment that will be undertaken as part of the South Eastern CFRAM will quantify residual risk and feed into the management options for the area. The CFRAM will result in the publication of a Flood Risk Management Plan that will include management and mitigation options to deal with flood risk in the future.

This section will discuss how flood risk can be managed from a spatial planning perspective and will also outline measures that may be adopted at a site specific level.

10.1 Management of Flood Risk from a Planning Perspective

The Planning Guidelines recommend a sequential approach. This works well where there are no constraints to development and there is an ample source of developable land.

The Carlow Graiguecullen urban area is greatly constrained by the river and natural flood plain and spatial planning objectives for the area must coincide with the overall flood management strategy. Substantial development has occurred in the past and flood protection to existing development has been provided in the form of the Carlow Flood Relief Scheme.

10.1.1 Specific Development Planning Applications

The following outlines the key requirements relating to the management of development in areas at risk of flooding;

- All development proposals, regardless of location, will require an appropriately detailed flood risk assessment. As a minimum this will include a "Stage 1 - Identification of Food Risk"; where flood risk is identified a "Stage 2 - Initial FRA" will be required and depending on the scale and nature of the risk a "Stage 3 - Detailed FRA" may be required. The requirement for all applications to have an accompanying stage 1 assessment is important, as for example a large site located in flood zone C may be appropriate in terms of vulnerability, but might be at potential risk of surface water flooding
- All development proposals for large sites, i.e. an area greater than 0.5Ha, will require a FRA to consider surface water management.
- All development proposals, within or incorporating areas at moderate to high flood risk, that are vulnerable to flooding will require the application of the development management justification test in accordance with Box 5.1 of the Planning Guidelines, The Planning System and Flood Risk Management.
- The planning authority will explore opportunities to include flood alleviation proposals and upgrades that benefit the wider Carlow Graiguecullen area as a whole, as part of specific development applications.

Any proposal that is considered acceptable in principle shall demonstrate the use of the sequential approach in terms of the site layout and design and, in satisfying the Justification Test, the proposal will demonstrate that appropriate mitigation and management measures are put in place.

10.1.2 Development in Defended Areas

Much of the development potential within the town centre is in areas benefitting from the recently constructed defences. The Flood Zones, by definition do not include for these

defences. However, planning policy in this area must take into account the fact that the risk in these areas benefitting from defences (ABDs) has been altered. The scale of residual risk is directly correlated to the design standard of the flood defences but also the topography and receptors located behind the defences. The Carlow flood relief scheme is designed to a 1% AEP (1 in 100 year) standard of protection. Overtopping will occur during larger flood events and climate change will reduce the standard of protection in future years. The management of flood risk on a strategic level will require the quantification of residual risk and the consideration of climate change scenarios. Detailed modelling as part of the SECFRAM will be essential to feed into the strategic flood risk management policies for the area.

The zoning of land behind defences for development must satisfy the Justification Test, to proceed. The application of the Justification Test for opportunity sites located behind defences is discussed under Section 12.

10.1.3 General Policies to Manage Flood Risk

Pending completion of the CFRAM and publication of FRMP options, a number of policies can be adopted to deal with the risk of flooding. For example:

Floor levels - Habitable floor levels should be kept above the 1% AEP flood level. Where this level is high in comparison to existing street level, this will mean ensuring a less vulnerable use is planned for the ground floor. For example, the impact of flooding to a large retailer will be less than the impact to a family residing at the same location. In ABDs, the acceptable floor level may be reduced below the flood defence crest level. This reflects that due to the defences the probability and hence risk is reduced, and while the consequences of flooding are not removed, the risk is managed and ensures the safety of occupants is maintained. Consideration of other issues such as the provision of disability access should be taken into account.

Access and Egress - raising habitable floor levels brings with it the challenge of access and egress to and from properties in times of flood. Safe access and egress (whether wet or dry) should be provided for the 1% AEP. The strategic flood risk management plan should include a strategy for maintaining access and egress during larger more extreme events.

Housing Type and Resilience Measures - flood resilient design will be required for all development in areas of flood risk, including areas at residual flood risk. As a minimum these measures will be required up to the 1% AEP flood level. The various resistance and resilience design measures are discussed below in Section 10.4.

10.2 Policy Relating to Management of Surface Water

Development has the potential to cause an increase in impermeable area and an associated increase in surface water runoff rates and volumes. This can lead to potential increase in flood risk downstream due to overloading of existing drainage infrastructure.

Managing surface water discharges from new development is crucial in managing and reducing flood risk to other development downstream. The management of surface water is an important concern for large development sites i.e. those greater than 0.5Ha and a flood risk assessment should be completed to consider surface water issues. Regard should be given to the storm water management policy currently in use by Carlow Local Authorities.

10.2.1 Overland Flow Routes

Underground drainage systems have a finite capacity and regard should be given to events larger than the design capacity of the network. This should be considered along with potential surface water flows that may enter a development site from the surrounding area. Master planning should ensure that existing flow routes are maintained, through the use of green infrastructure. Floor levels should at a minimum be 300mm above adjacent roads and hard standing areas to reduce the consequences of any localised flooding.

10.2.2 Sustainable Drainage Systems (SUDS)

A specific requirement of the EU Water Framework Directive is that surface water discharge is controlled and managed so that any impact on its receiving environment is mitigated. This can be achieved through the use of Sustainable Drainage Systems (SUDS). SUDS can reduce the rate of runoff through a combination of infiltration, storage and conveyance (slowing down the movement of water). Sustainable drainage can be achieved through the use of green infrastructure such green roofs and pervious pavements, rainwater harvesting, soakaways, swales and detention basins, ponds and wetlands.

The effectiveness of flow management scheme within a single site is heavily limited by the land use and site characteristics including (but not limited to) topography, geology and available area. As such, surface water design and management must be carried out at a site specific level for any proposed development.

10.3 Flood Management Action Plan

There are various levels of flood management plans and these include the overall strategy for the river catchment, the emergency response plan of the local authority and the flood risk management plan at a site specific level.

Strategic Flood Risk Management Plan - this will be informed by the detailed assessment of the Carlow area. Completion of the CFRAM study in the South Eastern river basin. The formulation of a management plan is particularly important in Carlow due to the presence of the flood defences. The management plan must consider residual risk and an effective emergency response should the defences fail due to overtopping or breach. Under the CFRAM project for the South Eastern region, flood risk management options will be explored for all areas that will undergo detailed modelling i.e. Areas for Further Assessment (AFA). Under the EU Floods Directive, the CFRAM programme is due for completion by the end of 2015.

Major Emergency Response Plan - this is prepared by the local authority and is specific to the authority and the resources available. Carlow Local Authorities have prepared a Major Emergency Response Plan[17] that deals with severe weather scenarios, including flooding, and the document incorporates a 'Flood Plan' in Appendix A2. The plan defines a major emergency as the following:

"*A Major Emergency is any event which, usually with little or no warning, causes or threatens death or injury, serious disruption of essential services or damage to property, the environment or infrastructure beyond the normal capabilities of the principle emergency services in the area in which the event occurs, and requires the activation of specific additional procedures and the mobilisation of additional resources to ensure an effective, co-ordinated response*."

Site Specific FRMP - this will be specific to the development and associated activities. A site specific FRMP, which may include an emergency plan, will be required for any development proposal that is granted approval in an area of flood risk.

10.4 Flood Mitigation Measures at Site Design

Any development proposal in an area at moderate or high risk of flooding that is considered acceptable in principle must demonstrate that appropriate mitigation measures can be put in place and that residual risks can be managed to acceptable levels.

To ensure that adequate measures are put in place to deal with residual risks, proposals should demonstrate the use of flood-resistant construction measures that are aimed at preventing water from entering a building and that mitigate the damage floodwater causes to buildings. Alternatively, designs for flood resilient construction may be adopted where it can be demonstrated that entry of floodwater into buildings is preferable to limit damage caused by floodwater and allow relatively quick recovery.

[17] Major Emergency Response Plan 2010, Carlow Local Authorities

Various mitigation measures are outlined below and further detail on flood resilience and flood resistance are included in the Technical Appendices of the Planning Guidelines, The Planning System and Flood Risk Management.[18]

10.4.1 Site Layout and Design

To address flood risk in the design of new development, a risk based approach should be adopted to locate more vulnerable land use to higher ground while water compatible development i.e. car parking, recreational space can be located in higher flood risk areas. Highly vulnerable land uses (i.e. residential housing) should be substituted with less vulnerable development (i.e. retail unit).

The site layout should identify and protect land required for current and future flood risk management. Waterside areas or areas along known flow routes can be used for recreation, amenity and environmental purposes to allow preservation of flow routes and flood storage, while at the same time providing valuable social and environmental benefits.

10.4.2 Ground Levels

Modifying ground levels to raise land above the design flood level is a very effective way of reducing flood risk to the particular site in question. However, in most areas of fluvial flood risk, conveyance or flood storage would be reduced having an adverse effect on flood risk elsewhere.

10.4.3 Raised Defences

Construction of raised defences (i.e. flood walls and embankments) traditionally has been the standard response to flood risk. However, this is not a preferred option as a residual risk remains. Compensatory storage must be provided where raised defences remove floodplain storage.

In some cases, collection of developer contributions may be appropriate to allow construction or improvement of flood defences that would benefit the development site and the local community.

10.4.4 Building Use and Finished Floor Levels

Raising finished floor levels within a development is an effective way of avoiding damage to the interior of buildings (i.e. furniture and fittings) in times of flood.

Assigning a water compatible use (i.e. garage / car parking) to the ground floor level of a building is an effective way of raising vulnerable living space above design flood levels.

10.4.5 Resilient and Resistance Measures in Building Design

Depending on the scale of residual risk, resilient and resistance measures may be an appropriate response but this will mostly apply to less vulnerable development.

Design can include for wet-proofing of a building to make it flood resilient and reduce the impact of flooding. For example, use of water-resistant materials such as tiles on floors and walls that can be easily washed down and sanitised after a flood event and the installation of electrical sockets and other circuits at higher levels, with power wires running down from ceiling level rather than up from floor level.

Flood resistance measures can also be incorporated such as the provision of temporary and permanent flood barriers. Permanent barriers, in the form of steps (or ramps) at doorways, rendered brisk walls and toughened glass barriers, can help prevent flood water entering buildings. Alternatively, temporary barriers can be fitted into doorways and windows, with discrete permanent fixings that keep architectural impact to a minimum. However, flood warning becomes a very important issue when dealing with temporary or demountable defences.

[18] The Planning System and Flood Risk Management Guidelines for Planning Authorities, Technical Appendices, November 2009

11 Development Zoning in Carlow Graiguecullen

11.1 Land Zoning Objectives

The purpose of zoning is to indicate to property owners and members of the public the types of development, which the Planning Authority considers most appropriate in each land use category.

Zoning is designed to reduce conflicting uses within areas, to protect resources and, in association with phasing, to ensure that land suitable for development is used to the best advantage of the community as a whole.

The zoning objectives can be related to the vulnerability classifications in the 'Planning System and Flood Risk Management'; highly vulnerable, less vulnerable and water compatible. The vulnerability of the land use, coupled with the Flood Zone in which it lies, guides the need for application of the Justification Test.

The land zoning objectives and their respective vulnerabilities are shown in Table 11-1. It is important to note that this table is provided as a general guide and the specific development types within the zoning objective must be considered individually, and with reference to Table 3-1 of the 'Planning System and Flood Risk Management'. For example, in planning terms a guest house or hotel is permitted in principle under the 'Leisure and Tourism' zoning, but are considered to be highly vulnerable to flooding. The vulnerability class does not take into account economic damages; for example, high-tech manufacturing would be permitted under the 'Innovation and Business' zoning objective and could pass the Justification Test within Flood Zones A or B, but the costs associated with flooding of such a development may point to its preferential location within Flood Zone C.

Table 11-1 Land Zoning Objectives and Vulnerabilities

USE	OBJECTIVE	VULNERABILITY	JUSTIFICATION TEST REQUIRED?
Town Centre Primary	To protect the vitality and vibrancy of the town centre and provide for town centre activities	Highly and less vulnerable	For highly vulnerable development in Flood Zone A or B For less vulnerable development in Flood Zone A
District Centre	To provide for shopping, amenity, commercial and community facilities of a scale and type to serve residents living within the district without undermining the town centre	Highly and less vulnerable	For highly vulnerable development in Flood Zone A or B For less vulnerable development in Flood Zone A
Neighbourhood Centre	To provide for shopping, amenity, commercial and community facilities of a scale and type to serve residents living within the neighbourhood without undermining the town centre	Highly and less vulnerable	For highly vulnerable development in Flood Zone A or B For less vulnerable development in Flood Zone A
Retail Warehousing	To provide for retail warehousing development	Less vulnerable	For development in Flood Zone A
Residential 1	To protect and enhance the amenity of developed residential communities	Highly vulnerable	For development in Flood Zone A or B
Residential 2	To provide for new residential development,	Highly vulnerable	For development in Flood Zones A or B

	residential services and community facilities within the Plan period 2012-2018		
Strategic Reserve	To provide lands for future development in line with national and regional targets over the next Plan period 2018-2024	Less vulnerable	For less vulnerable development in Flood Zone A
Open Space and Amenity	To preserve, provide for and improve active and passive recreational public and private open space	Water Compatible	Development is generally appropriate
Demesne Landscape	To conserve the special character of Demesne Landscapes and provide for research activities	Less vulnerable Water Compatible	For less vulnerable development in Flood Zone A
Community Services, Education, Institutional Uses	To protect, provide and improve community services including places of worship, primary and secondary education services and institutional uses along with ancillary amenity or recreational uses	Highly vulnerable, Less vulnerable, Water Compatible	For highly vulnerable development in Flood Zone A or B For less vulnerable development in Flood Zone A
Leisure and Tourism	To provide for and improve tourist and leisure amenities in the County	Highly vulnerable Less vulnerable and Water Compatible	For highly vulnerable development in Flood Zone A or B For less vulnerable development in Flood Zone A
Industrial	To provide for and foster industrial development	Less Vulnerable	For development in Flood Zone A
Enterprise and Employment	To provide lands for enterprise and employment uses, that do not generate emissions including campus-style offices, storage and warehousing uses, wholesaling and distribution, commercial services with high space and parking requirements that may not be suitable for town centre locations	Less Vulnerable	For development in Flood Zone A
Innovation and Business	Provide for high technology related office based industry and general offices over 400 sqm.	Less vulnerable	For less vulnerable development in Flood Zone A
Infrastructure and Utilities	To provide for the needs of all transport users and other utility providers.	Highly vulnerable Less vulnerable	For highly vulnerable development in Flood Zone A or B For less vulnerable development in Flood Zone A

11.2 Flood Risk Identification at Opportunity Sites

The Joint Spatial Plan indicates 'Opportunity Sites' within the development area. These sites provide particular opportunity for future development and are of strategic importance to the plan area and surrounds.

Flood risk to each opportunity site has been appraised based on the Flood Zones which cross the site boundary and this appraisal is summarised in Table 11-2. Where sites are identified as being wholly within Flood Zone C, no further review of fluvial flood risk is required. Where some of the site is within either Flood Zone A or B, the need for a further review of flood risk and the specific zoning objectives is required.

For those settlements which are located within Flood Zone C, a summary of the likelihood of the site being vulnerable to pluvial or other sources of flooding is indicated in Table 11-2. Vulnerability to pluvial flood risk should not be a limitation to development, but should be incorporated into the local drainage strategy at the site specific masterplanning or planning application stage of development. For large sites, with gross area greater than 0.5Ha, a flood risk assessment will be requried to address surface water issues and ensure that runoff does not impact on flood risk downstream.

Table 11-2 Flood Risk Identification at Opportunity Sites in Carlow Town

Opportunity Site	Flood Zones			Comment
	A	B	C	
Site 1: Former Penney's Site	√			Construction of defence measures is a condition of future planning approval; a flood risk assessment including a flood risk management plan required
Site 2: Barrow Track Site	√	√	√	Area benefiting from defences; flood risk management plan required
Site 3: Court Place			√	Potential surface water flow route to the north of the site. PFRA flood mapping indicates pluvial flood risk.
Site 4: Plas na Saoirse and Potato Market	√	√	√	Area benefitting from defences; flood risk management plan required
Site 5: Former Crotty's Site			√	This is a relatively small area site and there is no evidence of pluvial or other flood risk.
Site 6: Pembroke Road Site	√			Flood relief scheme underway; on completion area will benefit from defences; a flood risk assessment including a flood risk management plan required.
Site 7: Marlborough Street, Graiguecullen	√	√	√	Area benefiting from defences; flood risk management plan required
Site 8: Barrack Street	√	√	√	Flood relief scheme underway; potential area benefiting from defences subject to completion of scheme; a flood risk assessment including a flood risk management plan required.
Site 9: Railway Station and Surrounds			√	As a large area site, this requires consideration of surface water management at a strategic level.
Site 10: Former Braun Site, O'Brien Road			√	As a large area site, a flood risk assessment is required to consider surface water management. PFRA flood mapping indicates some pluvial flood risk.
Site 11: Former Celtic Linen Site	√			Area benefiting from defences; flood risk management plan required

Site 12: Kelvin Grove Site	√	√	√	Area benefiting from defences; flood risk management plan required
Site 13: Former Erin Foods Site			√	As a large area site, a flood risk assessment is required to consider surface water management. PFRA flood mapping indicates pluvial flood risk.
Site 14: Former Lapple Site, O'Brien Road			√	As a large area site, a flood risk assessment is required to consider surface water management. A minor watercourse runs adjacent to the site.
Site 15: Barrowside Business Park, Sleaty Road	√	√		Evidence of local land raising; further site study and survey required to confirm levels
Site 16: Kernanstown Industrial Estate			√	As a large area site, a flood risk assessment is required to consider surface water management. PFRA flood mapping indicates pluvial flood risk to the east of the site.
Site 17: Greenvale	√	√	√	Area benefiting from defences; flood risk management plan required
Site 18: Hanover Retail Park	√	√	√	Majority of site is in Flood Zone C; flood risk assessment required.

Table 11-3 Flood Risk Identification at Opportunity Sites in Graiguecullen

Opportunity Site	Flood Zones			Comment
	A	B	C	
Site 19 Glanbia Site, Portlaoise Road			√	As a large area site, a flood risk assessment is required to consider surface water management. PFRA flood mapping indicates pluvial flood risk to the south of the site.
Site 20 Sleaty Road District Centre and Carlow Business Park			√	Adjacent to but not within Flood Zones A and B. As a large area site, a flood risk assessment is required to consider surface water management. PFRA flood mapping indicated pluvial flood risk at the site.

Table 11-4 Flood Risk Identification at Opportunity Sites in Carlow Town Environs

Opportunity Site	Flood Zones			Comment
	A	B	C	
Site 21 Former Greencore Site, Athy Rd	√	√	√	Extremity of site within Flood Zone A . flood risk assessment required.
Site 22 Teagasc's Oak Park Research Centre			√	As a large area site, a flood risk assessment is required to consider surface water management. PFRA flood mapping indicates areas of pluvial flood risk throughout the site
Site 23 Ballinacarrig Inner Relief Road			√	Adjacent to but not within Flood Zones A and B. PFRA flood mapping indicates pluvial flood risk to the south and east of the site.
Site 24 Quinnagh, Southern Relief Road	√	√	√	Flood risk identified in low-lying areas of the site; flood risk assessment required.

Where appropriate, a precautionary approach has been adopted to the issue of flood risk management at both the identification and flood risk assessment stages. This reflects

uncertainties or gaps in readily available flood data sets, risk assessment and estimation techniques. More detailed assessment on a site specific basis may lead to a refinement of the flood zoning.

The Flood Zone maps covering the overall development area of Carlow Town are presented in Appendix A. These are indicative flood maps based on broadscale 2D hydraulic modelling. They have been refined in areas where detailed data is available, namely surveyed local ground levels and flood levels based on detailed hydraulic modelling carried out by previous studies.

12 The Justification Test

The opportunity sites which have been identified for future development and which include areas in Flood Zones A or B (as detailed in Table 11-2) are subject to the Justification Test. Where development does not pass the Justification Test, responses which have been considered include:

- Removal of the zoning objective;
- Rezoning to less vulnerable or water-compatible uses;
- Development of specific objectives relating to zones of mixed use vulnerability;
- Phasing of development within zoned areas.

This has been undertaken in an iterative process, and has involved consultation between the planning authorities, namely Carlow Local Authorities, Laois County Council and JBA Consulting.

Figure 12-1 Justification Test for Development Plans

Where, as part of the preparation and adoption or variation and amendment of a development/local area plan[1], a planning authority is considering the future development of areas in an urban settlement that are at moderate or high risk of flooding, for uses or development vulnerable to flooding that would generally be inappropriate as set out in Table 3.2, all of the following criteria must be satisfied:

1 The urban settlement is targeted for growth under the National Spatial Strategy, regional planning guidelines, statutory plans as defined above or under the Planning Guidelines or Planning Directives provisions of the Planning and Development Act, 2000, as amended.

2 The zoning or designation of the lands for the particular use or development type is required to achieve the proper planning and sustainable development of the urban settlement and, in particular:

- (i) Is essential to facilitate regeneration and/or expansion of the centre of the urban settlement[2];
- (ii) Comprises significant previously developed and/or under-utilised lands;
- (iii) Is within or adjoining the core[3] of an established or designated urban settlement;
- (iv) Will be essential in achieving compact and sustainable urban growth; and
- (v) There are no suitable alternative lands for the particular use or development type, in areas at lower risk of flooding within or adjoining the core of the urban settlement.

3 A flood risk assessment to an appropriate level of detail has been carried out as part of the Strategic Environmental Assessment as part of the development plan preparation process, which demonstrates that flood risk to the development can be adequately managed and the use or development of the lands will not cause unacceptable adverse impacts elsewhere.

N.B. The acceptability or otherwise of levels of any residual risk should be made with consideration for the proposed development and the local context and should be described in the relevant flood risk assessment.

Source: Box 4.1 The Planning System and Flood Risk Management

12.1 General Responses to the Justification Test

A number of important issues and responses arose in relation to the SFRA process. The general responses to the Justification Test which were applied throughout the overall zoning plan area, are outlined below.

12.1.1 Development of Town Centre in areas at risk of flooding

The flood risk assessment identifies parts of the existing and undeveloped town centre zoned lands as being at moderate or high risk of flooding. In most instances, existing development in the town centre meets the Justification Test. The priority here is to ensure long-term viability in the core. Planning policy will seek to address flood risk through substitution or replacement of uses (for example non-residential uses at ground floor) and design for residual flood risk as applications for replacement development are received. Proposals for new development will be subject to the development management Justification Test.

As the range of development normally permitted under this zoning objective includes both highly vulnerable and less vulnerable development, it is assumed that the Justification Test is required for Flood Zones A and B. (Note: The Justification Test would not be required in the case of less vulnerable uses located in Flood Zone B.)

12.1.2 Existing Zoned Residential Development in areas at risk of flooding

The strategic flood risk assessment identifies existing residential developments, or parts of developments, as being in areas at moderate or high risk of flooding (Flood Zones A and B). As residential use is considered highly vulnerable to flooding, the 'Planning System and Flood Risk Management' permits only minor development, such as small extensions and most changes of use, be considered in these areas.

In addition, in established residential areas where the replacement or reconstruction of an existing dwelling is considered appropriate for wider planning reasons, the Planning Authority should require that:

- A development management Justification Test is carried out in accordance with the 'Planning System and Flood Risk Management' (see Box 5.1 of the Planning System and Flood Risk Management).
- There will be no increase in the number of residential units or households.
- There will be no adverse impact on the function of the floodplain, watercourse or conveyance routes.
- Residual risk is addressed and reduced where possible, for example, through relocation of buildings, and/or flood resilience/resistance measures applied.

12.1.3 Existing Utilities and Infrastructure located in areas at risk of flooding

The flood risk assessment identifies existing utilities on zoned land as being in areas at moderate or high flood risk of flooding. The 'Planning System and Flood Risk Management' allows for consideration of the development of **essential infrastructure**, such as primary transport and utilities distribution, (including electricity generating) within these Flood Zones, provided that it cannot be located elsewhere. Reconstruction or replacement, and minor extensions or alterations to such infrastructure will not be required to satisfy the Justification Test. However, an appropriate level flood risk assessment should be carried out in accordance with the 'Planning System and Flood Risk Management'.

Reconstruction or replacement of existing **non-essential infrastructure** currently located within areas at moderate or high risk of flooding may be considered appropriate for wider planning reasons and, in such instances, must be shown to pass the Justification Test. Minor alterations to existing non-essential infrastructure currently located within areas at moderate or high risk of flooding should be subject to preliminary, appropriate flood risk assessment.

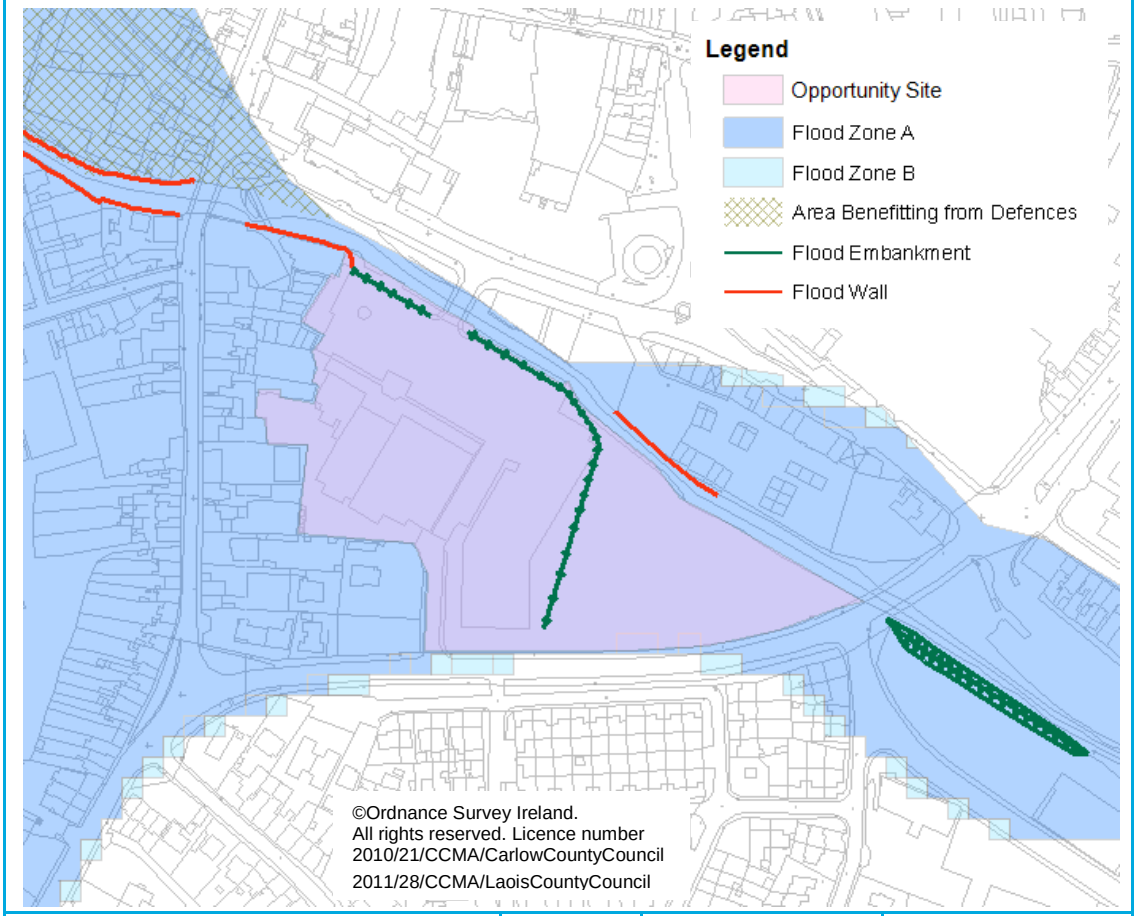
12.1.4 Development in areas benefitting from defences

Development behind defences should consider residual flood risk and the impact should the defences fail due to overtopping in the case of extreme events (greater than 1% AEP flood

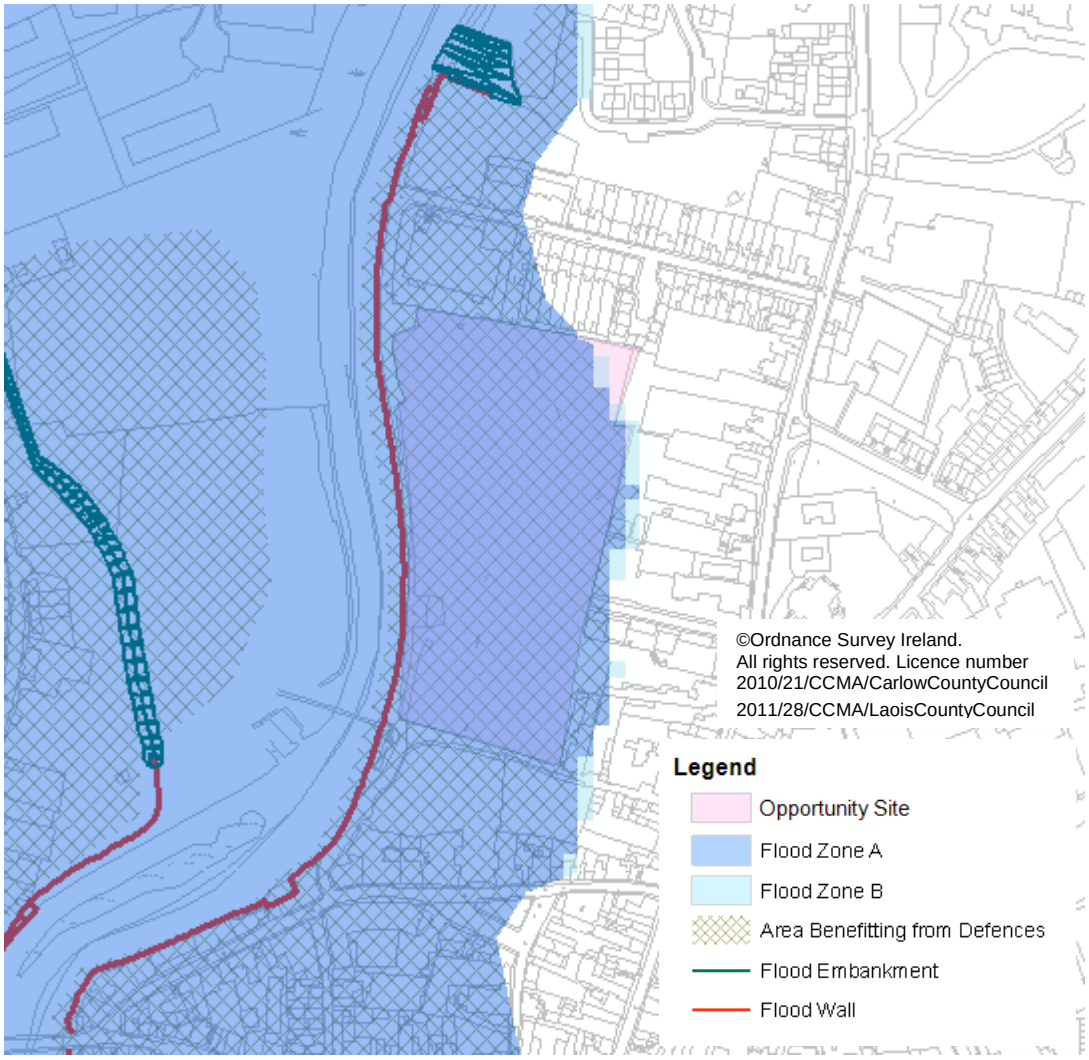
event) or breach. Development should strike a balance between sustainability and acceptable levels of risk. For example, residential development should be avoided in areas of residual risk; alternatively floor levels should be maintained above residual 1% AEP flood levels or as a minimum floor levels should allow evacuation in a 1% AEP flood event (maximum 600mm above ground level). All development proposals in ABDs will require an appropriately detailed flood risk assessment and management plan.

12.2 Specific Responses to the Justification Test

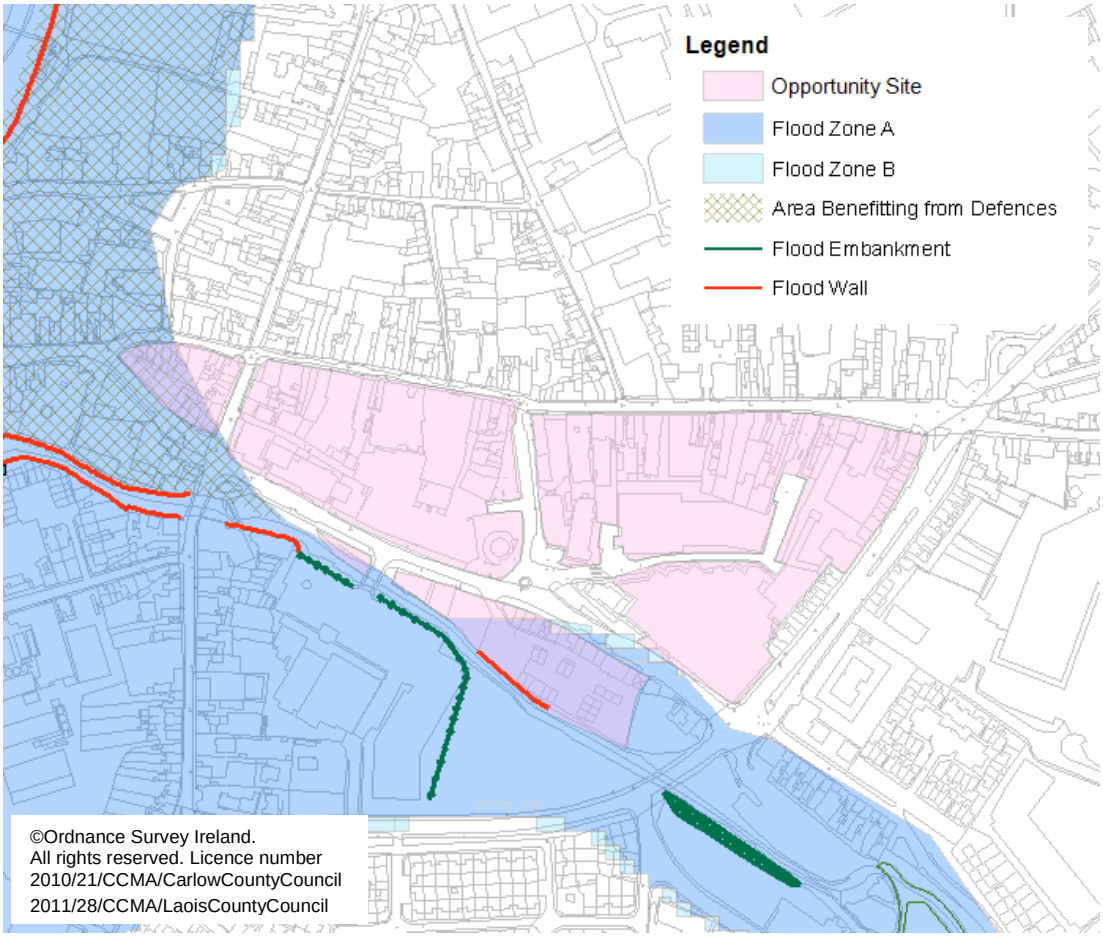
Details of the flood risk within the opportunity sites and the consequences of the application the Planning Guidelines are provided in table format below. The application of the sequential approach and where necessary, justification test, is an iterative process that is assessed in conjunction with the planning authorities; this process, for each of the opportunity sites, is informed in this section.

Opportunity Site 1: Former Penney's Site off Kennedy Avenue			
Site Code:	OP1		
Site Area:	2.7 Ha		
Catchment:	Burrin, tributary of Barrow		
Zoning Objective:	Town Centre Primary		
Site Location: 			
Flood Zone Coverage	A - 100%	B - N/A	C - N/A
Benefitting from Defences (flood relief scheme works)	At present there are no defences offering protection to this site. However, works have been proposed on the River Burrin. Completion of these works will be required as part of any planning approval for development on this site.		
Sensitivity to Climate Change	Currently low. Climate change should be incorporated into any flood relief works which are carried out on the site.		
Residual Risk	Currently none. Residual risks associated with any future flood relief works should be assessed.		
Historical Flooding	There are no specific reports of flooding on this site.		
Surface Water	Large urbanised site, paved area with high surface water runoff; low-lying site adjacent to the River and behind flood defences; FRA required to consider surface water management, including discharge of runoff to River Burrin.		
Commentary on Application of Planning	This is an existing developed site that is		

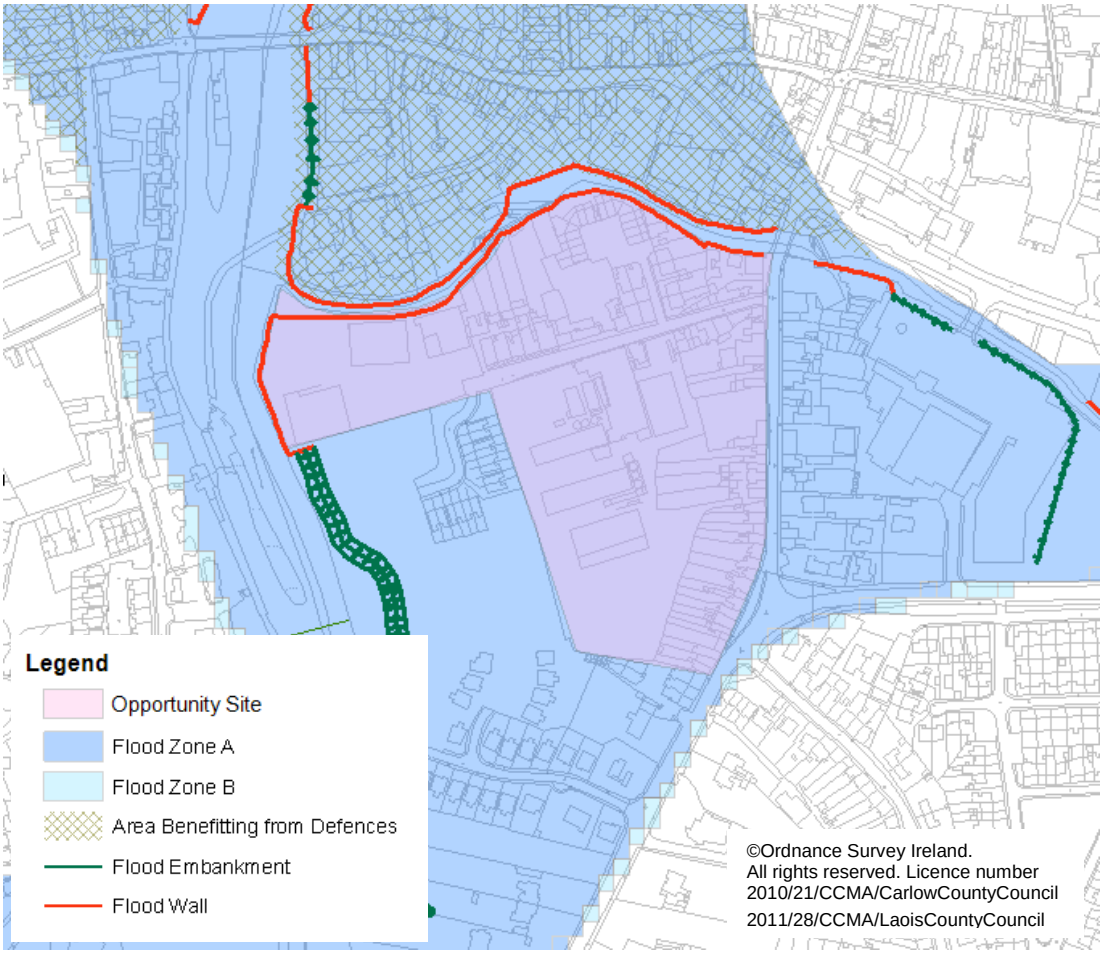
Guidelines	proposed for redevelopment. This site is in Flood Zone A, with a high risk of flooding. Permission for development at this site must first, under the sequential approach, consider alternative sites. If development cannot be avoided, due to overall planning objectives, the proposal must be for a less vulnerable land use. Flood defences are proposed at this site. It is intended that completion of these defences will be a condition of planning approval for any development of the site. Development will require a detailed site-specific FRA including consideration of residual risk. Before planning can be approved, the Justification Test must be applied and all criteria passed. This is assessed in conjunction with the Planning Authorities Justification Test: 1. urban settlement is targeted for growth √ 2 (i) essential to facilitate regeneration √ (ii) previously developed √ (iii) is within core √ (iv) essential in achieving compact and sustainable urban growth √ (v) no suitable alternative lands for particular land use √ Conclusion: If it is demonstrated that no suitable alternative lands are available within or adjoining the core then development at this site may be justified. Mitigation measures and management plans must be developed for this site if development proceeds.

Opportunity Site 2: Barrow Track Site			
Site Code:	OP2		
Site Area:	3.3 Ha		
Catchment:	Barrow		
Zoning Objective:	Town Centre Primary		
Site Location: 			
Flood Zone Coverage	A - 97%	B - <1%	C - 2%
Benefitting from Defences (flood relief scheme works)	Yes, works have been completed along this stretch of the Barrow River. The defences here consist of concrete flood walls.		
Sensitivity to Climate Change	High as the defences have not been designed to protect from increased river flows.		
Residual Risk	Should the defences overtop flood risk to the site would be high. The defences are new, so breach is unlikely to occur.		
Historical Flooding	This site has been reported to flood on a number of occasions including major flood events in 1947, 1995, 2008 and 2009. This site is shown within the 1947 recorded flood extent.		

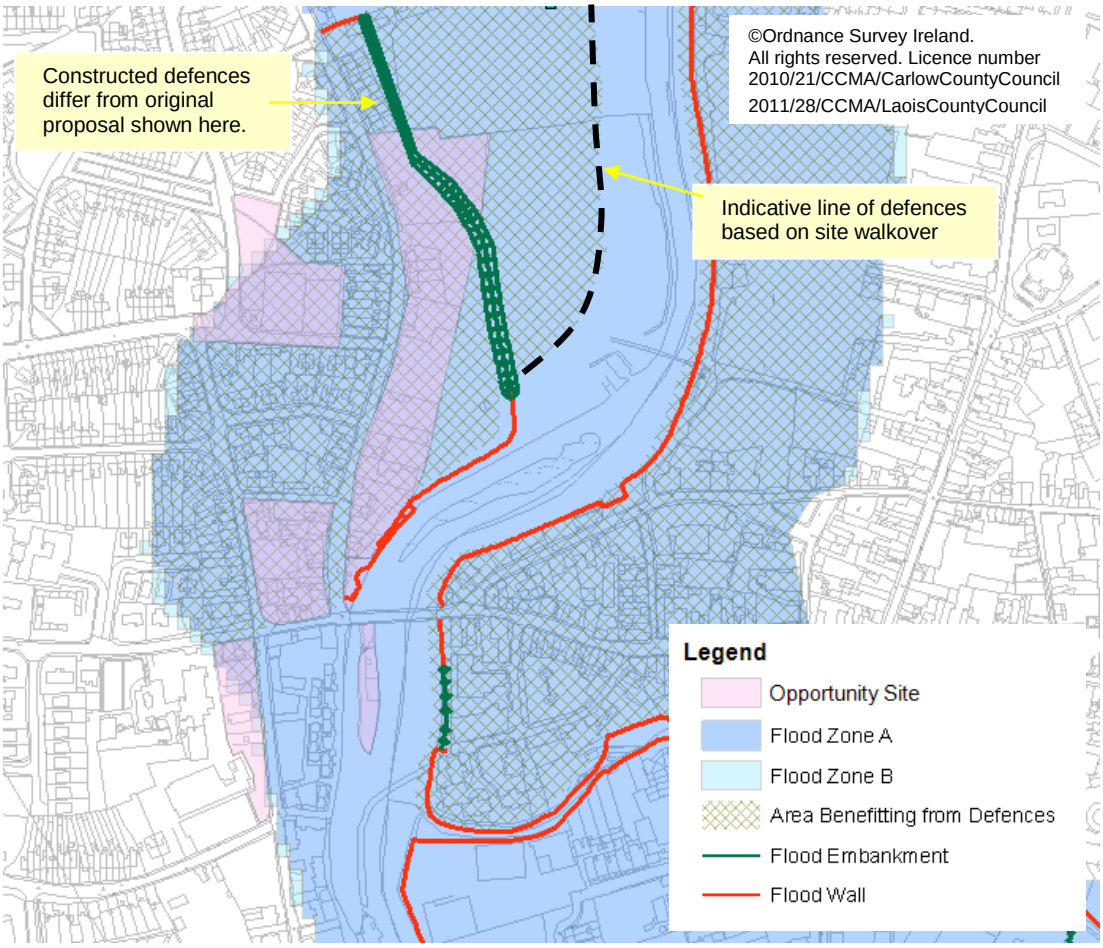
Surface Water	Large site partially urbanised; adjacent to the river and located behind flood defences. FRA required to consider management of surface water, including discharge to the Barrow.
Commentary on Application of Planning Guidelines	The northern half of this site has existing development (not shown on above mapping). The rest of the site is under-utilised. The site is in Flood Zone A, with a high risk of flooding. This land lies behind recently constructed flood defences. The Planning Guidelines require careful consideration of planning approval on under-utilised sites at flood risk whether or not they benefit from defences. It is important in these situations that residual risk is more fully understood. Under the sequential approach if development cannot be avoided it must be of a less vulnerable land use. Any development at this site will require a detailed FRA including consideration of residual risk and management of such risk. The Justification Test must be applied and all criteria passed. This is assessed in conjunction with the Planning Authorities Justification Test: 1. urban settlement is targeted for growth √ 2.(i) essential to facilitate regeneration √ (ii) previously developed √ *partly developed* (iii) is within core √ (iv) essential in achieving compact and sustainable urban growth √ (v) no suitable alternative lands for particular land use √ Conclusion: Unless all criteria can be passed, development should not be permitted in un-developed parts of this site, except for 'water compatible' development.

Opportunity Site 4: Plas Na Saoirse and Potato Market			
Site Code:	OP4		
Site Area:	11 Ha (4.7 Ha in Flood Zone A)		
Catchment:	Barrow and Burrin		
Zoning Objective:	Town Centre Primary		
Site Location: 			
Flood Zone Coverage	A - 15%	B - <1%	C - 57%
Benefitting from Defences (flood relief scheme works)	Some works have been completed as part of the Carlow Flood Relief Scheme. More detailed site specific assessment is required to quantify risk.		
Sensitivity to Climate Change	High as the defences have not been designed to protect from increased river flows.		
Residual Risk	Should the defences overtop flood risk to the site would be high. The defences that are in place have been recently constructed, so breach is unlikely to occur.		
Historical Flooding	This site has been reported to flood on a number of occasions including major flood events in 1947, 1995, 2008 and 2009. This site is shown within the 1947 recorded flood extent.		
Surface Water	Large urban site; paved area with high surface water runoff. FRA required to consider surface water management. Ground levels fall from the northwest towards the river. Some minor pluvial flooding		

	indicated on the PFRA flood mapping to the north and east of the site.
Commentary on Application of Planning Guidelines	This is an existing developed site that lies within Flood Zone A, with a high risk of flooding. Permission for development at this site must first, under the sequential approach, consider alternative sites. If development cannot be avoided, due to overall planning objectives, proposal must be for a less vulnerable land use. Land use across the site should be appropriate to the scale of food risk. Defences are proposed adjacent to this site. Development in Flood Zone A will require a detailed FRA to include consideration of residual risk and management on a site specific level. The Justification Test must be applied and all criteria passed. This is assessed in conjunction with the Planning Authorities Justification Test: 1. urban settlement is targeted for growth √ 2.(i) essential to facilitate regeneration/expansion of centre √ (ii) previously developed √ (iii) is within core √ (iv) essential in achieving compact and sustainable urban growth √ (v) no suitable alternative lands for particular land use √ Conclusion: Development of this site should take into account flood risk and the overall plan for this opportunity site should incorporate suitable land uses in the section of the site at flood risk. Appropriate mitigation and management procedures should be prepared at in accordance with the specific development application.

Opportunity Site 6: Pembroke Street			
Site Code:	OP6		
Site Area:	5.7 Ha		
Catchment:	Barrow and Burrin		
Zoning Objective:	Town Centre Primary		
Site Location: 			
Flood Zone Coverage	A - 100%	B - N/A	C - N/A
Benefitting from Defences (flood relief scheme works)	Works are proposed along the Barrow and Burrin Rivers in this area; once completed this site will benefit from defences; flood risk management plan required		
Sensitivity to Climate Change	Currently low. Climate change should be incorporated into any flood relief works which are carried out on the site.		
Residual Risk	Currently none. Residual risks associated with any future flood relief works should be assessed.		
Historical Flooding	This site has been reported to flood on a number of occasions including major flood events in 1947, 1990, 1993, 1995, 2008 and 2009. This site is shown within the 1947 recorded flood extent.		
Surface Water	Large urban site; paved area with high surface water runoff; located adjacent to the river behind proposed flood defences. FRA required to consider surface water management.		

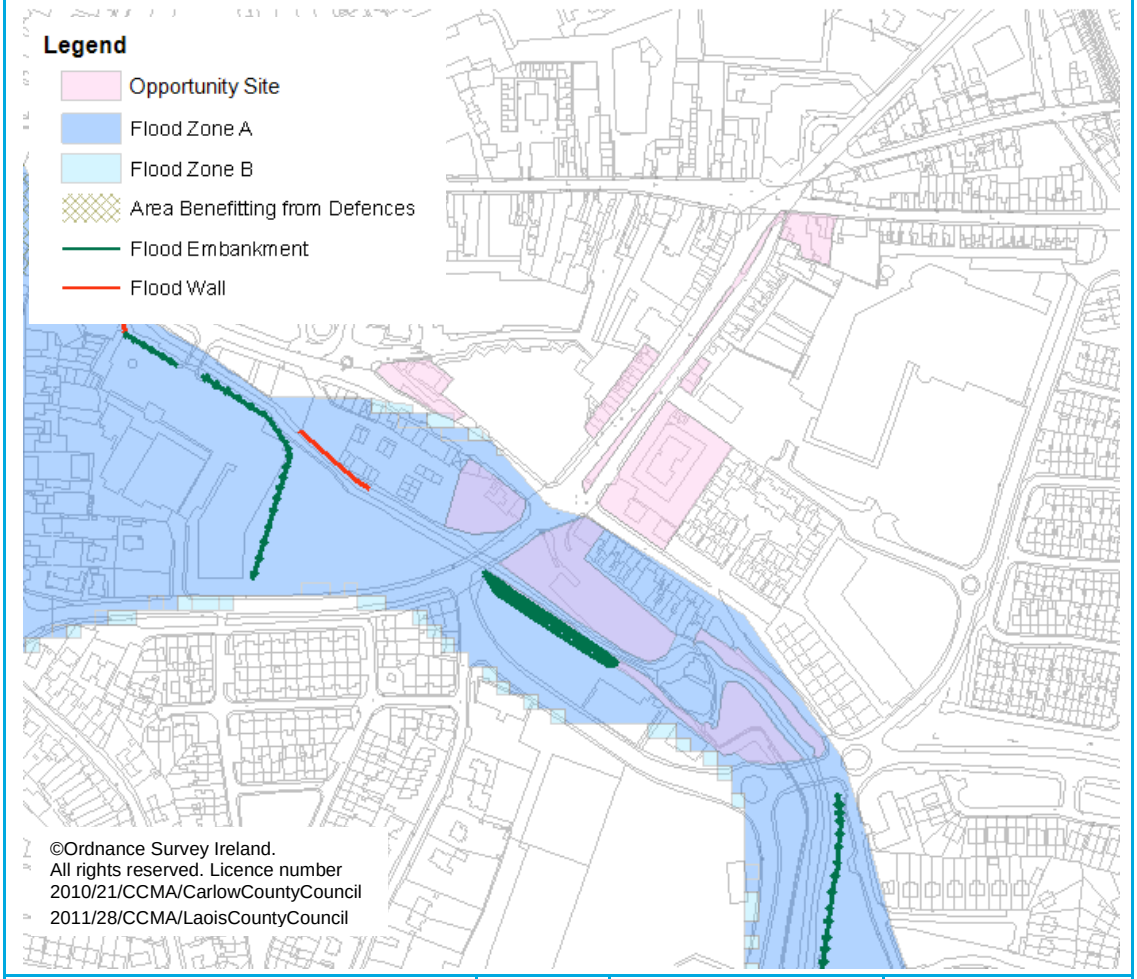
Commentary on Application of Planning Guidelines	This is an existing developed site that lies within Flood Zone A and has a high risk of flooding. This area is included in the Carlow Flood Relief Scheme and will benefit from defences once the scheme is complete. Further development of the site must consider residual risk and management. Permission for development at this site must first, under the sequential approach, consider alternative sites. If development cannot be avoided, due to overall planning objectives, proposal must be for a less vulnerable land use. The Justification Test must be applied and all criteria passed. This is assessed in conjunction with the Planning Authorities Justification Test: 1. urban settlement is targeted for growth √ 2 (i) essential to facilitate regeneration/expansion of centre √ (ii) previously developed √ (iii) is within core √ (iv) essential in achieving compact and sustainable urban growth √ (v) no suitable alternative lands for particular land use √ Conclusion: If it is demonstrated that no suitable alternative lands are available within or adjoining the core then development at this site may be justified. Appropriate mitigation and management procedures should be prepared as part of any specific development application.

Opportunity Site 7: Marlborough Street, Graiguecullen			
Site Code:	OP7		
Site Area:	11.2 Ha		
Catchment:	Barrow		
Zoning Objective:	Town Centre Primary / Open Space Amenity		
Site Location: 			
Flood Zone Coverage	A - 90%	B - <1%	C - 10%
Benefitting from Defences (flood relief scheme works)	Yes, works have been completed along this stretch of the Barrow River, upstream of Graiguecullen Bridge. The defences have been incorporated into the redesign of the town park.		
Sensitivity to Climate Change	High as the defences have not been designed to protect from increased river flows.		
Residual Risk	Should the defences overtop flood risk to the site would be high. The defences are new and incorporated into the landscaping of the park, so breach is unlikely to occur.		
Historical Flooding	This site is lies within the recoded 1947 flood extent. It is shown as "liable to flooding" on the historic OS mapping.		
Surface Water	Large area, comprising a number of discrete sites, located in low-lying ground adjacent to the River Barrow and behind recently constructed flood		

	defences. Indicated as an area at risk of pluvial flooding on the PFRA flood mapping,
Commentary on Application of Planning Guidelines	This is an existing developed site that lies within Flood Zone A and has a high risk of flooding. This area is included in the Carlow Flood Relief Scheme and benefits from recently constructed defences. The zoning objectives here include a mixture of town centre and open space. Land use across the site should be appropriate to the scale of food risk and under-utilised or undeveloped areas in Flood Zones A or B should be maintained as open space. Permission for new development at this site must first under the sequential approach consider alternative sites. If development cannot be avoided, due to overall planning objectives, proposal must be for a less vulnerable land use. The Justification Test must be applied and all criteria passed. This is assessed in conjunction with the Planning Authorities Justification Test: 1. urban settlement is targeted for growth √ 2 (i) essential to facilitate regeneration/expansion of centre √ (ii) previously developed √ (iii) is within core √ (iv) essential in achieving compact and sustainable urban growth √ (v) no suitable alternative lands for particular land use √ Conclusion: If it is demonstrated that no suitable alternative lands are available within or adjoining the core then development at this site may be justified. Appropriate mitigation and management procedures should be prepared as part of any specific development application. Greenfield sites or current open space should be maintained as open space / amenity.

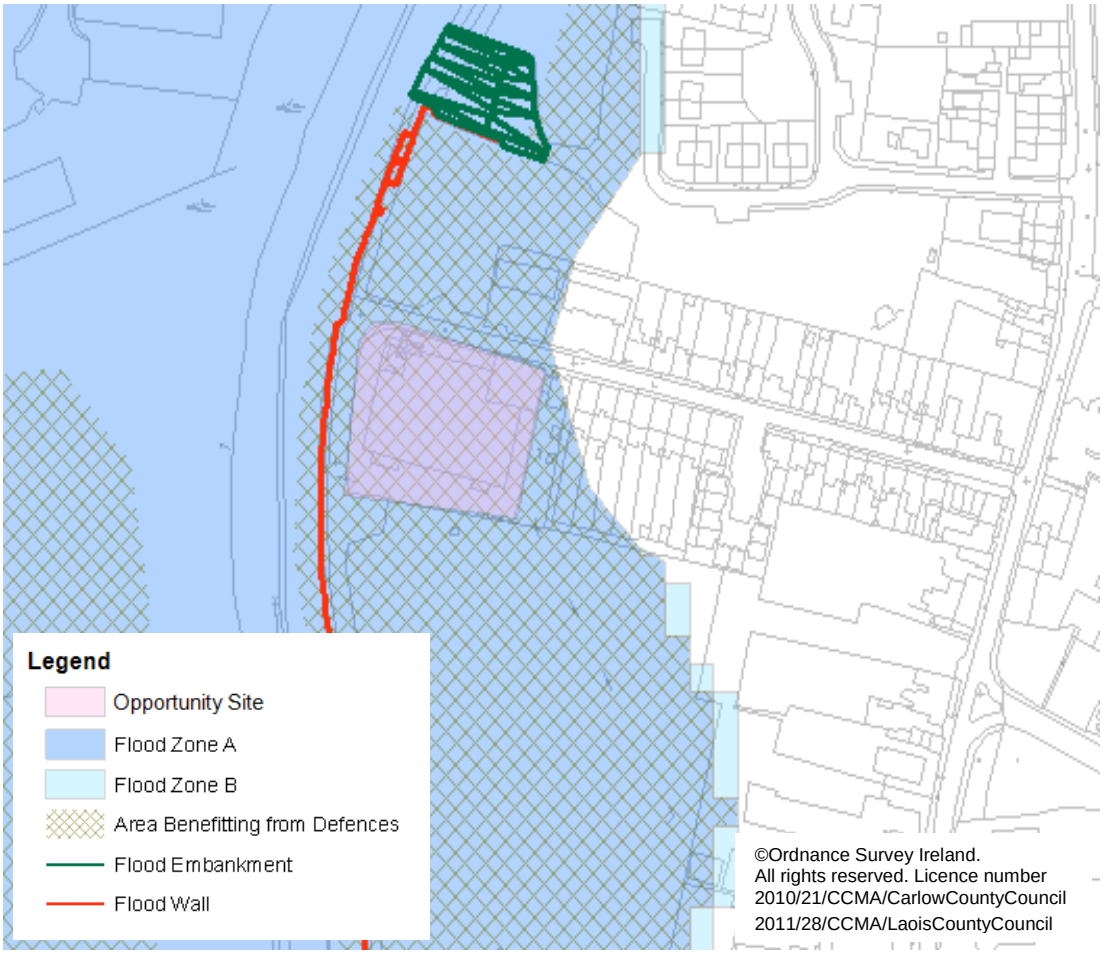
Opportunity Site 8: Barrack Street	
Site Code:	OP8
Site Area:	4.65 Ha (1.1 Ha within Flood Zone A)
Catchment:	Burrin, tributary of River Barrow
Zoning Objective:	Town Centre Primary / Amenity

Site Location:



Flood Zone Coverage	A - 5%	B - <1%%	C - 95%
Benefitting from Defences (flood relief scheme works)	Not currently fully protected. The Carlow Flood Relief Scheme proposes works on the River Burrin; some works have been carried out as part of the Aldi development.		
Sensitivity to Climate Change	Low; the extents of Flood Zones A and B are similar, but depths of flooding may increase with climate change		
Historical Flooding	There are no specific records of flooding at this site.		
Surface Water	Relatively large area, comprising a number of discrete sites adjacent to the River Burrin. Part of this area is included in the PFRA flood mapping at risk of pluvial flooding. FRA required to consider surface water management.		
Commentary on Application of Planning Guidelines	Part of this site consists of existing development, with some of this existing development in Flood		

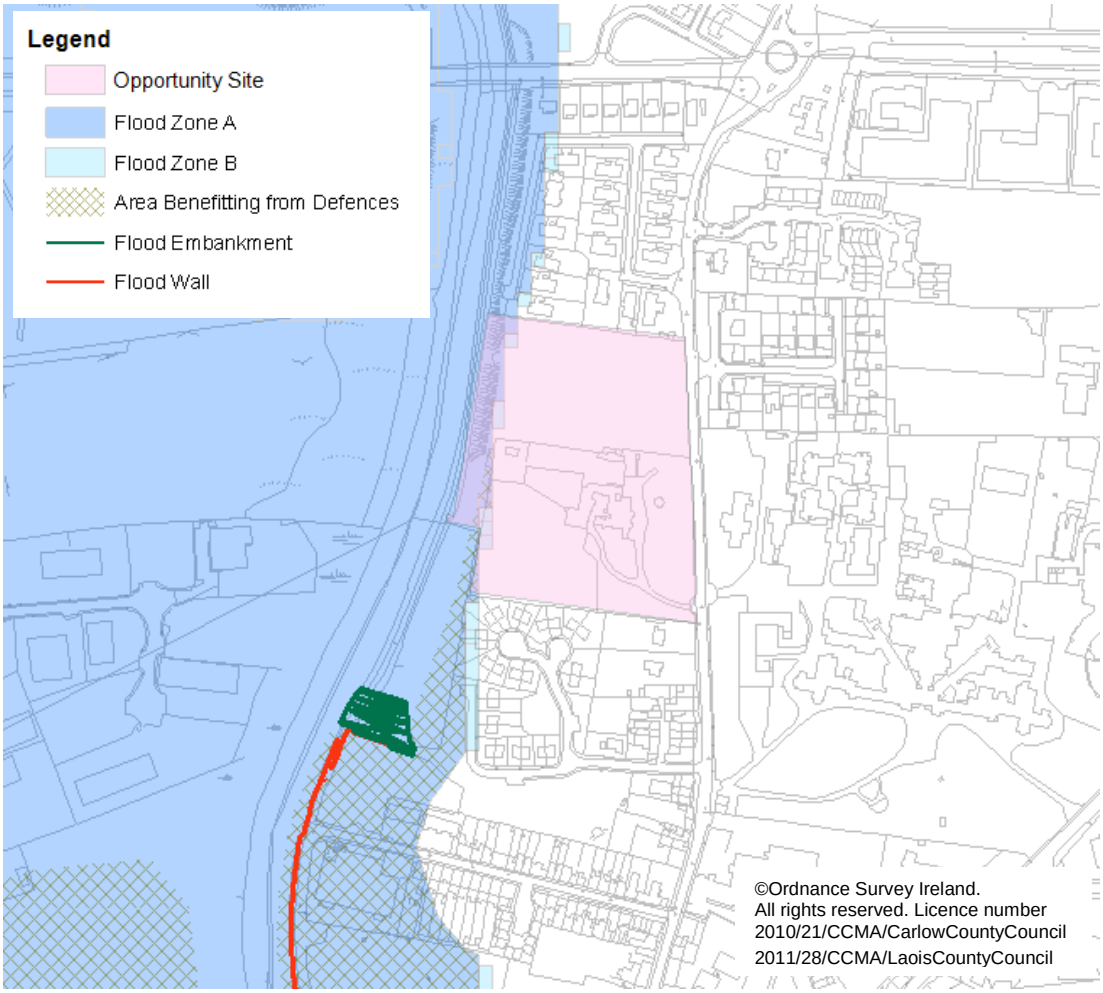
	Zone A. The zoning objectives here include a mixture of town centre and open space. Land use across the site should be appropriate to the scale of food risk and under-utilised or undeveloped areas in Flood Zones A or B should be maintained as open space. Works are proposed along the River Burrin as part of the Carlow Flood Relief Scheme. Development in Flood Zone A or B will require a detailed FRA to include consideration of the residual risk and management of flood risk on a site specific level. Permission for new development at this site must first, under the sequential approach, consider alternative sites. If development cannot be avoided, due to overall planning objectives, proposal must be for a less vulnerable land use. The Justification Test must be applied and all criteria passed. This is assessed in conjunction with the Planning Authorities Justification Test: 1. urban settlement is targeted for growth √ 2.(i) essential to facilitate regeneration/expansion of centre √ (ii) previously developed √ (iii) is within core √ (iv) essential in achieving compact and sustainable urban growth √ (v) no suitable alternative lands for particular land use √ Conclusion: If it is demonstrated that no suitable alternative lands are available within or adjoining the core then development at this site may be justified. Appropriate mitigation and management procedures should be prepared as part of any specific development application. Open space / amenity should be assigned to areas of high to moderate flood risk.

Opportunity Site 11: Former Celtic Linen Site			
Site Code:	OP11		
Site Area:	0.45 Ha		
Catchment:	Barrow		
Zoning Objective:	Town Centre Primary		
Site Location: 			
Flood Zone Coverage	A - 100%	B - N/A	C - N/A
Benefitting from Defences (flood relief scheme works)	Yes, works have been completed along this stretch of the Barrow River. The defences here consist of concrete flood walls.		
Sensitivity to Climate Change	High as the defences have not been designed to protect from increased river flows.		
Residual Risks	Should the defences overtop, flood risk to the site would be high. The defences have been recently constructed so breach is unlikely to occur.		
Historical Flooding	This site has been reported to flood on a number of occasions including major flood events in 1947, 1995, 2008 and 2009. This site is shown within the 1947 recorded flood extent.		
Surface Water	This is an existing site located behind recently constructed flood defences. Due to its location, FRA required to consider surface water management and discharge of surface water		

	runoff.
Commentary on Application of Planning Guidelines	This is an existing developed site that is proposed for redevelopment. This site is in Flood Zone A, with a high risk of flooding. Flood defences have been recently constructed along the River Barrow in this area. Development at this site must consider residual flood risk and management of such risk, on a site specific level. Permission for development at this site must first, under the sequential approach, consider alternative sites. If development cannot be avoided, due to overall planning objectives, proposal must be for a less vulnerable land use. The Justification Test must be applied and all criteria passed. This is assessed in conjunction with the Planning Authorities Justification Test: 1 urban settlement is targeted for growth √ 2(i) essential to facilitate regeneration √ (ii) previously developed √ (iii) is within core √ (iv) essential in achieving compact and sustainable urban growth √ (v) no suitable alternative lands for particular land use √ Conclusion: If it is demonstrated that no suitable alternative lands are available within or adjoining the core then development at this site is justified. Mitigation measures and management plans must be developed for this site if development proceeds.

Opportunity Site 12: Kelvin Grove Site	
Site Code:	OP12
Site Area:	3.5 Ha
Catchment:	Barrow
Zoning Objective:	Community Services and Education

Site Location:

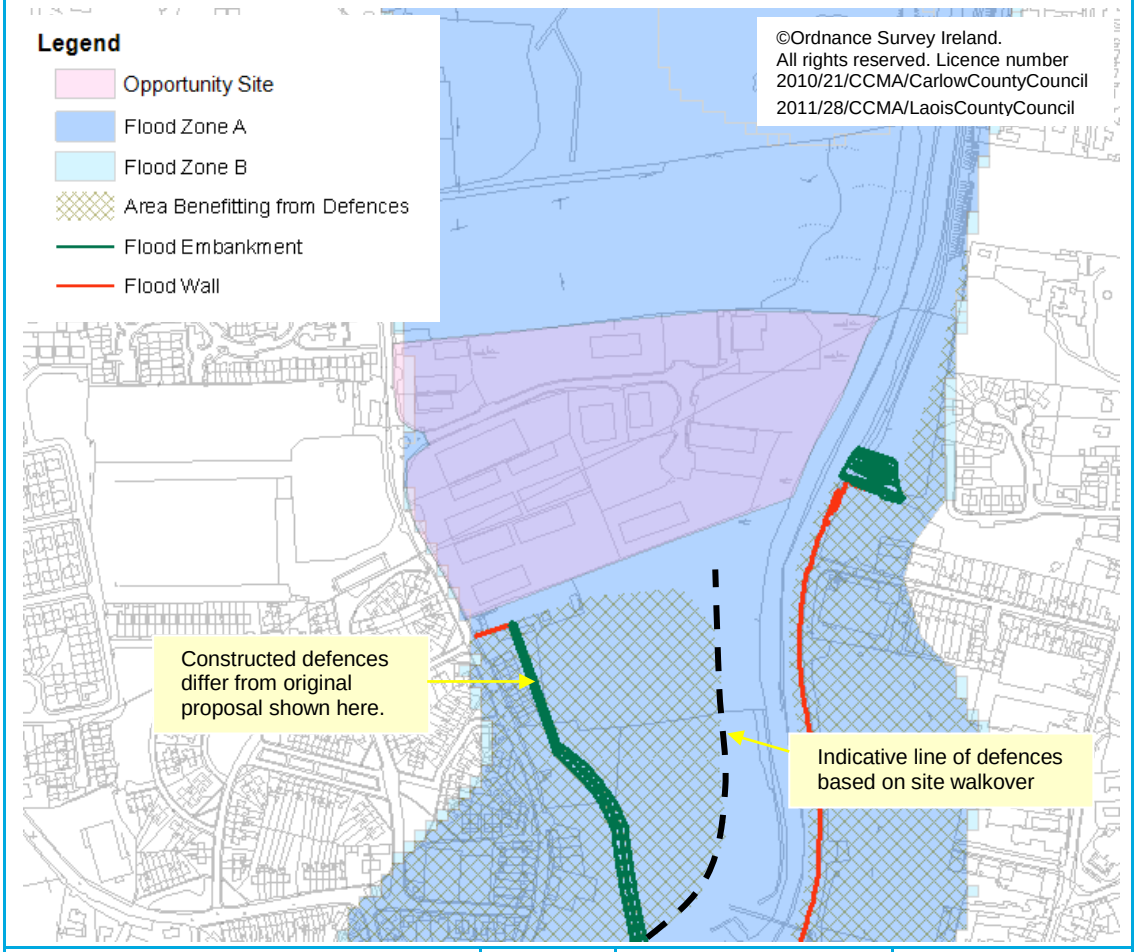


Flood Zone Coverage	A - 2%	B - 1%	C - 97%
Benefitting from Defences (flood relief scheme works)	The earthen embankment constructed along this bank of the Barrow tie into high ground at the boundary of this site. Much of the site is within Flood Zone C.		
Sensitivity to Climate Change	Low; the extents of Flood Zones A and B are similar, but depths of flooding may increase with climate change		
Residual Risk	The site is within Flood Zone C, so there are no residual risks associated with defence failure (up to a 0.1% AEP flood event).		
Historical Flooding	This site is adjacent to an area that has numerous accounts of historical flooding.		
Surface Water	Large site, located on high ground adjacent to the River Barrow. FRA required to consider surface water management including discharge		

	to the Barrow. PFRA flood mapping indicates area to the east of the site at risk of pluvial flooding.
Commentary on Application of Planning Guidelines	This is a site with some existing development. The majority of this site is within Flood Zone C with a very low (less than 1%) probability of flooding. The site boundary encroaches on Flood Zones A and B. From a flood risk management point of view development at this site is appropriate.

Opportunity Site 15: Sleaty Road	
Site Code:	OP15
Site Area:	7.9 Ha
Catchment:	Barrow
Zoning Objective:	Retail Warehousing

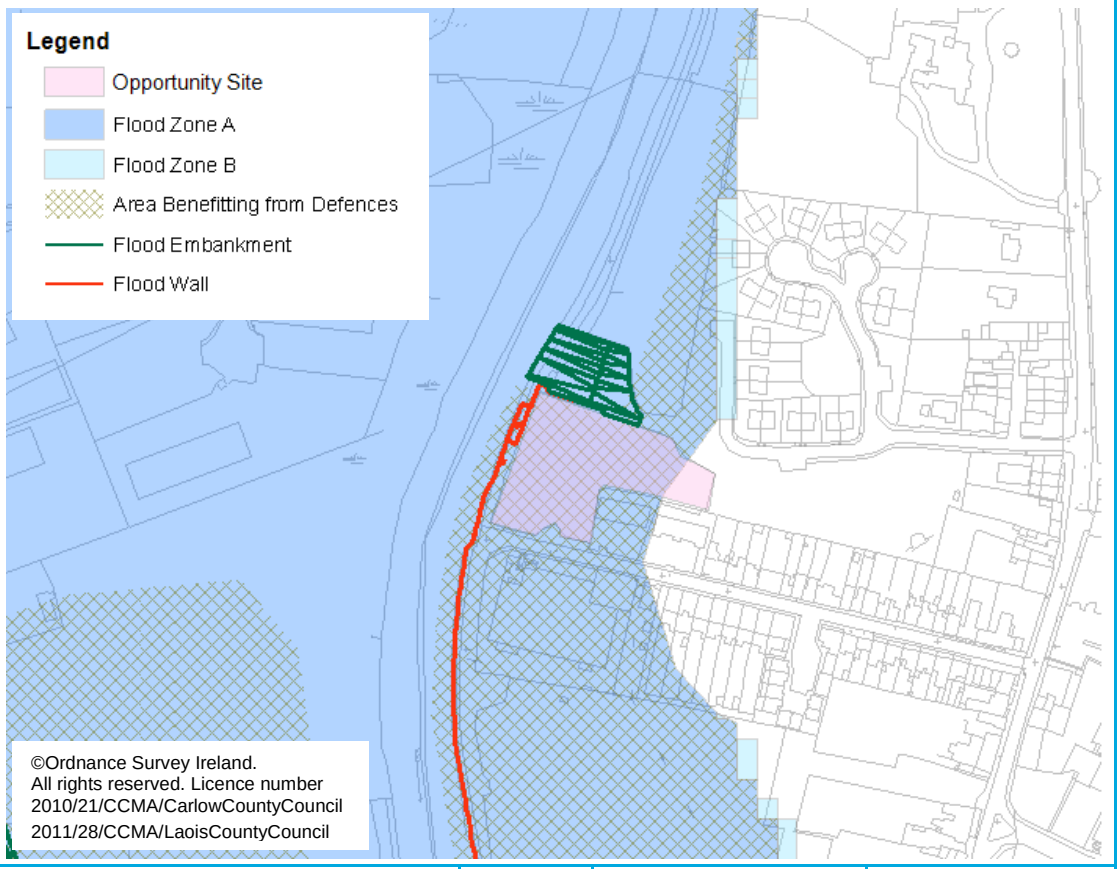
Site Location:



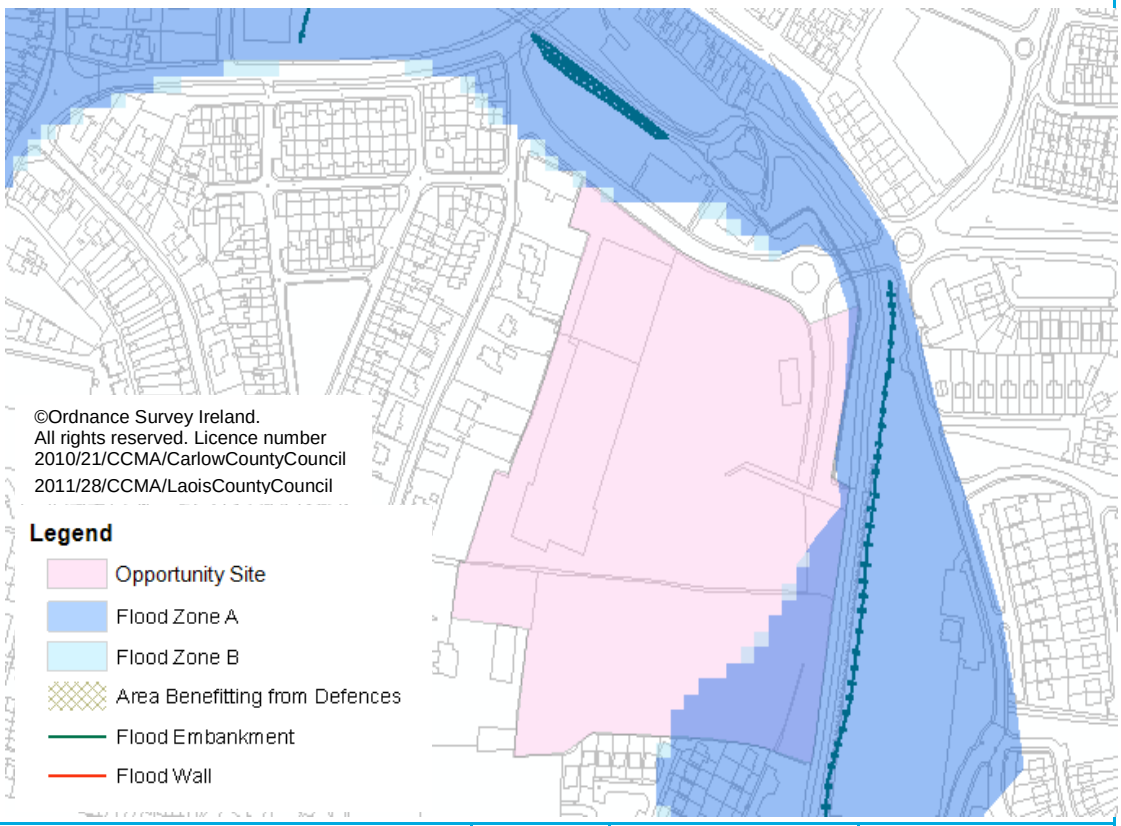
Flood Zone Coverage	A - 100%	B - <1%%	C - N/A

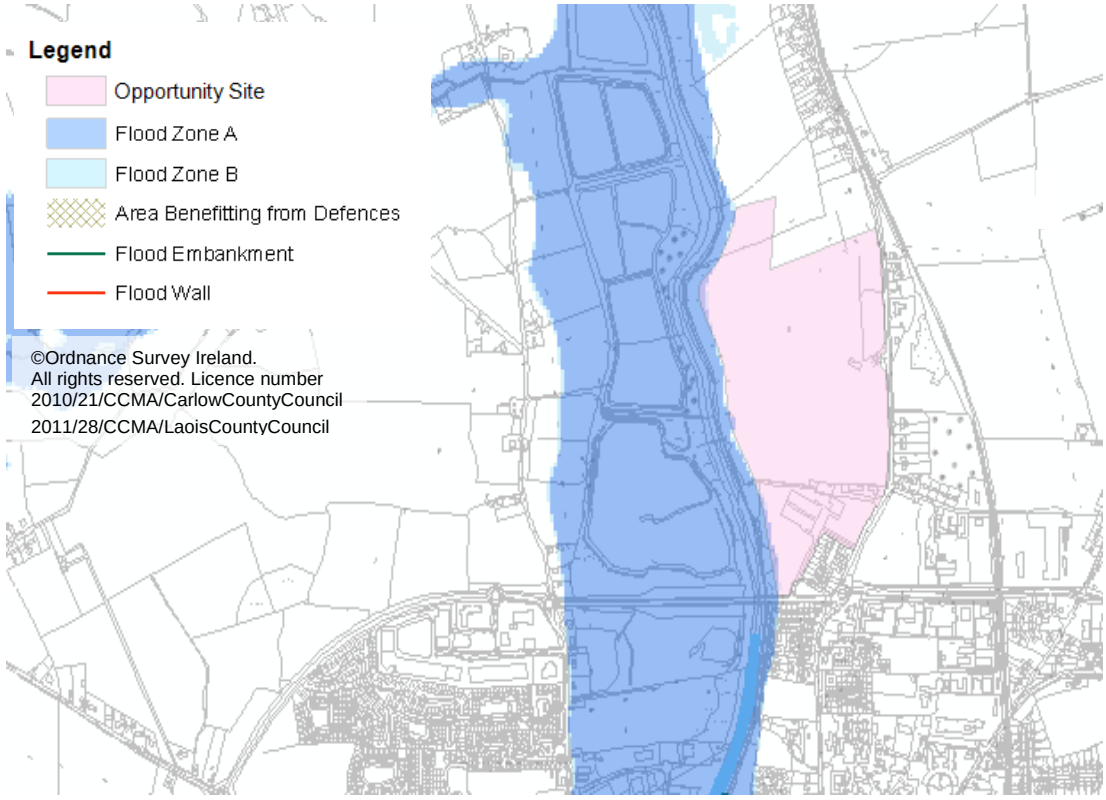
Benefitting from Defences (flood relief scheme works)	No. There is evidence of local land raising which has increased ground levels across the site however without confirmed levels, this site remains at flood risk within Flood Zone A.
Sensitivity to Climate Change	As the whole site is within Flood Zone A, it will remain in Flood Zone A. Flood levels will increase.
Historical Flooding	This site is adjacent to an area that has numerous account of historical flooding.
Surface Water	Large urban site, with local ground raising in recent years. FRA required to consider surface water management.
Commentary on Application of Planning Guidelines	This is an existing industrial development that is highlighted for continued development. This site is in Flood Zone A, with a high risk of flooding.

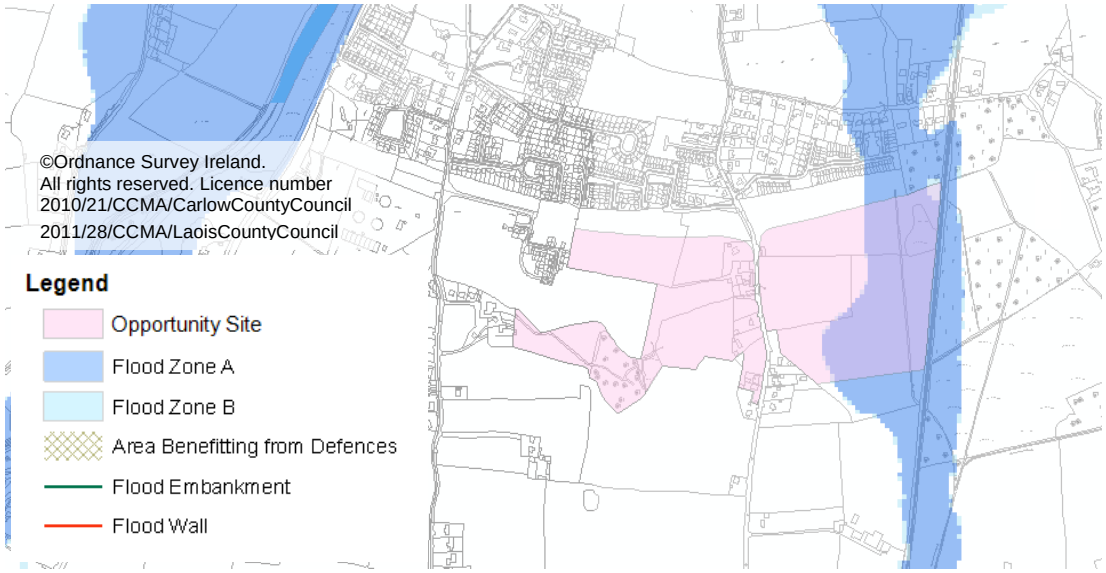
	Following the site walkover, there is evidence of local land raising here. Depending on the final ground levels the site may still be at flood risk. Permission for development at this site must first, under the sequential approach, consider alternative sites. If development cannot be avoided, due to overall planning objectives, proposal must be for a less vulnerable land use. The Justification Test must be applied and all criteria passed. This is assessed in conjunction with the Planning Authorities Justification Test: 1 urban settlement is targeted for growth √ 2(i) essential to facilitate regeneration √ (ii) previously developed √ (iii) is within core √ (iv) essential in achieving compact and sustainable urban growth √ (v) no suitable alternative lands for particular land use √ Conclusion: If it is demonstrated that no suitable alternative lands are available within or adjoining the core then development at this site is justified. A detailed flood risk assessment at this site is required to quantify flood risk following land raising and other local development.

Opportunity Site 17: Greenvale			
Site Code:	OP17		
Site Area:	0.46 Ha		
Catchment:	Barrow		
Zoning Objective:	Town Centre Primary		
Site Location: 			
Flood Zone Coverage	A - 90%	B - <1%%	C - 10%
Benefitting from Defences (flood relief scheme works)	Yes, works have been completed along this stretch of the Barrow River. The defences here consist of concrete flood walls and earthen embankment.		
Sensitivity to Climate Change	High as the defences have not been designed to protect from increased river flows.		
Residual Risk	Should the defences overtop flood risk to the site would be high. The defences have been recently constructed so breach is unlikely to occur.		
Historical Flooding	This site has been reported to flood on a number of occasions including major flood events in 1947, 1995, 2008 and 2009. This site is shown within the 1947 recorded flood extent.		
Surface Water	Site located behind recently constructed flood defences. FRA required to consider surface water management and discharge to the Barrow.		
Commentary on Application of Planning Guidelines	There is an existing development on this site (not shown on mapping above). The majority of the site is in Flood Zone A, with a high risk of flooding.		

	Flood defence works have been carried out along the Barrow Track adjacent to this site. The Planning Guidelines require careful consideration of planning approval on under-utilised sites at flood risk whether or not they benefit from defences. It is important in these situations that residual risk is more fully understood. Development at this site would require a detailed FRA. Permission for development at this site must first, under the sequential approach, consider alternative sites. If development cannot be avoided, due to overall planning objectives, proposal must be for a less vulnerable land use. The Justification Test must be applied and all criteria passed. This is assessed in conjunction with the Planning Authorities Justification Test: 1. urban settlement is targeted for growth √ 2 (i) essential to facilitate regeneration √ (ii) previously developed √ (iii) is within core √ (iv) essential in achieving compact and sustainable urban growth √ (v) no suitable alternative lands for particular land use √ Conclusion: If it is demonstrated that no suitable alternative lands are available within or adjoining the core then development at this site may be justified.

Opportunity Site 18: Hanover Retail Park			
Site Code:	OP18		
Site Area:	7 Ha		
Catchment:	Burrin		
Zoning Objective:	Town Centre Primary		
Site Location: 			
Flood Zone Coverage	A - 20%	B - <1%	C - 80%
Benefitting from Defences (flood relief scheme works)	No The flood relief scheme design did not propose any works at this site.		
Sensitivity to Climate Change	Low; the extents of Flood Zones A and B are similar, but depths of flooding may increase with climate change		
Historical Flooding	There are no specific reports of flooding at this site.		
Surface Water	Large urbanised site adjacent to the River Burrin. FRA required to consider surface water management of the site.		
Commentary on Application of Planning Guidelines	This is an existing development site. The majority of the site is within Flood Zone C; the eastern boundary of the site lies within Flood Zones A and B. For any new development of this site, land use across the site should be appropriate to the scale of food risk. Planning for development in Flood Zone C is appropriate and satisfies the Planning Guidelines. A site specific FRA was submitted during the public consultation (ref CTJSP84). This has been used to inform the Flood Zones (see Chapter 8)		

Opportunity Site 21: Former Greencore Site, Athy Road				
Site Code:	OP21			
Site Area:	30.7 Ha			
Catchment:	Barrow			
Zoning Objective:	Enterprise and Employment			
Site Location: 				
Flood Zone Coverage	A - 10%	B - <1%	C - 90%	
Benefitting from Defences (flood relief scheme works)	No the site is located on naturally elevated land adjacent to the Barrow River upstream of the N80, Duggan Bridge.			
Sensitivity to Climate Change	Low			
Residual Risk	None			
Historical Flooding	There are no records of past flooding at this site. The Barrow Track that runs adjacent to the site at a lower level is prone to flooding.			
Surface Water	Large site, located on high ground adjacent the River Barrow. PFRA indicates risk of pluvial flooding within the site. FRA required to consider surface water management.			
Commentary on Application of Planning Guidelines	The majority of the site in located within flood zone C and the proposed land use zoning is appropriate. Nevertheless, as potential flood risk has been identified, an appropriately detailed flood risk assessment should be completed to accompany any planning application for this site.			

Opportunity Site 24: Quinnagh, Southern Relief Road			
Site Code:	OP24		
Site Area:	27.4 Ha		
Catchment:	Burrin		
Zoning Objective:	Business and Innovation		
Site Location: 			
Flood Zone Coverage	A - 20%	B -	C -
Benefitting from Defences (flood relief scheme works)	No although some alleviation works have been carried out on the Burrin River recently.		
Sensitivity to Climate Change	Low		
Residual Risk	None		
Historical Flooding	There are no formal records of previous flooding at the site. However, the site is of naturally low-lying land and is susceptible to pluvial flooding.		
Surface Water	Large site, with low-lying ground to the east of the site at risk of flooding. PFRA flood mapping indicates risk of pluvial flooding mainly in the east. FRA required to consider surface water management.		
Commentary on Application of Planning Guidelines	Part of the site lies within Flood Zone A. Development, other than water compatible uses, should be avoided in this area of the site. An appropriately detailed flood risk assessment should be completed to accompany any application for development at this site.		

13 SFRA Review and Monitoring

There are a number of key outputs from possible future studies and datasets, which should be incorporated into any update of the SFRA as availability allows. A list of potential triggers for an SFRA review is provided in Table 13-1. Not all future sources of information should trigger an immediate full update of the SFRA; however, new information should be collected and kept alongside the SFRA until it is updated.

Table 13-1 SFRA Review Triggers

Trigger	Source	Possible Timescale
Catchment Flood Risk Assessment and Management (CFRAM) Mapping	OPW under the Floods Directive	2013
Catchment Flood Risk Assessment and Management (CFRAM) Studies	OPW	2015
Flood maps of other sources, such as canal breach and drainage networks	Various	Unknown
Significant flood events	Various	Unknown
Changes to Planning and / or Flood Management Policy	DoEHLG / OPW	Unknown
Detailed FRAs	Various	Unknown
Flood Defence Feasibility / Design Reports	Likely to be local authority and the OPW	Unknown

In addition, information on insurance claims from water related issues, i.e. flooding, could be compiled, if available.

Appendices

A Appendix - Flood Zone Mapping

North

NOTES

Flood Zone A defines the area that has a 1% (1 in 100) or greater chance of flooding each year.

Flood Zone B defines the area that has between a 1% (1 in 100) and a 0.1% (1 in 1000) chance of flooding each year.

The flood zones are defined without the influence of defences (as per the Planning Guidelines).

This map also highlights those 'Areas Benefitting from Defences' which takes into account the recently constructed sections of the Carlow Flood Relief Scheme.

Flood Zone C is everywhere that is not in Flood Zones A or B.

LEGEND

- Area Benefitting from Defences
- Flood Zone A
- Flood Zone B

JBA consulting

MAP A

GREATER CARLOW GRAIGUECULLEN URBAN AREA

FLOOD ZONES

Scale 1:25,000 @ A3

B Appendix - Responses to Submissions Received in Relation to the Draft Joint Spatial Plan

This appendix provides a response to the submissions received by Carlow Local Authorities in respect of the Draft Joint Spatial Plan for the Greater Carlow Graiguecullen Urban Area 2012 – 2018 which relate to, or contain any reference to, flooding and flood risk. Recommendations in response to each submission have been made and where appropriate have been incorporated into the amendments to the Draft Joint Spatial Plan.

A commentary on each of the submissions received (relating to flood risk) is provided below in Sections B.2 to B.6. The submission numbers below correlate to the reference number by Carlow Local Authorities.

B.1 Submission No. CTJSP50 – IE Consulting on behalf of Greencore (Group Plc)

This submission is in relation to the extent of the Flood Zones at the Greencore lands to the north of Carlow Town. The Greencore lands to the west of the River are not zoned in the Draft Joint Spatial Plan; the lands to the east of the river have been identified as an opportunity site.

The SFRA indicates the majority of the opportunity site lies within Flood Zone C, with a low probability of flooding. Due to the size of the land-holding, the flood risk policies recommended in the SFRA, require that a site specific flood risk assessment is carried out, prior to the approval of development. This requirement is acknowledged in the submission and is not challenged.

The submission argues that *"it is not appropriate to simply use PFRA flood zone mapping for these lands."*

The SFRA includes an appraisal of all readily available data in order to assess flood risk at a strategic level, this included PFRA mapping as well as JFLOW flood outlines, information from the Carlow Flood Relief Scheme and site walkover (see Chapter 4 of the main report). It does not intend to fulfil the requirements of a site specific flood risk assessment. The data that informed the SFRA has been compared and validated by a site walkover, the results of which did not provide sufficient evidence to discount flood risk at the site.

Consideration of the proposals to carry out remedial works under the EPA licence and specific analysis or assessment of these lands falls outside the scope of the SFRA. Where more detailed information was made available, for example site specific flood risk assessments or other studies that have been completed, these were reviewed against the SFRA in terms of validating the Flood Zones. No such detailed information was available for this publication of the Joint Spatial Plan. The flood zones and related land-use zonings may be subject to review if or when the Joint Spatial Plan is varied or reviewed under the Planning and Development Act 2000.

B.2 Submission No. CTJSP63 – Pat Nolan on behalf of Michelle Brennan, Mary Dunne and Catherine Nolan

This submission is in relation to the zoning of lands in the Loughlin Road area, identified as Area 1 and Area 2. Area 1 includes a small portion of land within Flood Zone A, designated as open space. The landowners "contend that this land has never flooded in living memory (40 years plus). Whilst it is accepted that the lands east of the Loughlin Road have flooded regularly, the flooding has never extended west of the Loughlin Rd into Area 1".

The Flood Zones represent the extent of extreme flood events, with Flood Zone A representing a 1% AEP flood event, which has a 1% chance of occurring in any given year. It can also be described as the flood that could occur on average once in any 100 year period. The probability of such an event occurring relates to statistical outcome rather than a certainty of recurrence. Records of historic flood events are valuable in the assessment of flood risk

however even where flooding has not been recorded or witnessed in the lifetime of this generation, flood risk can be present.

The Flood Zones indicate that the majority of Area 2 is prone to flooding, which the landowners agree with. However, they have expressed a concern relating to a *"small paddock/field immediately north of Avondale...which is undulating and only partially floods"*. Based on the map supplied there is not sufficient evidence to discount flooding at this site and allow an amendment to the proposed land use zoning. Flood Zone A relates to extreme events and the fact it has not flooded in living memory, even when adjacent lands floods regularly, does not mean it is outside Flood Zone A or B.

Based on the information available, it is recommended that this site is not zoned for residential development.

B.3 Submission No. CTJSP74 – Eddie and Lila Keogh

This submission is in relation to lands at Oakpark, which are zoned for residential development. The submission raises concerns in relation to frequent flooding observed at the zoned land, which is located directly behind the Keoghs' residence.

This land is not adjacent to any rivers or watercourses and does not lie within Flood Zones A or B, which are based on fluvial (river) or tidal flooding. The land is located within Flood Zone C which indicates a low probability of flooding from these sources. Flood Zone C indicates that no land is completely free from flood risk and flood risk may be present due to other flood sources such as groundwater or surface water runoff.

The PFRA pluvial flood outlines, which show flooding due to rainfall and surface water runoff, indicate potential flood risk at the lands in question. Whilst the potential for surface water flooding should not necessarily impede or restrict development, applications in such areas need to consider drainage thoroughly to ensure risks do not increase in the future, either to the development in question or to adjoining lands and property. Surface water management at the site should be considered and adequately addressed in the drainage design for the site.

The SFRA requires that for all large development sites i.e. those greater than 0.5Ha, a site specific FRA is required, which should include consideration surface water issues.

It is recommended that Carlow Local Authorities ensure that the policies and procedures relating to flood risk management, including drainage design, as outlined in the Joint Spatial Plan (and in Chapter 10 of the main report) in respect of site specific development applications, are adhered to.

B.4 Submission No. CTJSP96 – Department of Community, Heritage and Local Government

The submission recommends that *"further integration of the flood risk assessment and zoning objectives is required"* particularly in relation to the opportunity sites in or near the town centre, *"to ensure appropriate uses of areas at risk of flooding".*

The Flood Zone mapping will be displayed on the land use zoning maps in the final publication of the Joint Spatial Plan.

The zoning of the individual opportunity sites and the issues in relation to flood risk, including the application of the Justification Test, are discussed in Chapter 12 of the main report. The recommendations follow the principles of the Planning Guidelines, and also consider the presence of flood defences where they have been constructed.

All development in Flood Zone A must satisfy the Justification Test, demonstrating that the zoning is necessary to achieve proper planning and sustainable development, is within or adjoining the urban core, that are no suitable alternative lands and that flood risk can be adequately managed and will not cause an adverse impact elsewhere.

As the Planning Guidelines require, the Flood Zones included in the SFRA do not take into account the presence of defences. Zonings which relate to sites that benefit from the Carlow Flood Relief Scheme, and are therefore in Flood Zone A, must pass the Justification Test, as per the Planning Guidelines. The presence of the flood relief scheme for Carlow Town means

that flood risk will be mitigated to protect properties from flooding up to a 1% AEP event. Management of the residual risk that remains must be considered both at a site specific level and for the town as a whole. The management of flood risk on a strategic level will require the quantification of residual risk and the consideration of climate change scenarios. Flood hazard mapping from a more detailed assessment will be undertaken as part of the South Eastern CFRAM, and will help define management options for the town, including the completion and implementation of a flood risk management plan.

The land use zoning designations for lands benefitting from defences, that satisfy the justification test, are less vulnerable where possible and highly vulnerable land uses are not recommended.

Based on the submission received, the Flood Zone mapping will be displayed on the land use zoning maps for the Joint Spatial Plan area.

It is also recommended that the Joint Spatial Plan is expanded to deal specifically with developments that are at flood risk but benefit from flood defence measures, and within the commentary on each of the opportunity sites, the Joint Spatial Plan should provide an outline of the type of development considered appropriate where flood risk is a concern e.g. less vulnerable development such as retail; if residential is to be proposed only on first floor level etc.

B.5 Submission No. CTJSP97 – Office of Public Works

This submission from the OPW *"welcomes the following flooding and flood related policy and objectives in the joint Spatial Plan: policy ENV P07, ENV P17-20, ENV P22 and Objectives ENV 009."*

The OPW reiterates that *"the precautionary approach suggests that due care is taken with all development in the outlined, known or suspected, flood risk areas."* And the OPW recommend that all development applications in areas of flood risk require a site specific flood risk assessment. This is in-line with the flood risk management policies recommended in Chapter 11 of the main SFRA report and the flood risk policies included in the Joint Spatial Plan (in particular ENV P20).

The management of flood risk to existing property will be considered in the South Eastern CFRAM study that is currently underway. The detailed assessment that will be undertaken as part of the South Eastern CFRAM will quantify residual risk and feed into the management options for the area. The CFRAM will result in the publication of a Flood Risk Management Plan that will include management and mitigation options to deal with flood risk in the future.

B.6 Submission No. CTJSP99 – Monaco Properties Ltd

This submission is in relation to the de-zoning of lands in the Castle Oaks area at Pollerton Little on the Dublin Road to the northeast of the town.

"The Askea Stream flows through the site, however, the hydrology of this stream has been significantly altered as part of the Castle Oaks development"

The SFRA is an appraisal of readily available data and does not intend to fulfil the requirements of a site specific FRA.

In section 5.5, item 1 of the submission the applicant requests that the council reconsider the Flood Zones *"based on a more detailed examination of the hydrology of the site in question".* This falls outside the scope of the SFRA which appraises existing available data. Should more detailed information regarding flood risk at the site be made available the flood zones and related land-use zonings may be reviewed if or when the Draft JSP is varied or reviewed under the Planning and Development Act 2000.

In response to item 2 of section 5.5, the Joint Spatial Plan does satisfy the requirements of the Planning Guidelines by including *"robust flood risk policies"* that allow for the management of flood risk where potential flood risk had been identified. It is acknowledged that the Flood Zone mapping is indicative only, based on broadscale modelling, and may be amended where more detailed assessment of flood risk is available. A more detailed flood risk assessment of

the Askea Stream within the SFRA is not required nor is it considered necessary for the overall strategic planning of the Carlow Graiguecullen area.

In relation to Item 3 and 4 of section 5.5, the planning files have been requested from Carlow Local Authorities and have been reviewed in this context. The data reviewed includes Drainage Design Calculations dated December 2004, originally received under a request for further information on planning application Pl04/592, a Drainage Report dated 24th March 2010 and a series of drawings relating to the development at Castle Oaks. The documents reviewed relate to the storm water drainage design of the proposed development and demonstrates that the drainage of the site is suitably attenuated and discharge is limited to Greenfield runoff rates. While the documents and drawings outline the proposed works to the Askea Stream, they do not comment on flood risk or provide an assessment of the fluvial flows in the the Askea Stream.

A *"Preliminary Assessment of Proposed Flood Zone Mapping"* was prepared in support of the submission. This report concludes that *"there is no historical or anecdotal evidence of flooding from the Askea Stream in the vicinity of the proposed development lands"* and *"has been collaborated with a local landowner who has not witnessed or experienced any flooding in the previous 60 years."* The Flood Zones indicate flooding due to a 1% AEP event for Flood Zone A, and a 0.1% AEP event for Flood Zone B. Flood Zone A representing a 1% AEP flood event, has a 1% chance of occurring in any given year. It can also be described as the flood that could occur on average once in any 100 year period. The probability of such an event occurring relates to statistical outcome rather than a certainty of recurrence. Records of historic flood events are valuable in the assessment of flood risk however even where flooding has not been recorded or witnessed by in the lifetime of this generation, flood risk can be present.

The SFRA does not include a more detailed hydrological and hydraulic analysis of the watercourse in and around Carlow but rather appraises the existing available data in relation to flood risk. The existing data includes the PFRA flood mapping, JFLOW flood outlines, information from the Carlow Flood Relief Scheme along with walkover survey and consultation with the local authorities. Where local flood studies are available these were also taken into account.

A walkover was carried out in the vicinity of the Castle Oaks development. The watercourse in question was identified, along with the modification referred to in the submission. However, the site walkover did not provide sufficient evidence to allow the broadscale modelled Flood Zones to be amended, primarily as the land either side of the watercourse at bank full level is flat.

It is recommended that without further detailed flood risk assessment, the Flood Zones remain unchanged.

B.7 Submission No. CTJSP84 – Reid Associates on behalf of Thomas Thompson Holdings Ltd.

This submission includes information in relation to flood risk at Opportunity Site 18, the Hanover Retail Park.

"TTH contend that the extent of Zone A is showing an overly cautious assessment of the flood risk associated with this site" and in support, a site specific flood risk assessment was included in the submission. The Flood Risk Assessment Report by BFP Consulting Engineers was prepared and submitted as part of a planning application for an extension of the existing Carlow Retail Park.

In response to this submission, this site specific FRA was reviewed and the Flood Zones have been amended accordingly based on the content of that report.

The report included a flood extent based on a comparison of design flood levels from the Carlow Relief Scheme and surveyed site levels. The Flood Zone adjacent to defences has not been amended as it is unclear how the site specific assessment has considered such defences.

C Appendix - Responses to Submissions Received in Relation to the Proposed Amendments

C.1 Submission by Department of Environment, Community, Heritage and Local Government

This submission asks that the local authorities "review the appropriateness of the proposed amendment Number 23" to rezone lands in Flood Zone A as Residential 2 and that the reasons and evidence supporting the proposed amendments are made clear.

The SFRA indicates potential flood risk at Castle Oaks and under "The Planning System and Flood Risk Management Guidelines", zoning land in Flood Zone A for residential development or other vulnerable land use is not appropriate. Based on the findings of the SFRA, it is recommended that this land is not zoned for residential development. Notwithstanding this, it is noted that the findings at this location, are based on the best available data including broad-scale flood mapping, which has limitations and in some instances may be refined by further detailed assessment at a site specific level.

As these lands remain zoned in the plan, a specific "FRA" objective has been applied to highlight potential flood risk. This is to ensure that flood risk is assessed in more detail to define the Flood Zones with more accuracy before any proposed development can proceed. The Joint Spatial Plan objectives and policies will ensure that any development proposal here demonstrates that it lies outside the 1% AEP flood extent (Flood Zone A).

C.2 Submission by Office of Public Works

The OPW commend the local authorities for their consideration of flood risk and the inclusion of the Strategic Flood Risk Assessment for the Joint Spatial Plan.

The OPW recommend that more evidence is provided "to justify the opinion that for any development in a known flood zone A risk area: Less vulnerable types of development are suitable on the lands".

This statement appears in the Draft Plan and relates to the zoning objectives at opportunity sites that benefit from defences. The Carlow Flood Relief Scheme offers a level of flood protection to the existing town centre and in-line with the Planning Guidelines, the Flood Zones as mapped do not take into account the benefit of such infrastructure.

Each opportunity site that lies in a Flood Zone was subject to the Justification Test. Under the Planning Guidelines, where this test is satisfied the land may be zoned for development and where possible, following the sequential approach, less vulnerable land are preferred. The Justification Test is applied regardless of whether the site benefits from defences or not. As noted in the SFRA, all development proposals in areas benefitting from defences will require an appropriately detailed flood risk assessment and management plan.

In response to the submission, it is recommended that the statement in the Draft Plan is re-worded to ensure it is interpreted in the right context.

Current wording:

Less vulnerable types of development are suitable on the lands (less vulnerable types of development are described in the Flood Risk Guidelines and include retail, office use, playing pitches, showroom and storage uses); residential uses may be acceptable to upper floors subject to emergency flood-risk considerations. This statement relates to flood risk considerations only; zoning, retail policy and wider policy considerations will be applied separately in relation to planning application assessments.

Proposed wording:

Following the guidance of the "Planning System and Flood Risk Management Guidelines for Local Authorities", the application of the Justification Test and consideration of the flood defences, less vulnerable types of development are suitable on these lands; (less vulnerable

types of development are described in the Flood Risk Guidelines and include retail, office use, playing pitches, showroom and storage uses); residential uses may be acceptable to upper floors subject to emergency flood-risk management considerations. All development proposals will require an appropriately detailed flood risk assessment and management plan. This statement relates to flood risk considerations only; zoning, retail policy and wider policy considerations will be applied separately in relation to planning application assessments.

C.3 Submission by Environmental Protection Agency

The submission by the EPA refers to Mapped Amendment 23 and recommends that the proposed re-zoning of lands within Flood Zone A from 'Open Space & Amenity' to 'Residential 2' is reconsidered.

The SFRA strongly recommends that "Planning System and Flood Risk Management Guidelines for Local Authorities" are adhered to and, based on the best available data on potential flood risk, these lands are not suitable for residential zoning. However, as these lands remain zoned in the plan, a specific "FRA" objective has been applied to highlight potential flood risk. This is to ensure that flood risk is assessed in more detail to define the Flood Zones with more accuracy before any proposed development can proceed. The Joint Spatial Plan objectives and policies will ensure that any development proposal here demonstrates that it lies outside the 1% AEP flood extent (Flood Zone A).

C.4 Submission by BMA Planning

This submission relates to Mapped Amendment 23 and "seeks removal of the specific objective "FRA" on the subject lands from the Carlow Town Environs Zoning Map on the basis that it discriminates against the subject lands and is unnecessary given the general policies in relation to flood risk assessment and management which apply to all sites."

In response, it is noted that the consideration of flood risk and the general policies do apply to all sites. These lands are exceptional because they are located in Flood Zone A and therefore under the Planning Guidelines should not be zoned for development. The specific flood risk objective is necessary if the lands are to remain zoned and was included to ensure that any development in this area would be subject to a detailed FRA, quantifying flood risk, and that approval for development would only be granted if sufficient evidence was presented to show that the development area lies outside the existing 1% AEP flood extent (Flood Zone A).

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