Flood Risk Management Plans

2015 – 2021

DRAFT

Department of Agriculture and Rural Development
www.dardni.gov.uk
AN ROINN Talmhaíochta agus Forbartha Tuaithe
MÀNNYSTRIE O Fairms an Kintra Fordèrin

Foreword

I am pleased to present this consultation paper on the draft Flood Risk Management Plans, which are required under the EU Floods Directive.

In recent years flooding has become more frequent and climate change projections suggest an increase in overall winter precipitation, sea level rise and an increase in the intensity and duration of extreme rainfall events in the future. Flooding has potentially devastating impacts, including a threat to human life, damage to buildings, pollution and a severe compromise of economic activity.

The implementation of the EU Floods Directive, “The Assessment and Management of Flood Risk”, 2007, sets out a catchment-based approach to the management of flood risk from all sources of flooding in a holistic and sustainable way.

The Preliminary Flood Risk Assessment which was carried out in 2011 and the publication of the Flood Hazard and Risk Maps in 2014 have enhanced our understanding of and ability to predict flood risk. This mapping information is used to target those communities at greatest risk of flooding and, in turn, to inform the need for flood protection works. The revised Planning Policy Statement 15, “Planning and Flood Risk”, along with the detailed flood maps also helps us to make better informed decisions on land use planning and embody Government’s commitment to sustainable development and the conservation of biodiversity.

The development of Flood Risk Management Plans is the next important step in the implementation of the Floods Directive. It provides an opportunity to assimilate a broad range of information on flood risk in one overarching document and to develop a range of mitigation measures.

In order to inform the development of the draft Plans, there has been extensive engagement with the public and interested parties through a number of stakeholder group and flood forum meetings. We have also worked in partnership with other departments, such as the Department of the Environment and Department for Regional Development to develop a shared understanding of flood risk and to consider and agree roles and responsibilities in managing this risk.

The draft Plans have been developed in line with the Water Framework Directive (WFD) River Basin Districts and I welcome the opportunities this presents to further develop the synergies between these 2 important pieces of complementing legislation.

This consultation pack includes a Strategic Environment Assessment (SEA) and a Habitats Regulatory Assessment (HRA) and the attached Environment Report sets out the results of the SEA.

Two of the three Rivers Basin Districts are trans boundary with the Republic of Ireland. Cross Border issues are co ordinated with the Office of Public Works (OPW) in the Republic of Ireland, through a structured programme of engagement.

I welcome your views on the draft Flood Risk Management Plans. This consultation, which will last for a period of 6 months, will close on 22 June 2015.

Rivers Agency is committed to publishing the first Flood Risk Management Plans by December 2015 and they will be reviewed every 6 years thereafter.

Catherine McCallum
Chief Executive
Rivers Agency

Acknowledgments

Rivers Agency is grateful to the following organisations that have supported, contributed to and helped develop the draft Flood Risk Management Plans.

- DRD
- DRD Transport NI
- N.I Water
- Flood Investment Policy Group (FIPG)

List of Acronyms

AEP	Annual Exceedance Probability
ASSI	Area of Significant Scientific Interest
AOD	Above Ordnance Datum
BRA	Belfast Royal Academy
CPD	Central Procurement Directive
DARD	Department of Agriculture and Rural Development
DRD	Department for Regional Development
DOE	Department of Environment
FIPG	Flood Investment and Policy Group
FRMP	Flood Risk Management Plan
FRISM	Flood Risk Metric Tool
GIS	Geographical Information System
HEC-RAS	Hydrologic Engineering Center - River Analysis System
ICM	Integrated Catchment Model
IPPC	Integrated Pollution Prevention and Control
ISIS	Integrated Spectrographic Innovative Software
LFMA	Local Flood Management Area
LiDAR	Light Detection and Ranging
LMA	Local Management Area
NIEA	Northern Ireland Environment Agency
NPV	Net Present Value
Nr	Number
PFRA	Preliminary Flood Risk Assessment
PPS 15	Planning Policy Statement 15
RBD	River Basin District
RRA	Reservoir Risk Area
SAAR	Standard Annual Average Rainfall
SFRA	Significant Flood Risk Area
SOF	Standard of Protection
WFD	Water Framework Directive

Annexes 508 – 544

Section 1

1. Introduction

This document is in 11 sections, the first 4 of which provide an insight into how the draft Plans have been developed, the background, legislative and policy contexts for the work being carried out on the EU Floods Directive and an update on the implementation of the Directive to date.

Sections 5, 6 and 7 includes the detail of the draft Plans as they relate to the 3 River Basin Districts and the areas identified under the Preliminary Flood Risk Assessment as being at significant risk of flooding.

Sections 8 and 9 detail how the draft Plans will be implemented and an overview of costs.

Section 10 outlines the monitoring and reviewing arrangements for the draft Plans and Section 11 indicates the next steps in the consultation process.

1.1 Flood Risk Management Plans

The development of Flood Risk Management Plans (FRMP) is a requirement under the EU Floods Directive, which was introduced in 2007 and transposed into Northern Ireland legislation in 2009. The final plans, which are to be in place by December 2015, will complete a series of activities which have been undertaken in recent years as part of the implementation of the EU Floods Directive, which will be explained further in Section 2.

The purpose of the FRMP is to provide a holistic, structured approach to the management of flood risk and to inform decisions on reducing the adverse impact of flooding on human health, economic activity, cultural heritage and the environment. They include a number of objectives for the management of flood risk and introduce a number of proposed measures for achieving those objectives.

The draft Plans have been drawn up to in line with the 3 River Basin Districts – North West, Neagh Bann and North East, to complement the approach adopted by the Water Framework Directive. The Water Framework Directive, which is also a European Directive, was introduced in 2000, to provide a holistic approach to the management of water quality, with the primary focus on the protection and improvement of the water environment.

In parallel with the development of draft Plans, a Strategic Environmental Assessment (SEA) and a Habitats Regulatory Assessment (HRA) have been carried out. The SEA highlights the significant environmental affects of the specific flood risk management plans within the 3 River Basin Districts and identifies measures to mitigate any adverse affects. The HRA considers, in more detail, any potential affects on sites with

international designations, for example, Special Areas of Conservation, Special Protection Areas and Ramsar sites.

The attached Environmental Report sets out the results of the SEA.

Following separate 6 month consultation on both the SEA and the draft Plans, the final Flood Risk Management Plans will be made available by the 22nd December 2015.

1.2 Consultation Arrangements

This consultation is an important step in shaping the management of flood risk throughout Northern Ireland over the 6 year life cycle of the Flood Risk Management Plans. It gives you the chance to influence the approach and for us to take on board any ideas and comments that you might have.

In particular, we would welcome your views on the following questions.

Q1 Do you agree that, using the methodology noted, the draft Plans highlight the most significant flood risk areas in each of the three River Basin Districts?

Q2 Do you understand and agree with the objectives as described in the draft Plans?

Q3 Do you agree that there is the right balance between the social, economic and environmental objectives?

Q4 Do you agree with the proposed measures identified for each of the significant flood risk areas?

Q5 What measures do you think should be given the highest priority to manage the flood risk in your area?

Q6 Do you see any ways that you or your community can support and contribute to any of the measures set out in the draft Plans to reduce the flood risk?

Q7 Are there actions you think should be taken to improve the co ordination of river basin and flood risk management planning?

Questions on the Environmental Report

Q8 Do you agree with the conclusions of the environmental assessment?

Q9 Are there any significant environmental effects of the draft Plans which you think should be considered?

Q10 Are there further mitigations or opportunities that should be considered for the Plans?

This consultation document will be available for public response and comment for a period of 6 months from 22nd December 2014 to 22nd June 2015. Please provide comments in writing via letter, e-mail, or fax using the appropriate contact details below by 5.00 pm on **Monday 22nd June 2015.**

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Alternative formats

Copies of this document can be made available on request in alternative formats e.g. in large print, Braille disc, audio cassette and other languages.

If you consider that your views can be better obtained through other means the Department will; be happy to discuss suitable arrangements with you.

We will compile a response document which will contain any comments that you provide to us, will let you know what other people have said, how we have taken comments into account and the changes that will be made before we publish the final FRMP by 22nd December 2015.

We would also welcome your comments on the attached Environmental Report on the wider context of the draft FRMP.

Freedom of Information Act 2000 – Confidentiality of Consultations

Please note that your response and the responses of others to the consultation may be disclosed on request. The Department can only refuse to disclose information in exceptional circumstances. Before you submit your response please read the paragraphs below on the confidentiality of consultations which provide guidance on the legal position about any information given by you in response to this consultation.

The Freedom of Information Act 2000 gives the public a right of access to any information held by a public authority, namely the Department in this case. This right of access to information includes information provided in response to a consultation. The Department cannot automatically refuse to disclose any information supplied to it in response to a consultation. However, it does have the responsibility to decide whether any information provided by you in response to this consultation, including information about your identity should be made public or be treated as confidential.

This means that information provided by you in response to this consultation is unlikely to be treated as confidential, except in very particular circumstances.

For further information about the confidentiality of responses please contact the Information Commissioner's Office, further information is available at www.informationcommissioner.gov.uk).

Comments and complaints

If you have any comments on how this consultation has been conducted, please send them to the contact details on the previous page.

Section 2

2. Background/Context

2.1 Sources of flooding

Flooding is a natural process that cannot be entirely prevented. It can happen at any time and there is a consequent risk to people, property, infrastructure and the natural environment. There are four main sources of flooding:-

- **Flooding from rivers**, also known as fluvial flooding, occurs when the river channel capacity is exceeded and water is conveyed and stored within the natural flood plain of the river. Northern Ireland has one of the largest rates of run-off per unit area in the British Isles. Much of the country is low-lying and many of its rivers and streams have gentle gradients in their lower reaches. With lowland soils that are mostly clay rich and of low permeability there is the widespread potential for localised flooding.

- **Coastal flooding** occurs when inundation from the sea takes place along coastal areas and estuaries as a result of a combination of high tides, storm surge and wave action.Significant coastal flooding is a relatively infrequent occurrence in Northern Ireland. However coastal flooding is often characterised by flows that are more rapid and dynamic than for other sources of flooding and therefore the consequential risk to public safety and property is relatively high. Also, the long term economic and environmental damage is generally higher due the effects of saltwater inundation. In order to reflect the relatively high potential impacts from coastal flooding the Flood Hazard and Risk Maps on the Flood Maps NI, webpage indicates the likelihood of coastal flooding occurring with a medium probability as a 200 year event, or an event with 0.5% chance of occurring in any one year.

- **Surface water,** also known as **pluvial flooding,** occurs as a result of rainfall which overwhelms natural or man-made drainage systems resulting in water flowing overland and ponding in depressions in the ground. It is a particular problem in urban areas, which are often dominated by non-permeable surfaces (i.e. roofs, roads and car-parks). As a consequence of the predicted increase in the frequency and intensity of extreme rainfall events urban areas are susceptible to an increasing risk of this type of flooding**. It is estimated that surface water flooding now accounts for 50% of all flood events.** Belfast has a long history of pluvial flooding and there are extensive reports of major flooding in the city as far back as the early 1900s. Responsibility for surface water flooding is cross departmental and is shared between DARD (Rivers Agency) and DRD (NI Water and Transport NI).The surface water flood map indicates that around 20,000 or 2.5% of the properties in Northern Ireland are sited in an area where the likelihood of flooding is greater than or

equal to a 1 in 200 year event and at a depth greater than 300mm deep.Many of these properties would also already be at risk of flooding from fluvial and/or coastal flooding.

- **Flooding from reservoirs**. Flooding from water impounding structures such as reservoirs, constitute a potential source of flood risk. Flooding of surrounding areas can occur if the reservoir either fails structurally or by an unusually high release of water, via spillways. Although the likelihood of flooding is low, the impact on communities is high due to the sudden release and rapid inundation of flood water. Currently, the maintenance of impounding structures in Northern Ireland remains unregulated, although a Reservoirs Bill is currently going through the legislative process in the Assembly. This legislation will reduce the risk of flooding, through the management and regulation of controlled reservoirs with a capacity greater than 10,000 cubic metres. Reservoir flood risk maps, indicating potential areas of flood inundation should be available within the next year. More information on the Reservoirs Bill is available at **Annex F.**

It is generally accepted that we are likely to experience more regular flooding in the future. In urban areas, surface water flooding may increase due to the development of green spaces and the paving of gardens and driveways. Most urban drainage systems are designed to cope only with a 1 in 30yr (3.3% AEP) rainfall event. In addition, deforestation, together with agricultural drainage and land management practices has, as a consequence, increased conveyances and flows in watercourses and increased flood risk in urban areas lower down the catchment areas. Climate change predictions also suggest a rise in sea level, an increase in winter precipitation and an increase in the frequency and intensity of extreme rainfall events.

A fundamental reason why many people and property are at risk of flooding is that many towns and cities are located within functional flood plains. Historically, people chose to select locations for settlement close to rivers based on the need for drinking water, foul drainage, transport, commerce and fishing. The pressure for development within towns and cities that have a known flood risk has continued largely unabated until the introduction of relatively recent planning policies such as PPS 15, “Planning and Flood Risk”.

Flood risk has historically been addressed through a reactive approach by providing local engineered solutions to solve repeated flooding. However, this approach, particularly on a larger scale can cause increased flooding elsewhere through the removal of valuable flood storage areas.

2.2 Flood Risk Information

Flood risk information is currently presented through the use of the Flood Risk and Hazard maps on the Flood Maps NI webpage. The extent of the floodplains for river and coastal flooding for the significant risk

areas included in the draft Plans has been estimated by using predictive computer modeling techniques. Each of the floodplains highlighted in the maps is associated with a flood event which has a particular chance of occurring. For example, the area highlighted within the 1% AEP floodplain outline for rivers has a 1% or greater chance of flooding in any year. The Flood Hazard and Risk Maps, Flood Maps NI, indicate 3 levels of flood risk:

- 1,000 year event - Flood Event with low likelihood of occurrence.
- 100 year event - Flood Event with medium likelihood of occurrence.
- 10 year event - Flood Event with high likelihood of occurrence.

It is estimated that around 5.5% or 46,000 properties in Northern Ireland are within either the 100 year fluvial floodplain or the 200 year coastal floodplain. One third of these properties currently have some level of protection.

The extent of surface water flooding is hard to predict, as small changes to the height of ground surfaces can markedly change the direction of surface water flows and it is difficult to predict with certainty the exact route along which surface water will flow and pond. It is for this reason, therefore, that the surface water maps are strategic in nature and use the 0.5% AEP or 1 in 200 year flood event to predict flooded areas.

2.3 Legislative Context

2.3.1 The Floods Directive

The main legislation covering flood risk management is "The Assessment and Management of Flood Risk Directive" 2007, commonly known as the EU Floods Directive. http://ec.europa.eu/environment/water/flood_risk/ . It was introduced in 2007 and was largely a response to a significant increase in the number of flooding events across Europe. Its key aim is to reduce and manage the adverse risks that flooding can have on communities and the environment. It also promotes the retention and restoration of natural flood plains and reinforces the right of the public in terms of having a role in the management of flood risk.

Key features of the EU Directive include:-

- A catchment-based approach toward managing flood risk;
- A more proactive approach to identifying, planning and setting measures to reduce future predicted flood risk;
- Better co-ordination and sharing of information with stakeholders; and
- Promoting the use of natural flood risk management measures.

The EU Floods Directive was transposed into the Water Environment **"(Floods Directive) Regulations, NI",** in 2009 and, the Department of Agriculture and Rural Development (DARD) is the competent authority for its implementation in Northern Ireland. The key products required of all Member States, along with the associated timescales for delivery, are listed below:

- **A Preliminary Flood Risk Assessment – 2011:** This is an assessment of potential risks within the river basins and/or associated coastal areas. It identifies areas that potential significant flood risk presently exists or might be likely to occur.

- **Flood Hazard and Risk Maps – 2013:** the Flood Hazard and Risk maps focus on those areas that have been identified as being at significant flood risk. The maps include, flood extents for high, medium and low probability events, water depths, levels and velocities, indicative numbers of inhabitants potentially affected and the type of economic activity impacted upon.

- **Flood Risk Management Plans – 2015:** On the basis of the Flood Hazard and Risk Maps, the preparation of Flood Risk Management Plans for the identified significant flood risk areas are the final stage in the implementation timetable and it is this stage which is the focus of this consultation document.

2.3.2 The Water Framework Directive

The Water Framework Directive 2000/60/EC, which was introduced in 2000 has a number of links with the EU Floods Directive. Its primary focus, however, is improvement in water quality, rather than flooding. Its approach is based around the same River Basin Districts as the Floods Directive and this provides a number of opportunities for Government to dovetail the activities of both Directives.

2.3.3 Strategic Environmental Assessment Directive, (SEA)

The SEA Directive, 2001/42/EC provides a framework for assessing the effects that certain plans and programmes may have on the environment. The Floods Directive promotes coordination with the Water Framework Directive, particularly in relation to sustainable land use practices, the retention of natural flood storage areas and the potential adverse consequences of flooding on the environment. It was considered that the Flood Risk Management Plans, are "likely to have significant environmental effects" and therefore a SEA assessment should be included as part of the development of the draft Plans.

2.3.4 Habitats Regulatory Assessment, (HRA)

The Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora, (the Habitats Directive), provides the framework for the legal protection for species and habitats of European

importance. Although the Habitats Directive has a narrower focus than the SEA ,it has been deemed prudent to undertake an **appropriate assessment** of the draft Flood Risk Management Plans in order to determine whether they will have a "likely significant effect" on sites designated at an international level (European Designated Site) for their nature conservation value.

2.4 Broader Legislative and Policy context

In addition to, but outside the direct legislative requirements of the Floods Directive, it should be noted that work is ongoing on a number of other policy/legislative initiatives which will, over time, contribute to the longer term management of flood risk in Northern Ireland. As well as legislative requirements, we need to continue to meet our long term obligations and challenges for managing flood risk by developing policies and strategies that can be delivered in the longer term. Some of these, amongst others, include:-

- **Long Term Water Strategy:** this is led by DRD and extends beyond flooding issues. However it highlights the need to manage flood risk in relation to integrated drainage systems, including funding and delivery arrangements.

- **Floods Bill:** work needs to commence on a Floods Bill to enable the effective delivery of all components of Flood Risk Management. This will add clarity to organisational roles and responsibility and encompass broader Flood Risk Management approaches.

- **Reservoirs Bill:** Once the Bill receives Royal Assent, it will enable the administration and safe management of all Reservoirs within Northern Ireland with a capacity greater than 10,000 m3. This is necessary to manage this source of flooding and bring Northern Ireland into line with the rest of the UK in this area.

- **Water Bill:** DRD is seeking to introduce a Water Bill to improve how water and sewerage services are delivered. One strand of this is to consider reducing the volume of surface water entering the public combined sewerage system by placing restrictions on the right to connect to public sewers and promoting the use of Sustainable urban Drainage Systems (SuDS)

- **Sustainable Drainage Systems (SuDS):** An outcome of the recommendations of the NIEA "Managing Stormwater report" promotes introducing legislation that will make on site SuDS solutions compulsory for all new development. This legislation will also ensure that no new surface water drainage systems are connected to existing combined sewer systems. Developing detailed guidance on "Designing for Exceedance", where excess flows from existing storm water systems can be temporarily stored in sacrificial areas such as parklands and car parks needs to be undertaken.

- **Northern Ireland Climate Change Adaptation Programme:** As a result of the first Northern Ireland Climate Change Adaptation Programme, published early in 2014, a range of adaptation activities and actions has been identified for each Government Department with a role in flood risk management.

- **Building Regulations** Engagement with DFP is necessary for the inclusion in the Building Regulations of flood resistance/resilience construction techniques for those properties within flood risk areas.

- **Countryside Management Strategy** Opportunities need to be identified to build on the links between sustainable agricultural land use and managing flood risk. A catchment based approach, and practical linkages will be sought over the life cycle of these Plans. Other opportunities in relation to fishing measures and forestation will be explored as appropriate.

The use of Flood maps NI will be essential in determining areas of focus in terms of conveyance routes and areas with the potential to retain flood water.

The use of informed Agricultural and Forestry land use practice will also contribute to reduced run off and sediment control. Opportunities throughout the cycle of this plan will be explored to embrace this approach.

Section 3

3. Objectives and Measures for Managing Flood Risk

3.1 The Flood Risk Management Plan Objectives

The Flood Risk Management Plans contain a number of objectives for the management of flood risk from all sources of flooding. The Objectives set out what needs to be achieved and, in accordance with the requirements of the Floods Directive, the Plans should give consideration to:

- reducing the likelihood of flooding; and,
- reducing the adverse consequences of flooding for human health, economic activity and the environment including cultural heritage.

The objectives set, in relation to each area of impact are:-

Economic Activity

- To reduce economic damages to properties;
- To reduce the economic costs on business caused by the disruption to essential infrastructure and services; and,
- To optimise the economic return on Flood Risk Management investment.

Human Health and Social

- To reduce the risk to life;
- To raise awareness of the consequences of flood risk;
- To reduce risk to health and wellbeing;
- To reduce the impact on people caused by the disruption to essential infrastructure and services; and,
- To improve recreation and public amenities.

Environmental (including cultural heritage)

- To consider the impact of Climate Change across all areas of impact;
- Under the Water Framework Directive, to support the achievement of good ecological potential/status for water bodies;
- To reduce the risk of pollution;
- To avoid or mitigate the impact on priority species and habitats; and,

- To avoid or mitigate the impact on designated environmental areas, including those of cultural heritage importance.

3.2 The Flood Risk Management Plans- Measures

The Flood Risk Management Plans identify Measures that are the specific actions which will deliver the Flood Risk Management Plans Objectives. In setting the Measures, the Floods Directive requires that the Flood Risk Management Plans should give consideration to:

- **Prevention** of increased flooding by appropriate land use planning.
- **Protection** of communities and the environment by provision of schemes and approaches to reduce flood risk.
- **Preparedness** arrangements, to improve dealing with flooding when it occurs.

A table detailing the links between the Objectives and Measures is included at **Annex H.**

In determining the proposed measures the Flood Risk Management Plans must have regard to:

- the preliminary flood risk assessment;
- the information available in the Flood Hazard and Risk Maps "Floods Maps NI''
- the Water Framework Directive environmental objectives;
- the cost and benefits of the various options for managing flood risk;
- the impact of climate change; and,
- the opportunity for natural flood plain management.

The measures adopted are:-

3.2.1 Prevention

The Regional Development Strategy provides a strategic planning framework for sustainable development throughout Northern Ireland. It is therefore important that land-use planning decisions do not increase flood risk. Planning Policy Statement, PPS 15, "Planning and Flood Risk", which has been revised recently, adopts a precautionary approach to development with the primary aim of preventing future development that may be at risk of flooding or that may increase the risk of flooding elsewhere. The policy takes account of climate change and emerging information relating to flood risk through the implementation of the EU Floods Directive. The new "Flood Maps NI" are therefore an important tool in identifying and assessing flood risk from the four main sources of flooding, at both the Development planning and Development application stages.

The key approaches in terms of Prevention are:-

Keep new development outside Flood Risk Areas

- Inform the development planning process to ensure, as far as possible, that new zonings within local development plans are located outside flood risk areas.

- Input to the development control process to ensure, as far as possible, that individual applications are located outside flood risk areas.

Ensure new development within Flood Risk areas is suitably constructed

- In accordance with PPS 15 ensure that any development which has to be located, **"by exception",** in flood risk areas is built in the appropriate manner with adequate flood resistance/resilience measures commensurate with the flood risk to the development and that the development does not cause increased flood risk elsewhere.

- Ensure that all proposed development applications within flood risk areas are accompanied by a flood risk or drainage assessment.

3.2.2 Protection

Flood protection is required where existing property is already located within flood risk areas. Structural measures, such as flood defence walls /embankments or culvert diversion channels are utilised where there is an economic benefit to society that will allow the works to be financed. Environmental measures can also be factored into the scheme, as appropriate.

The key approaches in terms of Protection are:-

Maintenance of the Existing Drainage and Flood Defense Network

- Continue to inspect and maintain designated watercourses and grilles as appropriate;
- Continue to regularly inspect the condition of all drainage and flood defence assets;
- Continue to implement a prioritised programme of works for the maintenance of all drainage and flood defence assets; and,
- Continue to implement a prioritised programme of maintenance of public sewer and drainage infrastructure.

New Flood Alleviation Schemes

- Continue to carry out feasibility studies to identify cost beneficial flood alleviation schemes in relation to property and communities at flood risk;
- Continue to implement a prioritised programme of flood alleviation schemes;
- Continue to implement a prioritised programme of works for integrated surface water drainage schemes; and,
- Continue to implement a prioritised programme of works to separate surface water systems from combined sewer systems.

Catchment Based Management

- Create opportunities to work with others, through partnership arrangements, to deliver sustainable flood risk management measures at a catchment level. These measures potentially include reduction in run-off through wetland creation and tree planting. Fishery enhancement works and improvements in water quality by lengthening flow paths and filtration techniques could also be considered as appropriate. These measures are likely to have a number of benefits that whilst unquantifiable, are still significant.

Surface Water Management

- Promote the use of SuDS in all new development to ensure that the post development runoff is no greater than the pre development run off rate. Legislation which endorses the use of SuDS, as noted earlier, is essential in underpinning this approach. Design for exceedance needs also to be considered.

3.2.3. Preparedness

It is not possible to prevent or protect against all flooding. Even where flood defences exist, in an extreme event, it is possible that these could be over-topped and flooding could still occur. Consequently there is a need to be prepared for flooding. There will also be situations where a flood protection scheme is not economically viable or not yet in place and therefore it is critical that preparatory activity is undertaken.

The provision of an effective emergency response from Government is a key feature of Preparedness. It needs to be recognised that communities at risk also have a key role in working with Government in order to be better prepared to deal with flooding when it occurs.

The key approaches in terms of preparedness are:-

Flood Emergency Response

- Government Departments, Councils and the emergency services need to continue to maximize the effectiveness of a coordinated emergency response;
- Responders need to continue to share Information and resources in order to streamline the approach to emergency response;
- Emergency response plans need to be used to bring clarity and focus to emergency response.

Exercising

- Regular emergency planning exercises need to continue as part of responders' work programmes to facilitate learning and provide opportunities to test capacity and capability. Roles and responsibilities need to be clearly established and understood by all responders.

Lead Government Department-for the Coordination of Flooding Emergencies

- DARD must ensure that its role as Lead Government Department (LGD) is clearly understood, both internally and among other key responder organisations;
- DARD will continue to undertake such activity as is necessary to ensure that this role adds value to emergency response. This will include the development of emergency planning events, coordination of communications and provision of technical expertise to inform the overall emergency response from Government Departments and other organisations.

Civil Contingencies Multi-Agency Preparedness Structures with a role in Flooding Emergencies can be found at Annex G.

Flood Warning and informing

- Rivers Agency will continue to monitor and refine the approach to the provision of flood warning and informing, which has been developed in response to the PEDU report of 2012. Northern Ireland does not have a flood forecasting centre, unlike the rest of the UK. The reason for this is that catchments here are smaller and any warning time would be much shorter. This would greatly reduce the benefit of such a centre in Northern Ireland. However there are improvements in this area that have been be made.

Further details of Flood Warning Proposals suitable for Northern Ireland are included at **Annex D.**

Community Engagement – Informing and Building Resilience

- Rivers Agency will continue to work with the other Drainage Agencies, the Emergency Services, Local Government, NIHE, Red Cross, Consumer Council, Met Office, etc, to develop and establish a consistent approach to flood warning and informing activities across Northern Ireland.
- The Regional Community Resilience Group (RCRG), which was established in 2013, will continue to co-ordinate self-help activities, (Through the auspices of this group the co-ordination of, self help activities is facilitated. This includes the pre-deployment of sandbags at areas known to flood and the use where appropriate of river level text alerts).

  Further details on the role of the RCRG can be found at Annex E.

Flooding Emergency Communications

Rivers Agency will:-

- Continue to engage with communities to facilitate the informing aspect of 'Flood Warning and Informing' activities.
- Continue to update and improve flood risk information on Flood Maps (NI).
- Continue to improve information on flooding on the NI Direct Website.
- Continue to work with NI Direct in the development of the Flooding Incident Line (FIL).
- Continue to consult and hold flood forums with stakeholders and others to make them aware of their role and responsibilities in managing flood risk.
- Seek to issue timely media messages to inform the Public of significant flooding events.

Individual Property Protection

- Rivers Agency will continue to progress arrangements for the introduction of a proposed scheme for grant aiding Individual Property Protection on the basis of the likelihood of future flooding and the frequency of past flooding events.

Flood Recovery, Welfare and Insurance Issues

In the aftermath of flooding, which extends well beyond the actual damage to property, Rivers Agency with others will-

- Continue to carry out and contribute to post flood investigations to gather information and improve knowledge and action on future flood events.
- Continue to report significant flood events to the European Commission as required by the Floods Directive.
- Continue to work with Councils and local communities at risk of flooding in providing advice and information to aid recovery after a flood event.

- Continue to engage and work with voluntary section organisations such as the Red Cross in providing Welfare Support.
- Continue to work with the insurance industry to assist them in introducing “FloodRe” to NI to help address long term flood insurance affordability issues.

Section 4

4. Floods Directive Implementation - Work to Date

This section of the document provides an insight into the work that has already been completed on the implementation of the Floods Directive. It also touches on the governance arrangements in place to oversee the full implementation of the Directive and provides some detail on the role and function of those organisations which contribute to the implementation programme of work.

4.1 Preliminary Flood Risk Assessment

The Floods Directive required each Member State to undertake a Preliminary Flood Risk Assessment (PFRA) for its respective territory by 22 December 2011. The PFRA is used as the basis for identifying those areas which could be considered as having the potential to be at significant risk of flooding. It is only for these areas that the Floods Directive requires detailed hazard and flood maps to be prepared. The PFRA was based on available and readily derivable information, mainly provided by the strategic flood maps.

The PRFA estimated that 46,000 or 5% of the 830,000 properties in Northern Ireland are located within the 1 in 100year (1% AEP) fluvial floodplain or in 200year (0.5% AEP) coastal floodplain. Of these properties, approximately 15,500 are protected to some extent by flood defence systems and the culvert network.

To assess the adverse consequences of flooding a GIS application based on a Source-Pathway-Receptor model was set up. The model is used to develop flooded areas for different return periods from each flooding source and visualizes how these flood and travel along various pathways, and, ultimately how they impact on people, property and infrastructure.

The flood risk is measured and represented through the use of Flood Risk Indicators and illustrated on maps for the whole of the province using colour scales, to highlight the scale of impact caused by the flood.

Examples of the Flood Risk Indicators used are:

- Number of different property types flooded;
- Economic damage arising from flood damage;
- Number of people at risk;
- Vulnerability of people at risk;
- Number of key infrastructure assets flooded;
- Areas of designated environmental sites flooded;
- Number of IPPC sites flooded, and
- Lengths of roads/railways flooded.

The table overleaf shows the 20 Significant Flood Risk Areas (SFRA) identified in Northern Ireland and an assessment of damages, based on an Annual Average Damage threshold. A further 49 “Areas for Further Investigation”, have also been identified and, although not part of these Plans, they may be considered at a point in the future.

The assessment of flood risk from reservoirs has not been conclusively addressed. The reason for this is the lack of available information. Unlike the rest of the UK, Northern Ireland does not yet have legislation in place for the management of reservoir safety and, as a consequence, the owners of impoundments have not been required to collate such information as would be necessary to assess the potential risk of their failure. That will change, however, once the Reservoirs Bill, which is currently going through the NI Assembly legislative process, becomes law. For the purposes of the PFRA, the flood risk from reservoirs will not be used in the determination of SFRA for the first six year planning cycle of the EU Floods Directive.

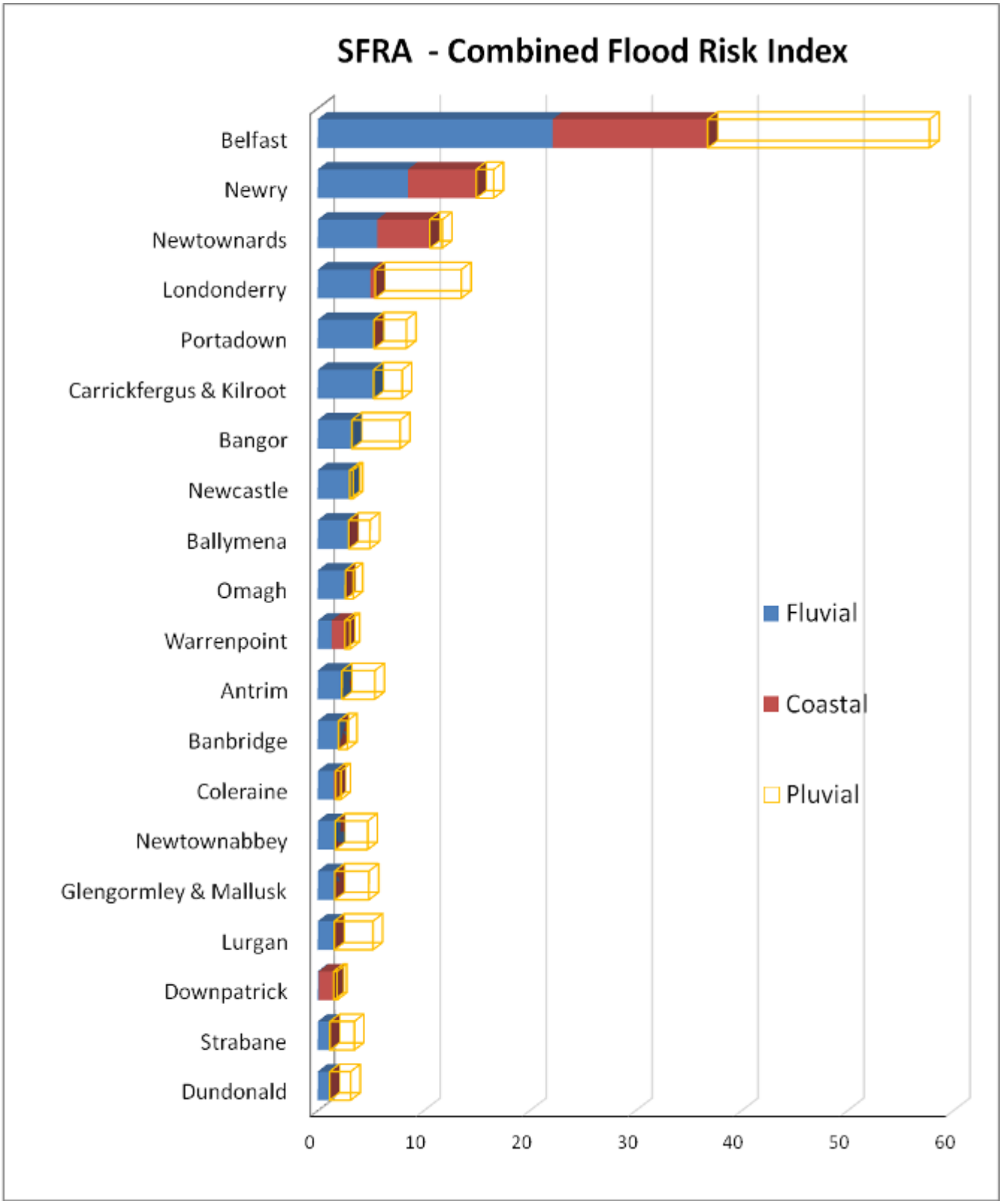

SFRA - Combined Flood Risk Index
Belfast
Newry
Newtownards
Londonderry
Portadown
Carrickfergus & Kilroot
Bangor
Newcastle
Ballymena
Omagh
Warrenpoint
Antrim
Banbridge
Coleraine
Newtownabbey
Glengormley & Mallusk
Lurgan
Downpatrick
Strabane
Dundonald
0
10
20
30
40
50
60
Fluvial
Coastal
Pluvial

Figure 4.1

4.2 Flood Maps

Rivers Agency in conjunction with Planning NI, published **Strategic Flood Maps** for NI in October 2008. These indicative maps are used to locate general areas at risk of flooding throughout NI, but are unable to give detailed flooding information at individual property level. Under the requirements of the Floods Directive, detailed **Flood Risk and Hazard Maps** were then developed for those areas that were identified through the PFRA as being at significant risk of flooding. The detailed maps overlay and replace the strategic maps where applicable. The maps were made available in December 2013 and published on Flood Maps (NI) website, in May 2014. The level of detail in these maps is such that they can be used to identify specific properties/sites at risk of flooding.

The maps identify and provide an understanding of the impact of flooding from all main flooding sources and are an important visual tool in communicating flood risk to inform decision making.

Flood Hazard Maps

The flood hazard maps show the areas, which will be flooded during the following scenarios.

- A high probability event – Greater than or equal to a 1 in 10 i.e. a 10% AEP chance in any given year.
- A medium probability event - Greater than or equal to a 1 in 100 i.e. a 1% AEP chance in any given year.
- A low probability event - Greater than or equal to a 1 in 1000 i.e. a 0.1% AEP chance in any given year.

For the coastal flood risk the medium probability event is taken as greater than or equals to a 1 in 200 i.e. a 0.5% AEP chance in any given year. A range of colours is used in these maps to indicate the different probability events and, for each event, where possible, they will show the flood depth, velocity and direction. The maps take into account areas that are protected by flood defence structures.

Flood Risk Maps

The flood risk maps will show the potential consequences of each flood scenario. In particular the maps will show the number of people and the types of economic activity affected by the flooding and also highlight the location of potentially polluted installations that may have an adverse affect on environmentally sensitive sites. The maps also make use of a Flood Risk Management (FRISM) tool, which is a coarse estimate of the likely economic damage to residential and commercial property that will occur for a 10 year, 25 year and 100

year flood event. An Average Annual Damage and Net Present Value estimate of total damage is also derived, to give an indication of whether a flood protection scheme would be economically viable.

Surface Water Map

The surface water flood map was published in December 2011. It is strategic in nature and indicates the potential flooded areas from high intensity rainfall or out of sewer flooding where the likelihood of flooding is:-

- High probability event – Greater than or equal to a 1 in 30 i.e. a 3.3% AEP chance in any given year.
- Medium probability event - Greater than or equal to a 1 in 200 i.e. a. 0.5% AEP chance in any given year.
- Low probability event - Greater than or equal to a 1 in 1000 i.e. a 0.1% AEP chance in any given year.

A range of colours is used to indicate the different probability events.

The maps can be read in conjunction with “Heat Maps” which give an indication of historical flood events where housing flood grant payments have been received. Reservoir inundation maps will not be available until 2015.

Mapping and Climate Change

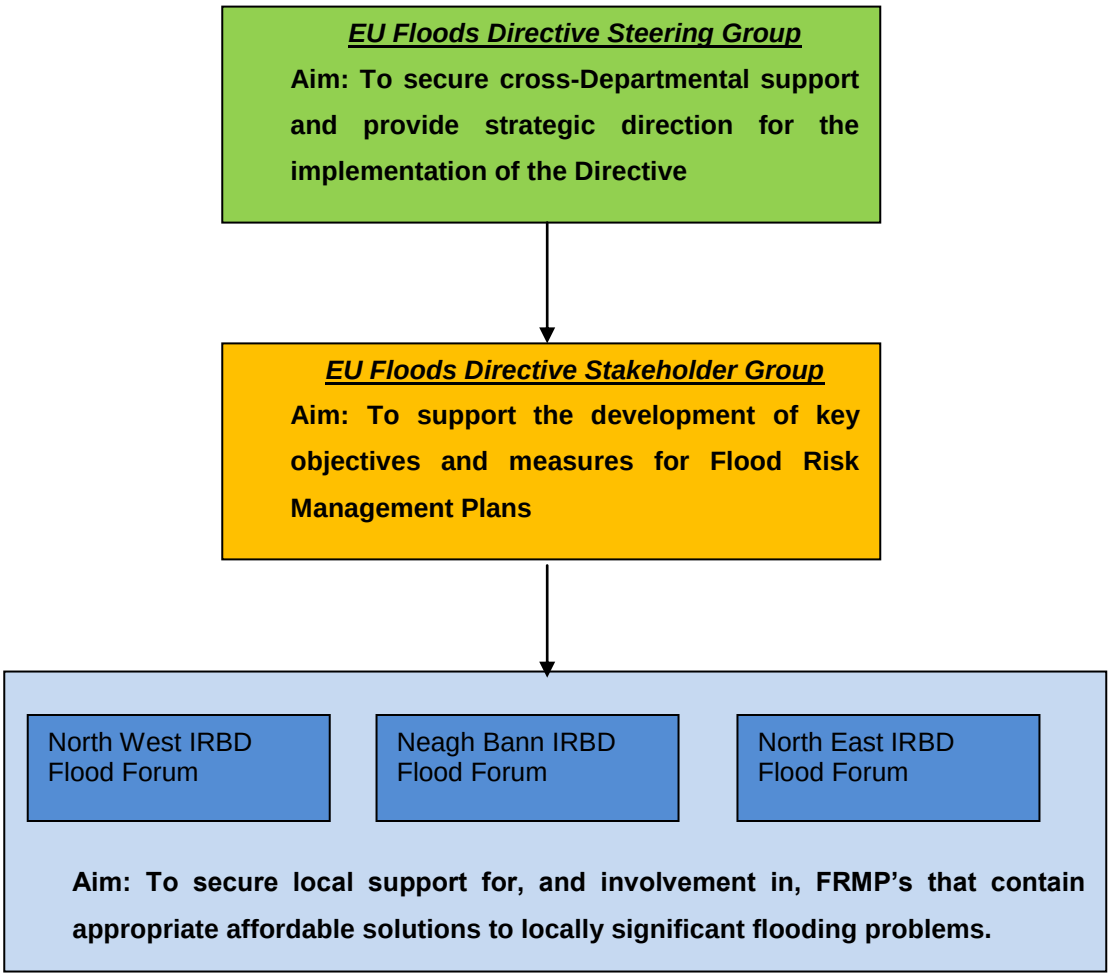
Flood Maps NI also take into account the predictive effects of climate change. This is based on a 2030 estimate. Flood maps inform the development of flood alleviation schemes, land use planning and emergency planning actions.

4.3 Coordination and Communication Activities

The Floods Directive encourages the active involvement of all interested parties in the production, reviewing and updating of the Flood Risk Management Plans. This includes making information available to the public at all stages of the process.

Throughout the preparation stages of the preliminary flood risk assessment, Flood maps and Flood Risk Management Plans, Rivers Agency as the competent authority set up the following governance structure:-

FLOODS DIRECTIVE CONSULTATION NETWORK



These groups normally meet once or twice a year.

The **Steering Group** comprises senior representatives from key Government stakeholders and ensures the successful implementation of the Directive by providing strategic direction and co-ordination across a number of Departments and Agencies.

The **Stakeholder Group** comprises Government representatives with responsibility for flood risk management, the environment, farming, fishing, insurance, planning and civil contingencies. This Group has the opportunity to ensure that issues, challenges and opportunities associated with flood risk management are identified and factored into the process to produce effective catchment-based flood risk management plans that will protect and enhance the environment.

Flood Forum Groups engage at the local River Basin level and interact with the public, local councils, local fishery and action groups, not only on flooding issues, but on the wider environmental issues of the Plans. This level of engagement provides a valuable source of information on many aspects of flooding and related issues of interest across the range of participants.

Key Infrastructure owners have also been engaged with, as has the Northern Ireland Environment Agency, given its role viz the Water Framework Directive. In addition, there is ongoing liaison with the Office of Public Works (OPW) in the Republic of Ireland, to ensure that mutual interests are facilitated in relation to the cross-border river basin districts of North West and Neagh Bann.

4.4 Flood Risk Management Organisations

The management of flood risk is the responsibility of a number of organisations, mainly DARD Rivers Agency, DRD, Transport NI, NI Water and Planning NI. Their roles and functions in relation to flood risk management are described below.

DARD, River Agency

The Department of Agriculture and Rural Development (DARD) is the statutory drainage and flood defence authority for Northern Ireland. The Department is also the competent authority in Northern Ireland for the implementation of the EU Floods Directive, which provides the legislative basis for the Agency's flood risk management role.

Under the terms of the Drainage (Northern Ireland) Order 1973, the Department has permissive powers to:

- Maintain watercourses and sea defences which have been designated by the Drainage Council for Northern Ireland.
- Construct and maintain drainage and sea defence structures.
- Administer advisory and enforcement procedures to protect the drainage function of all watercourses.
-

In addition to its role under the Drainage Order and EU Floods Directive, the Agency is also responsible for:

- Taking forward legislation on reservoirs safety;
- Maintaining flood defence and drainage infrastructure assets;
- Constructing new flood infrastructure to provide enhanced flood protection to people and property;
- Providing a flood emergency response service during flooding events;
- Fulfilling the role of Lead Government Department for the Co-ordination of Flooding Emergencies;

- Providing advice on flood risk;
- Providing advice to Planning NI on development plans and applications; and
- Providing advice to business, developers and the public on drainage and flood related issues.

Further information on Rivers Agency can be found on the NI Direct web site, Rivers and flooding.

DRD, NI Water

The Department for Regional Development (DRD) has responsibility for policy on water and sewerage services in Northern Ireland under the Water and Sewerage Services (NI) Order 2006.

Northern Ireland Water is a Government Owned Company, set up in April 2007 to provide the water and sewerage services in Northern Ireland. The company supplies 625 million litres of clean water a day and treats 134 million cubic metres of wastewater each year. The company also collects and treats surface water from domestic properties but does not have an absolute duty to provide effectual drainage. Also, its systems does not have to be designed to cope with exceptional weather events as the cost would be excessive. However it is responsible for flooding resulting from the failure of its infrastructure.

DRD, Transport NI

Transport NI is the sole Roads Authority in Northern Ireland. It has responsibility for over 25,000 km of public roads, together with 9,000 km of footpaths and a substantial number of bridges, street lights and public car parks.

Transport NI deals with the impacts of roads-related flooding. They maintain road drainage systems, organise road closures and traffic diversions, clear blockages during flooding and remove debris once the flood has receded. They will also take action to protect property that may be affected by road flooding.

Transport NI applies Sustainable Drainage Systems (SuDS) solutions to schemes costing in excess of than £1 million.

DOE, Planning NI

Planning NI is an agency of the Department of the Environment (DOE) and is the sole planning authority for Northern Ireland. The DOE has a statutory duty, through the Planning (Northern Ireland) Order 1991, to formulate and coordinate policy for securing the orderly and consistent development of land for development planning purposes. The DOE is required to ensure that such policy is consistent with the Regional Development Strategy for Northern Ireland, 2035

The DOE's Planning Policy Statements set out the policies on particular aspects of land use planning. PPS 15, "Planning and Flood Risk", sets out the planning policy to minimise and manage flood risk to people,

property and the environment. It adopts a precautionary approach to development and the use of land that takes account of climate change and emerging information relating to flood risk through the implementation of the EU Floods Directive.

Rivers Agency, through a Service Level Agreement provides advice to Planning NI on proposed development at flood risk at both the development plan and individual planning application stage.

Further information on Planning NI can be found on the website Planning NI.

Office of Public Works, Republic of Ireland

The Office of Public Works, (OPW), has 3 main business areas, Estate Portfolio Management, Heritage, and Flood Risk Management were it is the lead agency for flood risk management in the Republic of Ireland and is the competent authority for the implementation of the EU Floods Directive. Further information on the OPW can be found at the following website The Office of Public Works.

Local Government

Local Government assists with the management of flooding events, in cooperation with the statutory authorities. Emergency Planning Groups (EPGs) have recently been set up and these provide a forum to focus on flood emergency response action. In recent years, Local Government, through the auspices of the Emergency Planning Co-ordination offices (EPCOs), has played a key role in facilitating emergency response activities in relation to flooding. Councils also have a leading role in the 'recovery phase' after a flooding event has occurred. Local Government also administers a scheme of practical assistance to those affected by flooding.

4.5 Flood Risk Management Groups

A number of groups have been established in recent years to take forward various initiatives, both at strategic and operational level.

Flood Strategy Steering Group

The Flood Strategy Steering Group (FSSG), which normally meets quarterly, is a multi-agency Group, the role of which is to:-

- Develop strategies to improve flood response;
- Provide a steer to the Flood Working Groups linked to the Emergency Planning Groups (EPGs) which deal with issues at an operational level;

- Monitor and review the effectiveness of flood response during and following major events; and
- Ensure that there are effective communication channels and processes in place at strategic level among the flood response organizations.

Membership

The FSSG comprises membership from the following organisations:-

- Rivers Agency (Chair)
- Transport NI
- NI Water
- Department of Agriculture & Rural Development (DARD) Core
- Department of Regional Development (DRD) Core
- Local Government Emergency Management Group (LGEMG)
- Police Service Northern Ireland (PSNI)
- Northern Ireland Fire & Rescue Service

Multi-agency Civil Emergencies Preparedness Groups (EPGs)

Four additional multi-agency Civil Emergencies Preparedness Groups (EPGs) (North, South, East and West) have now been formally established alongside the existing Belfast Resilience Group.

Each EPG is responsible for:

- agreeing a joint approach to emergency preparedness and response and co-ordinate the multi-agency planning effort;
- conducting local risk assessments to provide a robust basis for planning;
- ensuring that relevant multi-agency plans, procedures, training and exercising are in place to address all local area risks; and
- addressing the implications of regional initiatives and the work/ decisions of the Civil Contingencies Group (NI) for the local area.

Flood Investment and Planning Group

This Group was established in the aftermath of the severe flooding which occurred in June 2012. It comprises membership from DRD, Water Policy, NI Water, Transport NI and DARD, Rivers Agency. Its purpose is to provide a co-ordinated approach to the investigation of flooding, agree responsibility and funding, propose potential solutions, prioritise investment and ensure joint responses including making the case for investment.

Strategic Drainage Infrastructure Programme Board

This Group has been established recently. It is let by DRD and comprises representation from across Central Government, and Belfast City Council. Its purpose is to develop a Strategic Drainage Infrastructure Plan, for consideration by the Executive, to support economic growth, protect the environment and address flood risk.

Stormwater Management Group

This Group was established in 2011 to facilitate implementation of the Northern Ireland Environment Agency's strategy for the promotion of the use of Sustainable Drainage Systems (SuDS) within Northern Ireland. The Group has cross-Departmental commitment, with representation from DOE, Water Management Unit, DRD, Water Policy Division and DARD, Rivers Agency, amongst others. The fundamental aim of the Group is to develop a more integrated and catchment based approach to stormwater management in reducing flood risk.

Section 5

Neagh Bann River Basin District

Flood Risk Management Plan

5.1 River Basin Overview

This Flood Risk Management Plan is based on the ***Neagh Bann River Basin District (RBD)***. The Neagh-Bann International River Basin District lies in the centre of Northern Ireland and includes Lough Neagh, the largest lake in Ireland, and the Bann River, which runs into and out of Lough Neagh. The Neagh Bann RBD has total area of 8,085 km² including the marine elements. It drains parts of counties Louth, Meath, Cavan, Monaghan, Armagh, Tyrone, Derry / Londonderry, Antrim and Down. (See Figure 5.1 below)

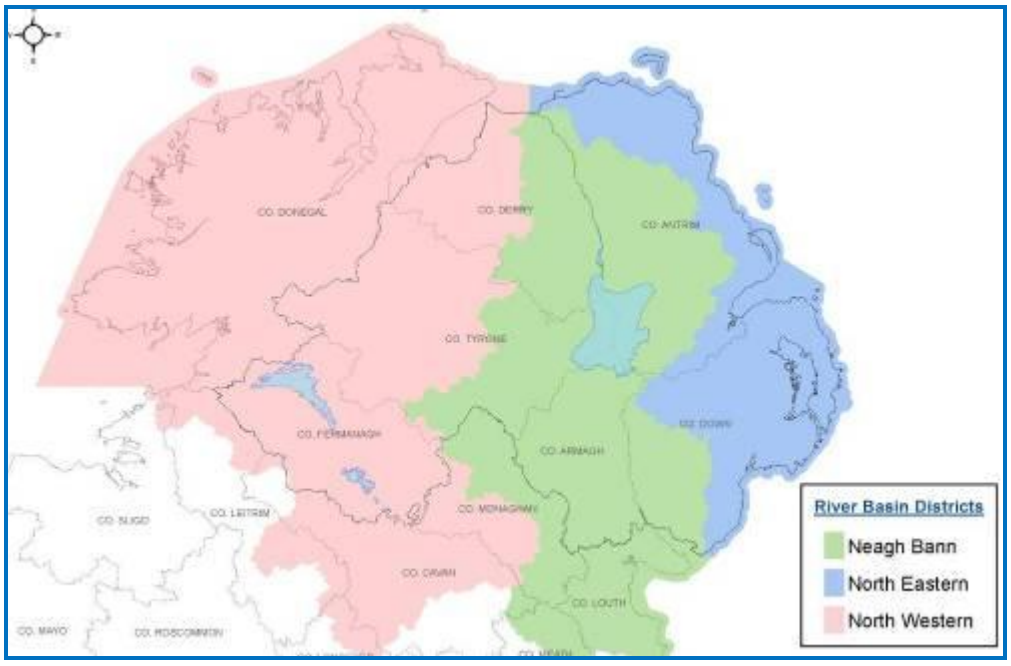


Figure 5.1 – Neagh Bann River Basin District (Green)

5.2 Areas of Significant Flood Risk

Following the Preliminary Flood Risk Assessment (PFRA) in 2009, twenty areas of potential significant flood risk were identified within Northern Ireland. Nine of the Significant Flood Risk Areas (SFRA) are located in the Neagh Bann River Basin District and named as follows:

- Lurgan
- Antrim
- Ballymena
- Newry
- Banbridge
- Portadown
- Glengormley and Mallusk
- Warrenpoint
- Coleraine

5.3 Lurgan SFRA – Lough Neagh

The core boundary of the Lurgan SFRA, which has been determined through the PFRA, is located within the Lough Neagh Local Management Area and illustrated in Figure 5.3 below.

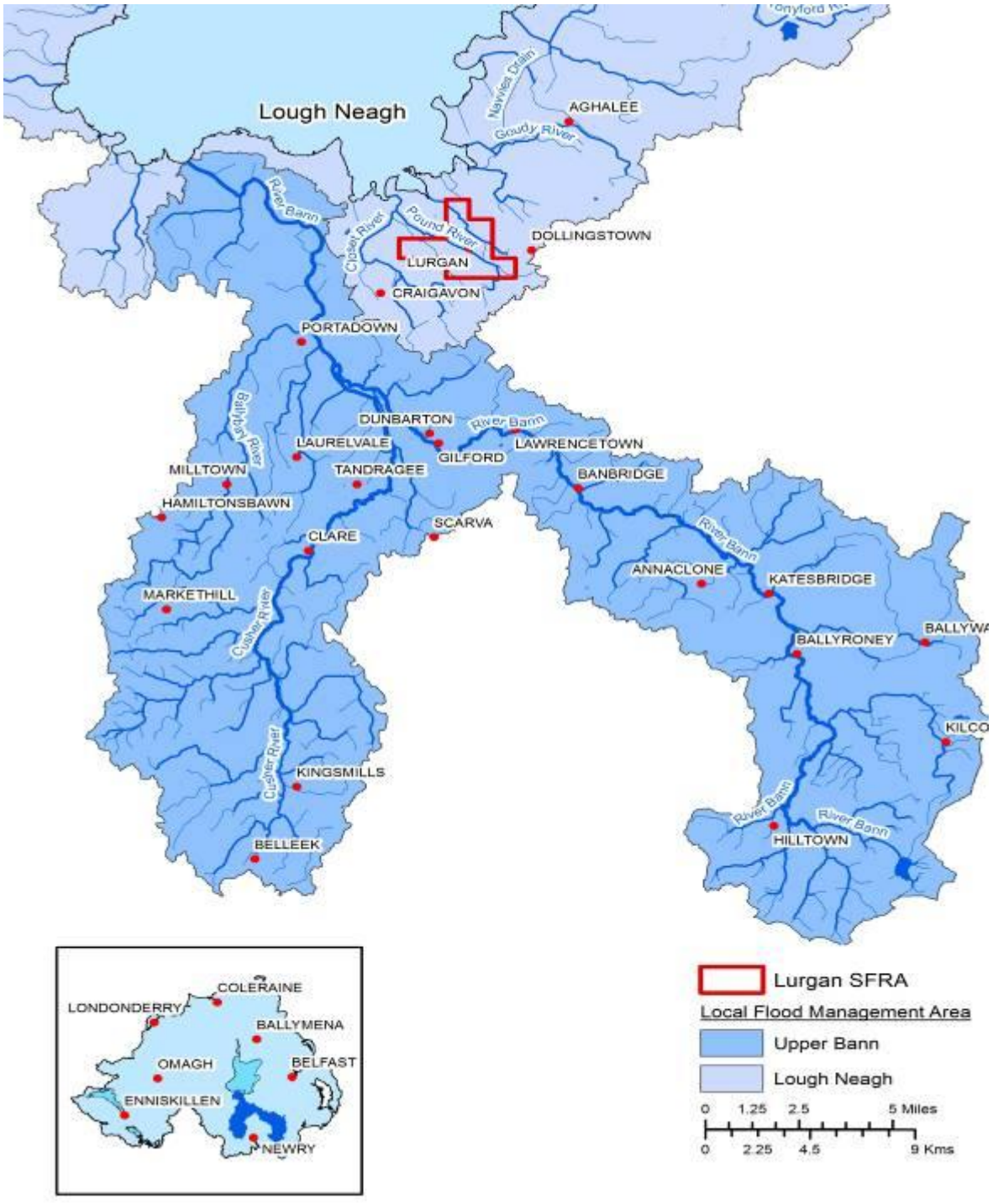


Figure 5.3 - Neagh Bann LFMA and Lurgan SFRA

5.3.1 Flooding History

A review of the entire available flood data, including the local and regional newspapers, would suggest that Lurgan is not prone to frequent flooding. It has not been possible to identify any major flood events prior to 2008. However, Rivers Agency records show there is a small number of areas in Lurgan which have flooded in the past. These areas include:

- Shane Park (Aug 2008)
- Knockramer Meadows (Aug 2008)
- Melrose Grove (Aug 2008)

Photo 5.3.1.1 - Halfpenny River in flood August 2008 at the Knockramer Meadows Development

After the flooding on 16th August 2008, which affected a number of locations in Lurgan, Rivers Agency carried out a post flood investigation to determine the flooding source.

One of the outcomes of this investigation to alleviate flooding in Lurgan was to replace the accommodation bridge located downstream of the Knockramer Meadows Development on the Halfpenny River. The existing bridge was found to be undersized and causing a restriction to the flow in a flood event.
Rivers Agency replaced the existing accommodation bridge on the Halfpenny River with a 2.8m x 1.5m precast concrete box culvert in 2010 at a cost of £48,000. (See Photo 5.3.1.2)

Photo 5.3.1.2 - Rivers Agency upgraded accommodation bridge on the Halfpenny River downstream of the Knockramer Meadows Development.

From the post flood investigation it was clear that there was also a problem with an accommodation bridge in the Shanes Park area of Lurgan on the Tirsogue Drain. The investigation found the existing accommodation bridge to be under capacity and required upgrading to a sufficient size.

The new scheme involved the construction of a new 2m X 1.5m precast concrete box culvert (See Photo 5.3.1.3) to replace an existing inadequate 1350mm diameter culvert which was prone to blockage. The scheme was developed to alleviate flood risk to 24 houses that had flooded in the past in the Shanes Park area of Lurgan. The scheme was appraised, designed and supervised by Rivers Agency engineering staff, and constructed by the Rivers Agency Direct Labour. The works were carried out at a cost of £43,000.

Photo 5.3.1.3 - Rivers Agency upgraded accommodation bridge on the Tirsogue Drain in Shanes Park, Lurgan

5.3.2 PRFA - Identification of Potentially Significant Flood Sources

According to the Preliminary Flood Risk Assessment (Dec 2011) the town of Lurgan, in terms of the potential adverse consequences of flooding, is ranked 17th of the twenty SFRA within Northern Ireland (see Figure 4.1). On the basis of this initial assessment, which was undertaken using the strategic flood maps, the predominant flood risk to the town was considered to arise from fluvial flooding.

It should be noted that the PFRA flagged up the potential for significant fluvial flooding at Lurgan because this national assessment is based on strategic 'undefended' flood models which ignore the presence of

existing flood defence systems. Therefore, the assessment is in effect based on the worst case scenario, as it assumes there is no benefit from the defences. This precautionary approach has been taken because at the time of the assessment there was a degree of uncertainty about the level of protection that each of the existing flood defence systems provides. By adopting this approach, the urban areas that are located behind existing flood defence structures were determined to be SFRA by default and as a consequence detailed Flood Hazard/Risk Maps had to be prepared in compliance with the requirements of the EU Floods Directive. This provided the opportunity to undertake the detailed structural assessments and flood modelling necessary to remove the uncertainty and establish the actual level of protection offered by these defences.

To facilitate a more robust assessment of the level of flood risk to Lurgan from fluvial flooding, Rivers Agency developed detailed predictive flood models for each of these sources. It is considered that the flood hazard maps produced from these models will give a more accurate prediction of the flooded areas which may have been over or under estimated by the strategic flood maps. Details of the models and their output are described in the following sections.

5.3.3 Catchment Description

Information not available for the draft Flood Risk Management Plan but will be included in the final Flood Risk Management Plan.

5.3.4 Fluvial Flood Risk Assessment

Flood Model

The Lurgan flood model was constructed using InfoWorks RS 1D/ 2D (Version 13) and InfoWorks ICM 1D/ 2D (Version 3.5) modelling software. InfoWorks RS is an integrated hydrological and hydraulic modelling package developed by Innovyze. It includes full solution modelling of open channels, floodplains, embankments and hydraulic structures. InfoWorks ICM (Integrated Catchment Modelling) is an integrated modelling platform which incorporates both urban and river catchments. It provides the ability to model the complete drainage system, both natural and engineered, above and below-ground drainage systems including sewers, surface water, river and floodplains.

Fluvial Flooding Mechanisms

Clanrolla Tributary

Figure 5.3.4.1 illustrates the predicted extents of the potential fluvial flooding from the Clanrolla Tributary in Lurgan and details of the impact of the flooding on property and key infrastructure is summarised in Table 5.3.4.1.

The model shows that at the relatively high frequency 10% AEP (Q10) flood event, floodwater is predicted to spill from the culverted Clanrolla Tributary watercourse within the Westwood Development and that the resulting surface water flow will pond to shallow depths up to 300mm in the low lying areas of the development. It is estimated that **76** residential properties could be internally flooded at this event at a cost of around **£414,000**.

At the more extreme 1% AEP (Q100) event the predicted flooding is generally confined to the same locations although the flood inundation areas are more extensive and deeper (up to 1m deep) particularly in the vicinity of the Westwood Development. Flooding from the 1% AEP (Q100) event is estimated to affect **130** residential properties and **1** non residential property at a cost of around **£1,188,000**.

The present value of the total property damages from potential future floods is calculated to be in excess of **£3.8 million.**

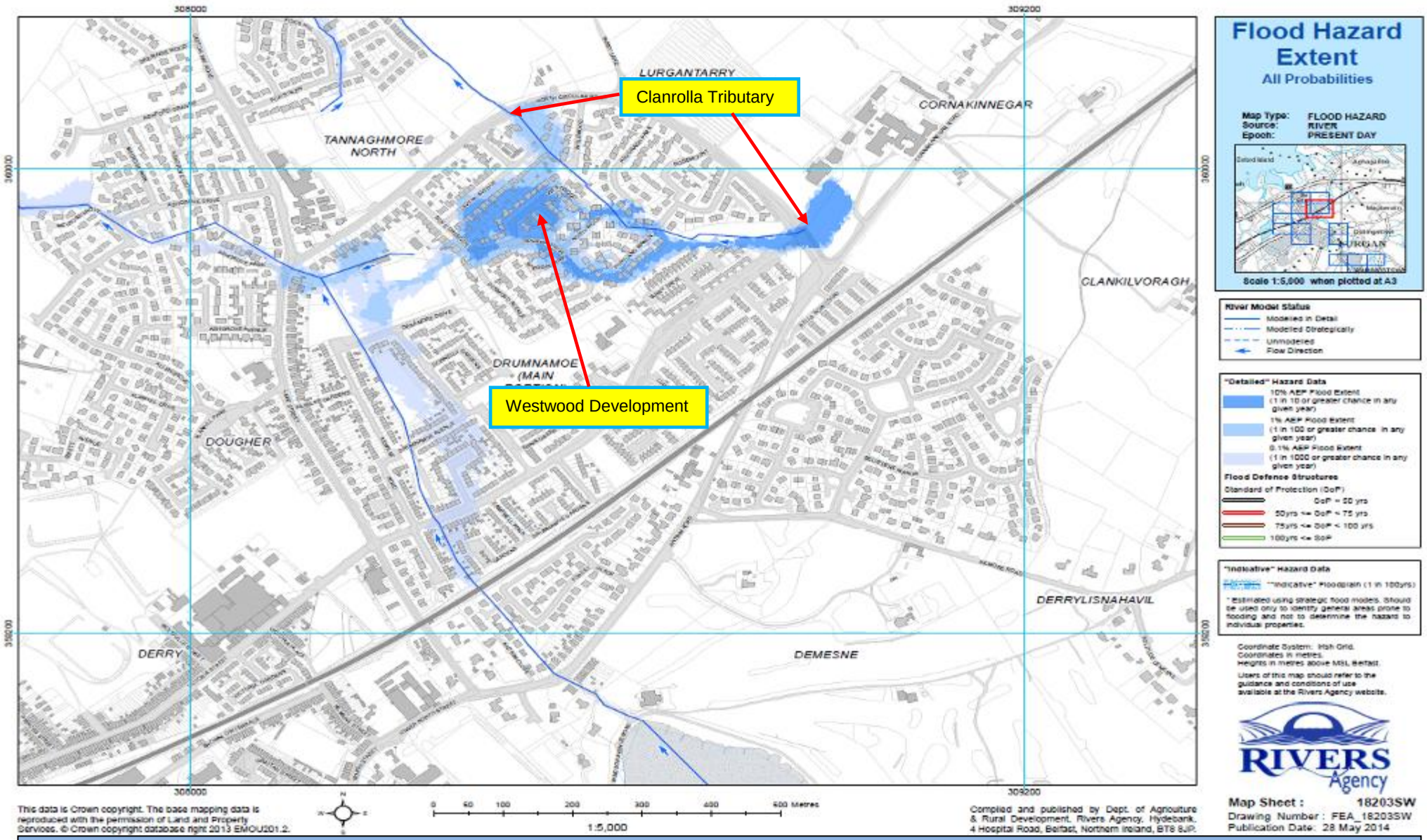


Figure 5.3.4.1 - Flood extent map for Clanrolla Tributary in Lurgan

Table 5.3.4.1 - Lurgan SFRA – Clanrolla Tributary			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	**76**	**90**	**130**
Non Residential (Nr)	**0**	**0**	**1**
Economic Damage (£)	**£414,572**	**£824,513**	**£1,188,274**
Annual Average Damage (£)	**£126,725**		
Present Value (£)	**£3,801,750**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)			
Care Homes	**0**	**0**	**0**
GP Surgery's	**0**	**0**	**0**
Fire stations	**0**	**0**	**0**
Hospitals	**0**	**0**	**0**
Police Stations	**0**	**0**	**0**
Schools	**0**	**0**	**0**
Key Infrastructure (Nr)			
NIW Wastewater Treatment Works	**0**	**0**	**0**
NIW Sewage Pumping Stations	**0**	**0**	**0**
NIW Water Treatment Work	**0**	**0**	**0**
NIW Treated Water Pumping Stations	**0**	**0**	**0**
NIE Substation 6to11kV	**0**	**0**	**0**
NIE Substation 33kV	**0**	**0**	**0**
NIE Substation 275kV	**0**	**0**	**0**
NIE Substation 110kV	**0**	**0**	**0**
Road Service - Trunk Road	**0**	**0**	**0**
Environmental Designated sites (Nr)			
AONB	**0**	**0**	**0**
ASSI	**0**	**0**	**0**
Environmentally Sensitive Areas	**0**	**0**	**0**
Maritime Nature Reserve	**0**	**0**	**0**
Nature Reserve	**0**	**0**	**0**
RAMSAR	**0**	**0**	**0**
SAC	**0**	**0**	**0**
Sites of Local Nature Conservation Importance	**0**	**0**	**0**
SPA	**0**	**0**	**0**
RSPB Reserve	**0**	**0**	**0**
UWT Nature Reserve	**0**	**0**	**0**
Built Heritage sites (Nr)			
National Trust	**0**	**0**	**0**
Listed Buildings	**0**	**0**	**0**
Sites and Monuments Records	**0**	**0**	**0**
Buildings of Special Architectural or Historical Interest	**0**	**0**	**0**
Areas of Significant Archaeological Interest	**0**	**0**	**0**
Historic Gardens	**0**	**0**	**0**

Halfpenny River

Figure 5.3.4.2 illustrates the predicted extents of the potential fluvial flooding from the Halfpenny River in Lurgan and details of the impact of the flooding on property and key infrastructure is summarised in Table 5.3.4.2.

The model shows that at the relatively high frequency 10% AEP (Q10) flood event, floodwater is predicted to spill from the culverted watercourse known as Halfpenny River within the Knockramer Development and that the resulting surface water flow will pond to shallow depths up to 300mm in the low lying areas most notably at Knockramer Meadows. It is estimated that **13** residential properties could be internally flooded at this event causing damages in excess of **£172,000**.

At the more extreme 1% AEP (Q100) event the predicted flooding is generally confined to the same locations, although the flood inundation areas are more extensive and deeper (up to 1m deep) particularly in the vicinity of the Knockramer Meadows. Flooding from the 1% AEP (Q100) event is estimated to affect **30** residential properties at a cost of around **£448,000**.

The present value of the total property damages from potential future floods is calculated to be in excess of **£3.1 million.**

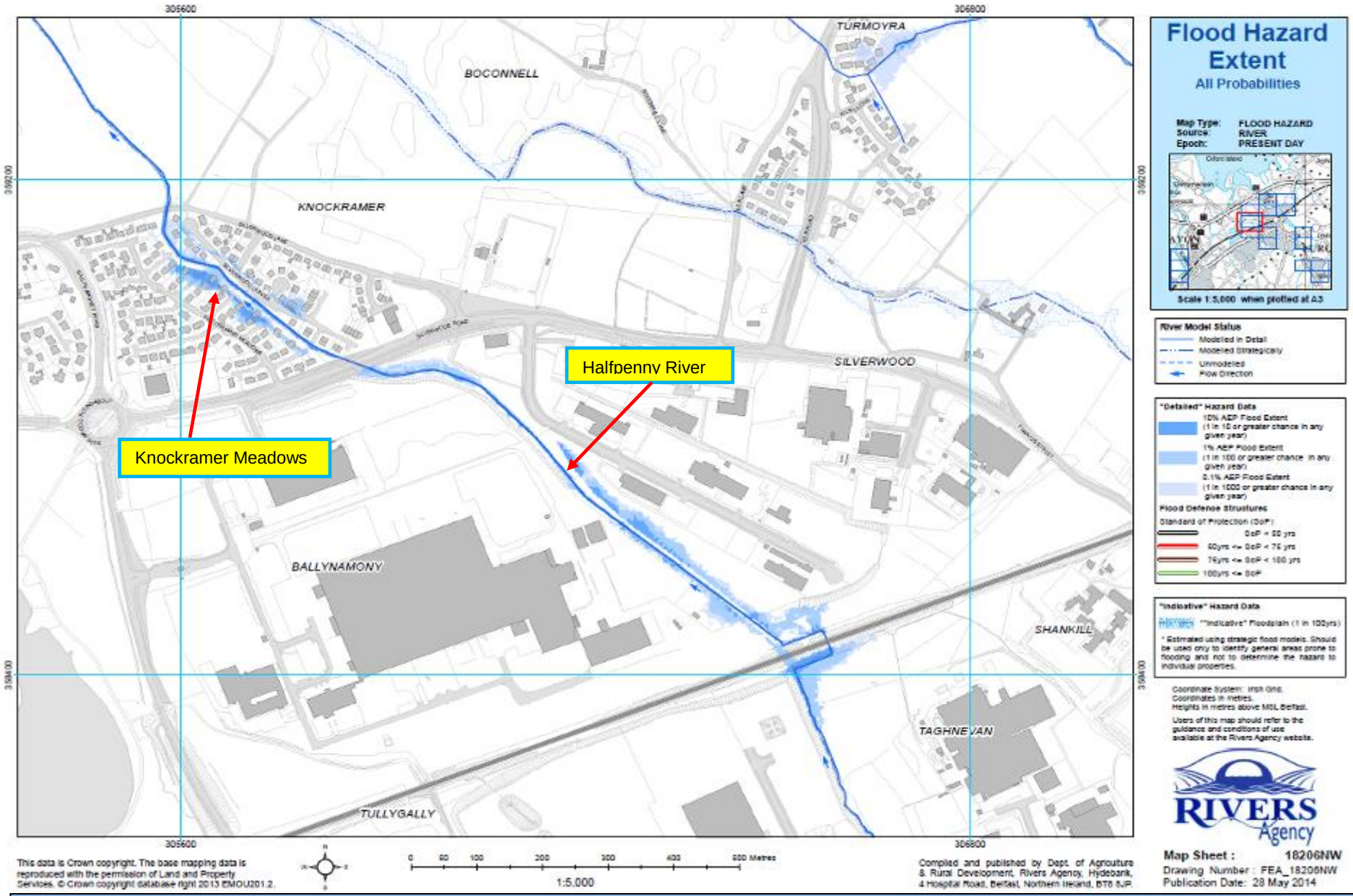


Figure 5.3.4.2 - Flood extent map for Halfpenny River in Lurgan

Table 5.3.4.2 - Lurgan SFRA – Halfpenny River			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	**13**	**15**	**30**
Non Residential (Nr)	**0**	**0**	**0**
Economic Damage (£)	**£172,440**	**£218,517**	**£448,873**
Annual Average Damage (£)	**£103,459**		
Present Value (£)	**£3,103,770**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)			
Care Homes	**0**	**0**	**0**
GP Surgery's	**0**	**0**	**0**
Fire stations	**0**	**0**	**0**
Hospitals	**0**	**0**	**0**
Police Stations	**0**	**0**	**0**
Schools	**0**	**0**	**0**
Key Infrastructure (Nr)			
NIW Wastewater Treatment Works	**0**	**0**	**0**
NIW Sewage Pumping Stations	**0**	**0**	**0**
NIW Water Treatment Work	**0**	**0**	**0**
NIW Treated Water Pumping Stations	**0**	**0**	**0**
NIE Substation 6to11kV	**0**	**0**	**0**
NIE Substation 33kV	**0**	**0**	**0**
NIE Substation 275kV	**0**	**0**	**0**
NIE Substation 110kV	**0**	**0**	**0**
Road Service - Trunk Road	**0**	**0**	**0**
Environmental Designated sites (Nr)			
AONB	**0**	**0**	**0**
ASSI	**0**	**0**	**0**
Environmentally Sensitive Areas	**0**	**0**	**0**
Maritime Nature Reserve	**0**	**0**	**0**
Nature Reserve	**0**	**0**	**0**
RAMSAR	**0**	**0**	**0**
SAC	**0**	**0**	**0**
Sites of Local Nature Conservation Importance	**0**	**0**	**0**
SPA	**0**	**0**	**0**
RSPB Reserve	**0**	**0**	**0**
UWT Nature Reserve	**0**	**0**	**0**
Built Heritage sites (Nr)			
National Trust	**0**	**0**	**0**
Listed Buildings	**0**	**0**	**0**
Sites and Monuments Records	**0**	**0**	**0**
Areas of Significant Archaeological Interest	**0**	**0**	**0**
Historic Gardens	**0**	**0**	**0**
	0	**0**	**0**

Tirsogue Drain/Tirsogue Drain Tributary

Figure 5.3.4.3 illustrates the predicted extents of the potential fluvial flooding from the Tirsogue Drain Tributary in Lurgan and details of the impact of the flooding on property and key infrastructure is summarised in Table 5.3.4.3.

The model shows that at the relatively high frequency 10% AEP (Q10) flood event, floodwater is predicted to spill from the open watercourse known as the Tirsogue Drain Tributary in the Bowens Meadows Development and that the resulting flood water ponds to a depth of up to 300mm in the low lying areas of the development. It is estimated that **4** residential properties could be internally flooded at this event causing damages in excess of **£1,217**.

At the more extreme 1% AEP (Q100) event the predicted flooding is generally confined to the same location in Bowens Meadows and in Glenshane Drive. Although the flood inundation areas are more extensive and deeper (up to 1m deep), particularly in the vicinity of the Bowens Meadows Development. Flooding from the 1% AEP (Q100) event is estimated to affect **10** residential properties at a cost of around **£21,351.**

The present value of the total property damages from potential future floods is calculated to be in excess of **£30,000.**

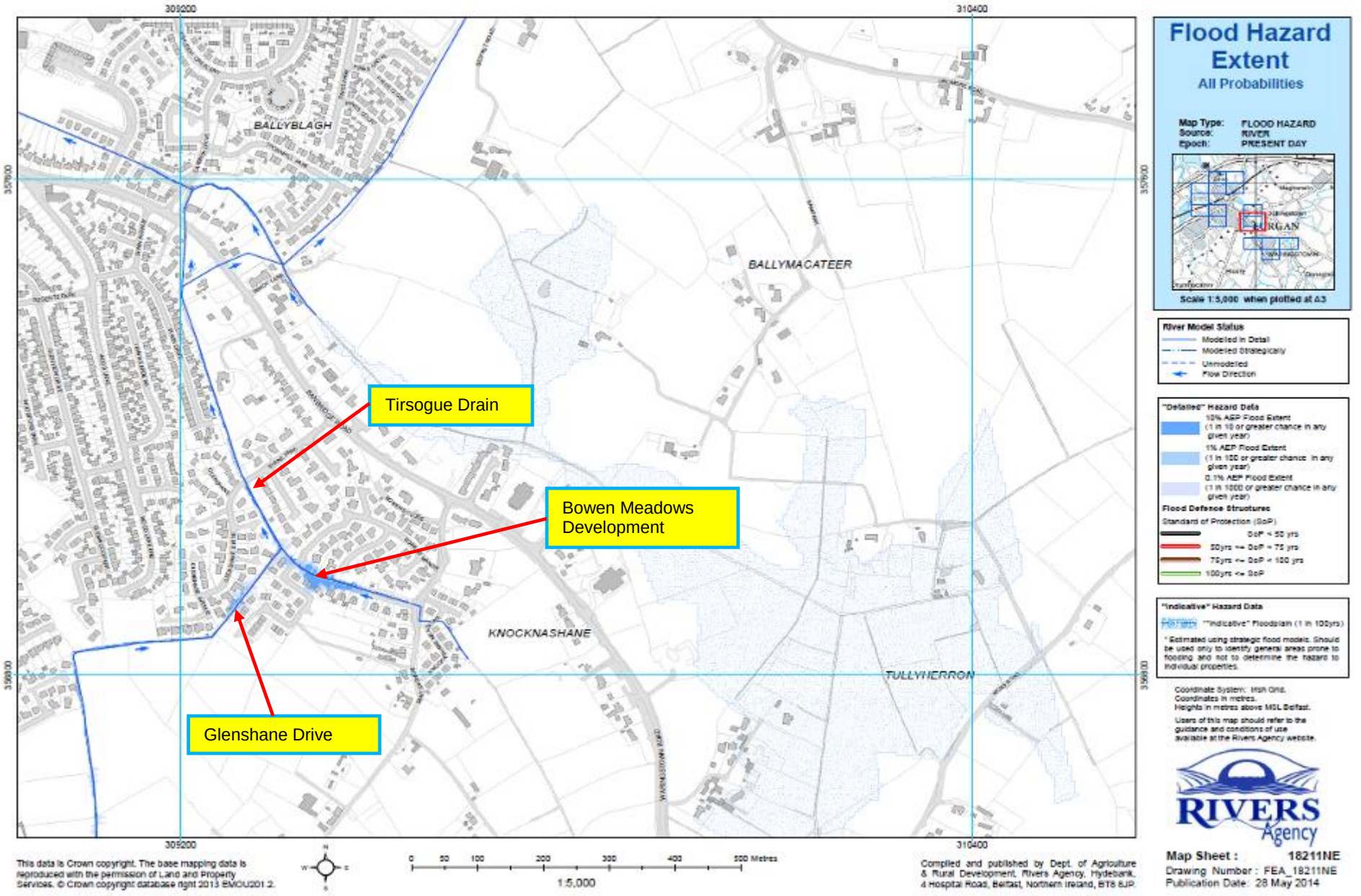


Figure 5.3.4.3 - Flood extent map for Tirsogue Drain/Tirsogue Drain Tributary in Lurgan

Table 5.3.4.3 - Lurgan SFRA – Tirsogue Drain			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	**4**	**7**	**10**
Non Residential (Nr)	**0**	**0**	**0**
Economic Damage (£)	**£1,217**	**£3,172**	**£21,351**
Annual Average Damage (£)	**£994**		
Present Value (£)	**£29,820**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)			
Care Homes	**0**	**0**	**0**
GP Surgery's	**0**	**0**	**0**
Fire stations	**0**	**0**	**0**
Hospitals	**0**	**0**	**0**
Police Stations	**0**	**0**	**0**
Schools	**0**	**0**	**0**
Key Infrastructure (Nr)			
NIW Wastewater Treatment Works	**0**	**0**	**0**
NIW Sewage Pumping Stations	**0**	**0**	**0**
NIW Water Treatment Work	**0**	**0**	**0**
NIW Treated Water Pumping Stations	**0**	**0**	**0**
NIE Substation 6to11kV	**0**	**0**	**0**
NIE Substation 33kV	**0**	**0**	**0**
NIE Substation 275kV	**0**	**0**	**0**
NIE Substation 110kV	**0**	**0**	**0**
Road Service - Trunk Road	**0**	**0**	**0**
Environmental Designated sites (Nr)			
AONB	**0**	**0**	**0**
ASSI	**0**	**0**	**0**
Environmentally Sensitive Areas	**0**	**0**	**0**
Maritime Nature Reserve	**0**	**0**	**0**
Nature Reserve	**0**	**0**	**0**
RAMSAR	**0**	**0**	**0**
SAC	**0**	**0**	**0**
Sites of Local Nature Conservation Importance	**0**	**0**	**0**
SPA	**0**	**0**	**0**
RSPB Reserve	**0**	**0**	**0**
UWT Nature Reserve	**0**	**0**	**0**
Built Heritage sites (Nr)			
National Trust	**0**	**0**	**0**
Listed Buildings	**0**	**0**	**0**
Sites and Monuments Records	**0**	**0**	**0**
Buildings of Special Architectural or Historical Interest	**0**	**0**	**0**
Areas of Significant Archaeological Interest	**0**	**0**	**0**
Historic Gardens	**0**	**0**	**0**

5.3.5 Proposed Fluvial Flood Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Lurgan it is important that the flood risk is not increased by new development in areas of known flood risk. Planning Policy Statement, PPS 15, "Planning and Flood Risk", adopts a precautionary approach to development with the primary aim "to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere".

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the "Exception" rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to "Greenfield" built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new Development Plans for Lurgan, Rivers Agency will advise against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 100 year fluvial floodplain or is susceptible elsewhere to surface water flooding.

Rivers Agency will also review the existing Development Plan for Lurgan (Craigavon Area Plan) with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

The main (undeveloped) flooded areas within the Lurgan area are:

- The playing fields north of Deramore Drive
- The south east corner of St Michaels Grammar School

Planning Applications

Fluvial Areas at risk

Rivers Agency will advise against the development of all sites that are located within the 1 in 100 year fluvial floodplain, irrespective of whether they are located within the current plan or as a single site application outside the plan area.

For those sites within the 1 in 100 year fluvial floodplain where the principle of development has been accepted by Planning NI as meeting the "Exception Test", Rivers Agency will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The main existing developed areas, amongst others, at flood risk within Lurgan where re-development may be likely to take place are:

- The area south of the North Circular Road
- The Knockramer Development
- Bowen Meadows Development

Areas at risk of surface water flooding

For those sites outside the 1 in 100 year fluvial floodplain that are located in an area where there is evidence of a historic surface water flooding Rivers Agency will further consider the application through the appraisal of the accompanying Drainage Assessment that will need to demonstrate suitable flood mitigation measures.

Where there is potential for surface water flooding as indicated in the purple predicted areas on the surface water maps, Rivers Agency will advise that the applicant should assess the flood risk and drainage impact to the site himself and construct in the appropriate manner.

Areas at risk of flood inundation from reservoirs

For all development proposals that are located within the potential flood inundation area of a controlled reservoir we will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures. If it is a new development proposal Rivers Agency will also need the applicant to demonstrate that the condition, management and maintenance regime of the reservoir is appropriate to provide sufficient assurance regarding reservoir safety.

Controlled reservoirs identified in the Lurgan area are as follows:

- The Park Lake

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is, therefore, important that we continue to target investment by providing flood defence, culvert alleviation schemes and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. The **Flood Investment and Planning Group, (FIPG)**, provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a “Flood Risk Metric Tool” (FRISM) is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total “damage avoidance benefits” that the scheme will provide to the property over the scheme’s design life. If the benefit/cost ratio is greater than 1 (Net Present Value, NPV, figure is positive) then the potential scheme will be referred to Rivers Agency’s Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely Rivers Agency’s responsibility, or is the responsibility of NI Water or Transport NI such as a local drainage or road infrastructure issue it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a benefit cost analysis identifies a viable scheme, a scheme will be placed on a prioritisation list for works with other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Within the Lurgan area the following potential schemes have been identified and will be referred to the appropriate bodies for further investigation or detailed feasibility study.

List of possible schemes in Lurgan SFRA.

Westwood Development, Clanrolla River

- Fluvial flooding from the Clanrolla River
- Flood damage avoidance figure of £3.8 million

Knockramer Development, Halfpenny River

- Fluvial flooding from the Halfpenny River
- Flood damage avoidance figure of £3.1 million

Bowens Meadows Development, Tirsogue Drain

- Fluvial flooding from the Tirsogue Drain
- Flood damage avoidance figure of £30k

Preparedness

In Lurgan it is not possible to prevent or protect against all flooding. Indeed even where flood defences exist it is possible in an extreme event that these could be over topped and flooding could still occur.

Having recognised this fact, considerable effort in recent years has been made by emergency planners in Government Departments, Councils and the Emergency Services working together and sharing information to ensure a coordinated response.

However, despite these improvements during significant flood events the emergency response of Government Departments and the Emergency Services can become over stretched. This means that not all calls for assistance during a flood event may be responded to in a timely manner. With this in mind it is important that households and communities, subject to a known flood risk, are prepared. The detail of preparedness actions, including flood warning and informing activities planned from a regional perspective, are provided in Annex E.

This is not Government withdrawing from any undertaking to respond in emergencies but an additional layer of support to ensure Government Departments and the public work together to reduce the overall impacts of flooding.

From the flood risk assessment there are certain areas of Lurgan which are subject to flood risk and may have flooded before. Therefore, they may benefit from the flood warning and informing proposals outlined in Annex D.

A pilot project of community engagement to deliver flood warning and informing, held in 2014, identified basic assessment formulae to assess and score areas that could potentially be a focus for flood warning and informing actions. Based on this scoring the following areas could be considered suitable for being included in a programme of community engagement to deliver flood warning and informing initiatives:

- Westwood / Sperrin Drive area.
- Knockramer Meadows / Silverwood Leaves area.

Key activities that could be undertaken are:

- Explaining the potential and limitations of Community Resilience
- Briefing communities on information available, particularly from the Met Office
- The facilitation of self-help initiatives, including remote sandbag storage; and
- Reviewing and validating all elements of the Community Engagement Plan to help the community communicate effectively in an emergency and work together.

A table in Annex J shows how this community ranks in the overall context of the 20 SFRAs in this Plan. It should be noted that this is an indicative assessment which may change subject to further information on flood risk becoming available.

The rollout of this work is dependent on funding being available.

5.4 Antrim SFRA – Sixmilewater

The core boundary of the Antrim SFRA, which has been determined through the PFRA, is located within the Sixmilewater Local Management Area and illustrated in Figure 5.4 below.

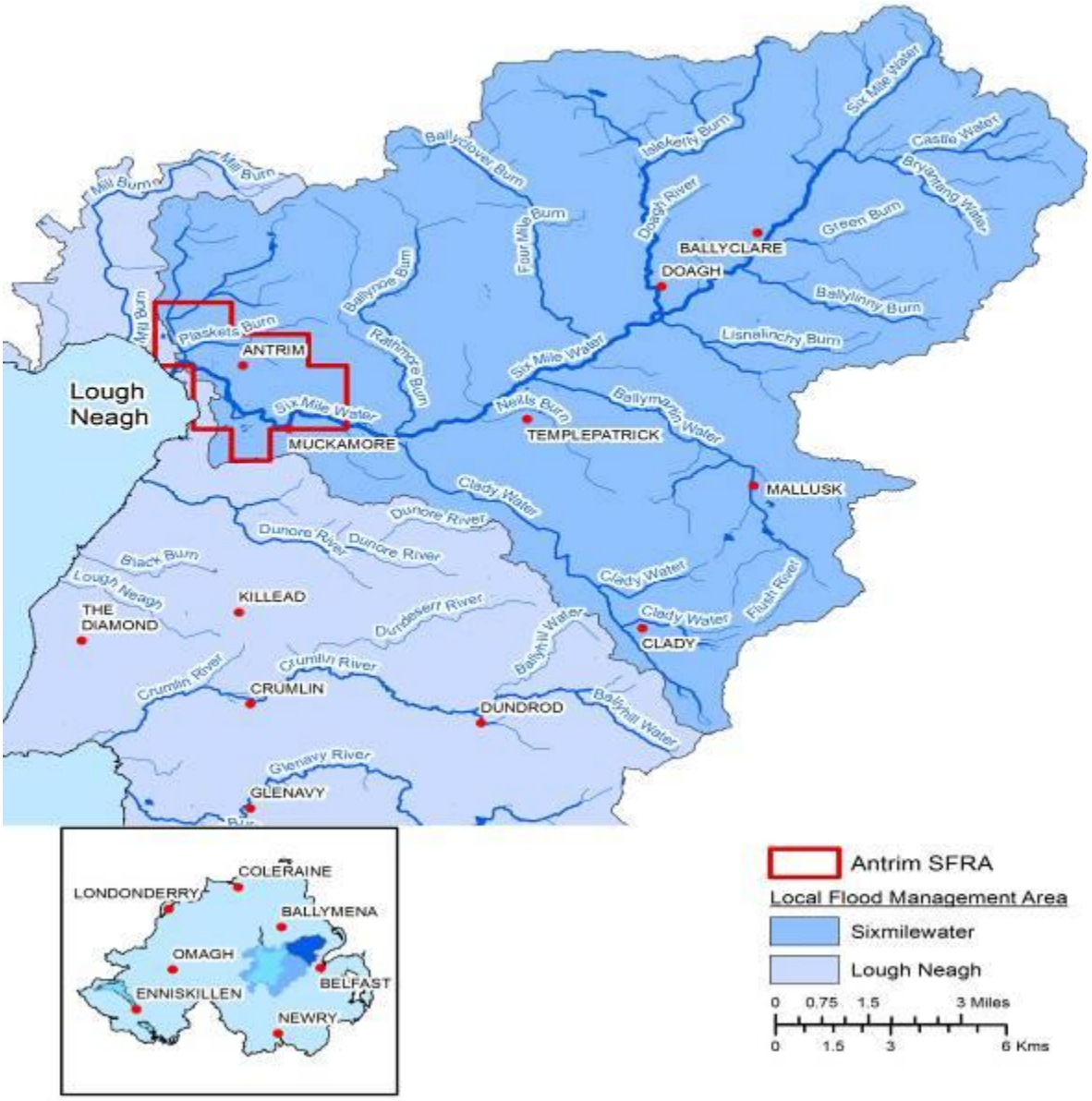


Figure 5.4 – Sixmilewater LFMA and Antrim SFRA

5.4.1 Flooding history

A search of flood records in the Antrim area has revealed very limited information on historic flooding along the Sixmilewater either in Antrim or elsewhere, with only very brief accounts for 1890 and 1949. There are two possible reasons for the lack of reporting:

1. **Properties flooded in 2008 event were built after the historic flood events.** Many of the properties flooded in 2008 were recently built. This includes properties at Greenmill in Muckamore and Riverside in Antrim. However, many affected properties in Antrim are more than 100 years old and most houses at Abbeyview Muckamore date from late nineteenth or early twentieth century.
   A flood of the magnitude of that in 2008 would have affected fewer properties had it occurred in 1968, 1952 or 1949. However, in these years and even in the nineteenth century, a sufficient number of properties would have been affected which one might have expected to have attracted regional journalistic attention.

2. **Flooding has occurred but not been reported.** Historic flood reporting is limited by the absence of a local newspaper until the 1970s. It is known that some flooding has occurred in Muckamore in the past which has not been reported in regional or local news papers based outside Antrim. A respondent resident in Abbeyview Muckamore indicated that a small number of houses, which were also flooded in 2008, had been affected by another flood in 1987.

It is, therefore concluded that the August 2008 flood in Antrim is not only the greatest in the river gauged record from 1971 but very likely is the greatest in the historic period reviewed from 1883.

Since the introduction of the flooding hardship payment scheme in 2007 there have been 152 payments issued to homeowners in the Antrim SFRA. The majority of these payments (129) relate to the extreme flooding on 16th August 2008 which affected large parts of the central and to a lesser extent, eastern parts of the province. Most of the flooding which occurred on that day was estimated to have a return period in excess of the 1%AEP (Q100) event. The properties affected during this particular event where mainly clustered in the vicinity of Meadowside, Riverside and Muckamore.

Photo 5.4.1.1 – Flooding at the entrance to Abbeyview 16th August 2008.

Photo 5.4.1.2 – Flooding at Greenmill, Muckamore 16th August 2008

Existing Flood Defences

Muckamore

The defence is located on the left bank of the river and has a total length of 800m between Alexandra Park and Abbeyview. The flood defence consists of a sheet pile wall with a concrete capping beam and short sections of reinforced concrete wall at the intersection with bridge the abutments. This defence was designed by Gault Cambers Bullen now (AECOM) and was constructed in November 2000. The flood defence was designed to provide a 1:100 year standard of protection, for which the flow estimate was 168.8m³/s. A previous level survey completed on the top of the flood defence was found to vary between 30.08 and 31.55m AOD.

Meadowside

The area of Meadowside is protected by a flood defence consisting of a 43m section of reinforced concrete wall and a 200m section of clay cored embankment. Design drawings indicate that the levels of the defences are:

- Flood Wall – 19.50m AOD
- Flood Embankment – 20.00m AOD

From the topographic survey completed as part of Meadowside Post Flood Review it was found that the defence height varied as follows:

- Flood Wall – 19.45 to 19.54m AOD
- Flood Embankment – 19.14 to 19.64m AOD

Following the flood event in August 2008, which almost over topped the defence in Meadowside, a decision was made by Rivers Agency to raise certain sections of the flood embankment, which had subsided over a period of time, to its original design level. Interim works to the flood wall where also carried out at the same time. These works consisted of increasing the level of the flood wall by adding concrete to the upstand.

Antrim, Riverside

A number of residential and commercial properties are protected in this area by a 100m long hard concrete retaining wall on the right bank approximately 120m downstream of the Belmont Road Bridge. As part of the Riverside and Massereene Street post August 2008 Flood Investigation by Rivers Agency, a comprehensive topographic survey of the defence and surrounding area was undertaken. It was found that the top of the concrete wall varied between 18.29m to 18.41m AOD. It was also found that ground levels behind the defence were higher than the defence, following redevelopment of the mill site.

5.4.2 PFRA – Identification of Potentially Significant Flood Sources

According to the Preliminary Flood Risk Assessment (Dec 2011) the town of Antrim, in terms of the potential adverse consequences of flooding, is ranked 12th of the twenty SFRA within Northern Ireland (see Figure 4.1). On the basis of this initial assessment, which was undertaken using the strategic flood maps, the predominant flood risk to the town was considered to arise from fluvial flooding.

It should be noted that the PFRA flagged up the potential for significant fluvial flooding at Antrim. This is because this national assessment is based on strategic ‘undefended’ flood models which ignore the presence of existing flood defence systems such as the Millside Flood Wall and Meadowside flood bank. Therefore, the assessment is in effect based on the worst case scenario, as it assumes there is no benefit from the defences. This precautionary approach was taken because at the time of the assessment there was

a degree of uncertainty about the level of protection that each of the existing flood defence systems provides. By adopting this approach, the urban areas that are located behind existing flood defence structures were determined to be SFRA by default and as a consequence detailed Flood Hazard/Risk Maps had to be prepared in compliance with the requirements of the EU Floods Directive. This provided the opportunity to undertake the detailed structural assessments and flood modelling necessary to remove the uncertainty and establish the actual level of protection offered by these defences.

To facilitate a more robust assessment of the level of flood risk to Antrim from fluvial flooding, Rivers Agency developed detailed predictive flood models for each of these sources. It is considered that the flood hazard maps produced from these models will give a more accurate prediction of the flooded areas which may have been over or under estimated by the strategic flood maps. Details of the models and their output are described in the following sections.

5.4.3 Catchment Description

The Sixmilewater rises at an elevation of approximately 330m AOD in an area of coniferous forest at Headwood 7km south of Larne and drains a catchment of approximately 301km² to its ultimate discharge to Lough Neagh at Antrim Boat Club just south of Shane's Castle. The study reach and associated catchment is shown in Figure 5.4.3.1 Approximately 7km downstream of the source, Sixmilewater is joined by Ballynure Water on its left bank, west of Ballynure village.

The catchment land use for both watercourses appears to be predominantly grass and agricultural with a few sporadic urbanised areas particularly in the upper (north eastern) reaches and some isolated areas of forestry.

Further downstream the catchment noticeably flattens and there is a small increase in the prevalence of urban areas, including Ballynure, Ballyclare and Antrim close to the Sixmilewater's ultimate discharge into Lough Neagh at an elevation of approximately 15m AOD.

The average annual rainfall for the Sixmilewater catchment is approximately 1000mm - 1200mm. Antrim town centre is a very heavily urbanised area with a lot of hard standing areas with some large green areas such as Antrim Castle Gardens. Approximately 90% of Antrim town is urbanised.

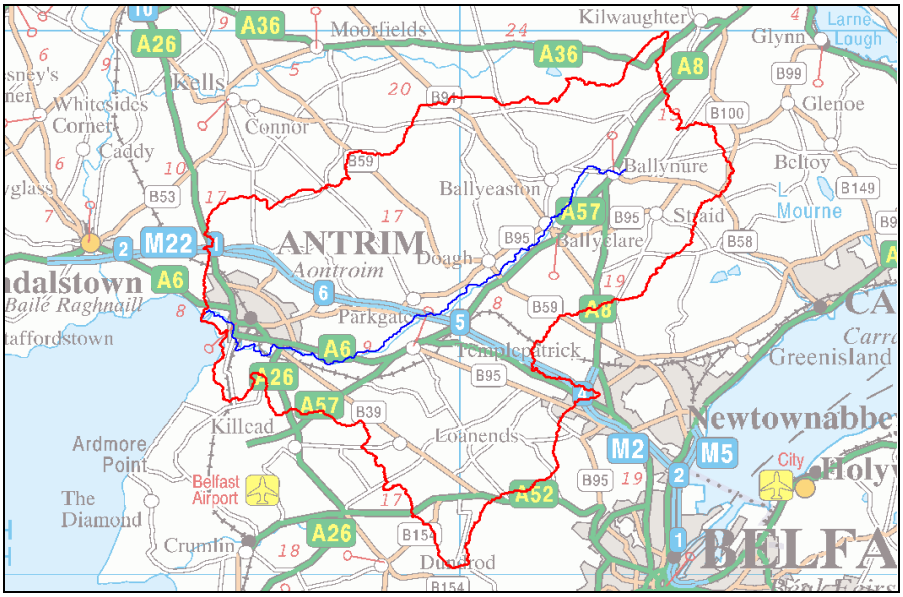


Figure 5.4.3.1 – Sixmilewater Catchment

5.4.4 Fluvial Flood Risk Assessment

Flood Model

The model constructed for the Antrim SFRA was an InfoWorks-RS model which was largely based on the existing steady state 1-dimensional HEC-RAS model. The existing geometry data within the HEC-RAS model was updated through the main urban areas via a commissioned channel survey undertaken during February and March 2009. All pre-existing hydraulic structure information within the HEC-RAS model was accepted as correct, although validation was undertaken via the surveying of soffit levels.

The existing cross sections were geo-referenced based on their approximate position obtained from the supplied archive drawings. The newly surveyed channel data was then imported directly in to the model geometry data. Cross-sections were extended across the full width of the floodplain using the supplied LiDAR data. The final model contained 264 cross-sections, 31 bridges and 10 weirs. The entire geometry file was then exported from HEC-RAS and imported into InfoWorks-RS, although this process did not transfer the hydraulic structures which required manual entry.

Fluvial Flooding Mechanisms

Muckamore

Rivers Agency's new hazard map indicates the Sixmilewater River begins to flood out of channel at Abbeyview, Muckamore between a 4%AEP (Q25) event and 2% AEP (Q50) event. (See Figures 5.4.4.1 and 5.4.4.2)

The model shows that at the relatively high frequency 10% AEP (Q100) flood event, floodwater is predicted to spill from the Sixmilewater to the south of the Greenmill Development and that the resulting surface water ponds to shallow depths. It is estimated that **1** residential property could be internally flooded at this event resulting in minimal damages.

At the more extreme 1% AEP (Q100) event, the predicted flooding is generally confined to the same location in Greenmill and also to the Abbeyview Developments. The flood inundation areas are more extensive and have a depth of 300mm to 1m. Flooding from the 1% AEP (Q100) event is estimated to affect **51** residential properties at a cost of around **£514,380**. The present value of the total property damages from potential future floods is calculated to be in excess of **£770,000.**

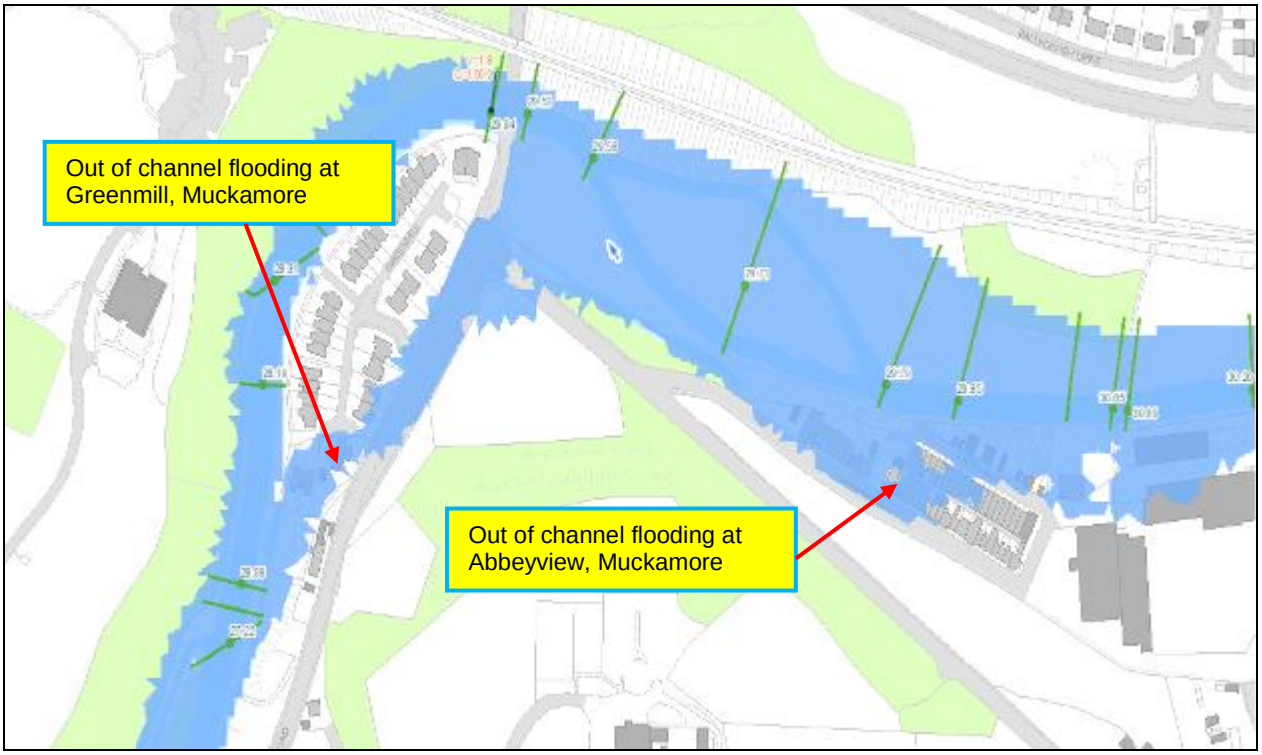


Figure 5.4.4.1 – Sixmilewater River out of bank at Muckamore 1% AEP (Q100)

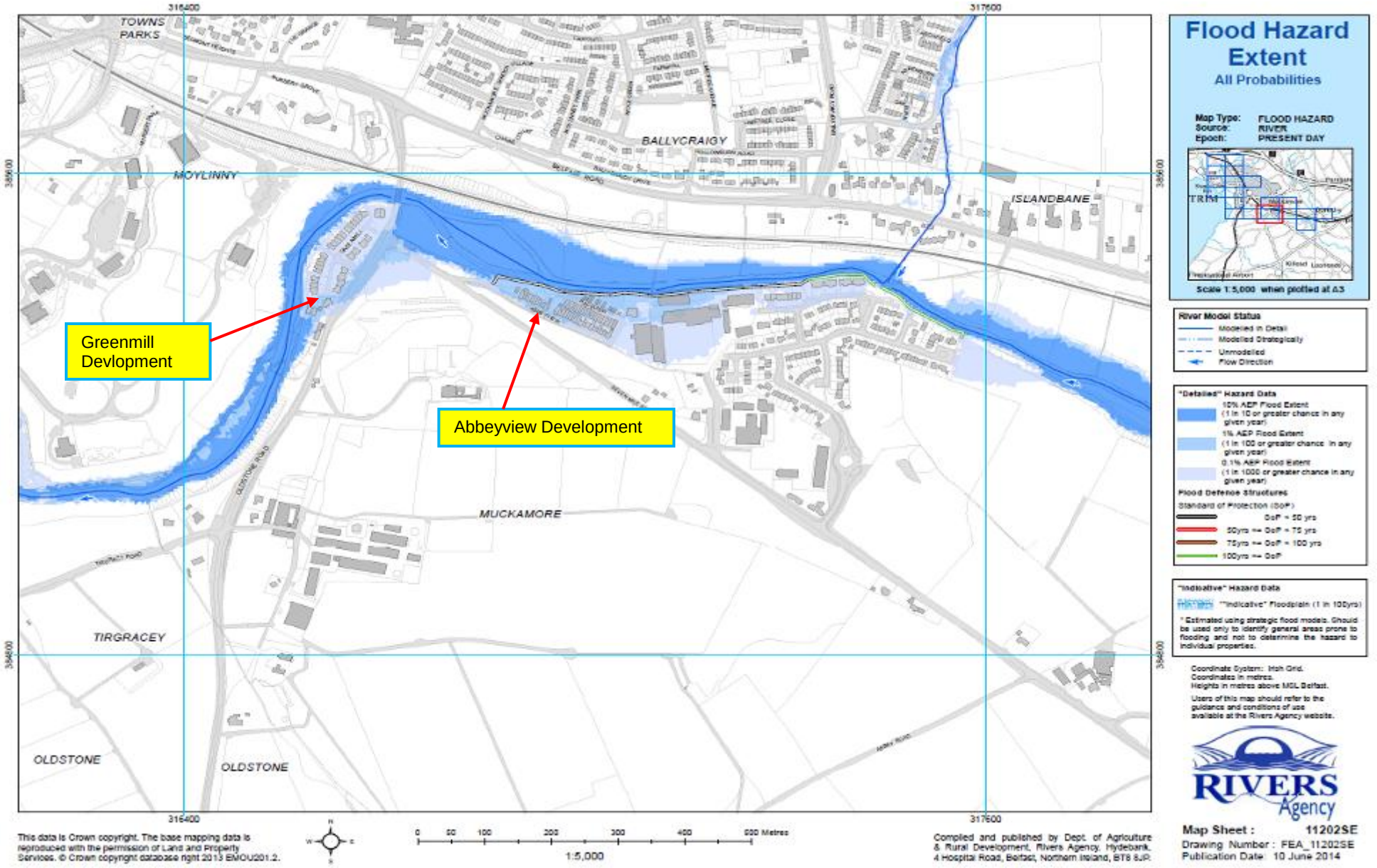


Figure 5.4.4.2 – Flood Hazard extent map for Muckamore, Antrim

Table 5.4.4.1 - Antrim SFRA – Muckamore			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	**1**	**3**	**51**
Non Residential (Nr)	**0**	**0**	**0**
Economic Damage (£)	**£500**	**£1500**	**£514,380**
Annual Average Damage (£)	**£25,703**		
Present Value (£)	**£771,090**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)			
Care Homes	**0**	**0**	**0**
GP Surgery's	**0**	**0**	**0**
Fire stations	**0**	**0**	**0**
Hospitals	**0**	**0**	**0**
Police Stations	**0**	**0**	**0**
Schools	**0**	**0**	**0**
Key Infrastructure (Nr)			
NIW Wastewater Treatment Works	**0**	**0**	**0**
NIW Sewage Pumping Stations	**1**	**1**	**2**
NIW Water Treatment Work	**0**	**0**	**0**
NIW Treated Water Pumping Stations	**0**	**0**	**0**
NIE Substation 6to11kV	**0**	**0**	**0**
NIE Substation 33kV	**0**	**0**	**0**
NIE Substation 275kV	**0**	**0**	**0**
NIE Substation 110kV	**0**	**0**	**0**
Road Service - Trunk Road	**1**	**1**	**3**
Environmental Designated sites (Nr)			
AONB	**0**	**0**	**0**
ASSI	**0**	**0**	**0**
Environmentally Sensitive Areas	**0**	**0**	**0**
Maritime Nature Reserve	**0**	**0**	**0**
Nature Reserve	**0**	**0**	**0**
RAMSAR	**0**	**0**	**0**
SAC	**0**	**0**	**0**
Sites of Local Nature Conservation Importance	**0**	**0**	**0**
SPA	**0**	**0**	**0**
RSPB Reserve	**0**	**0**	**0**
UWT Nature Reserve	**0**	**0**	**0**
Built Heritage sites (Nr)			
National Trust	**0**	**2**	**4**
Listed Buildings	**9**	**0**	**1**
Sites and Monuments Records	**0**	**0**	**0**
Buildings of Special Architectural or Historical Interest	**0**	**0**	**0**
Areas of Significant Archaeological Interest	**0**	**0**	**0**
Historic Gardens	**0**	**0**	**0**

Meadowside

Rivers Agency's new hazard maps show no flooding to the Meadowside Development in Antrim. Meadowside previously flooded in 2008. Since then Rivers Agency has carried out essential maintenance works to the existing flood defence surrounding Meadowside by returning the crest, which had subsided over time, to its original design level. (See Figures 5.4.4. and 5.4.4.4)

Rivers Agency commissioned a feasibility study on the Sixmilewater after the 2008 flood event. This was completed in 2013. The report highlighted that this development was at risk of flooding from the back up of surface water and not from fluvial flooding. The Meadowside defence now has a 1:100 year standard of protection.

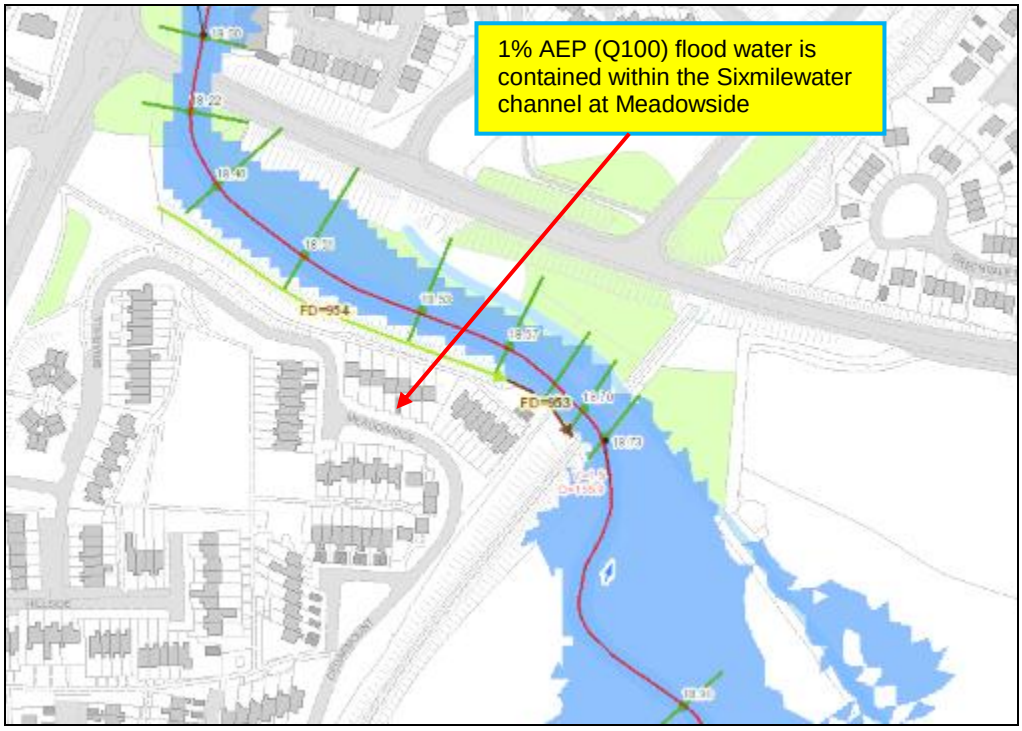


Figure 5.4.4.3 – Sixmilewater River at Meadowside, Antrim 1% AEP (Q100)

Therefore there is no potential scheme at this location as the Meadowside Development has a standard of protection greater than 100 years against fluvial flooding.

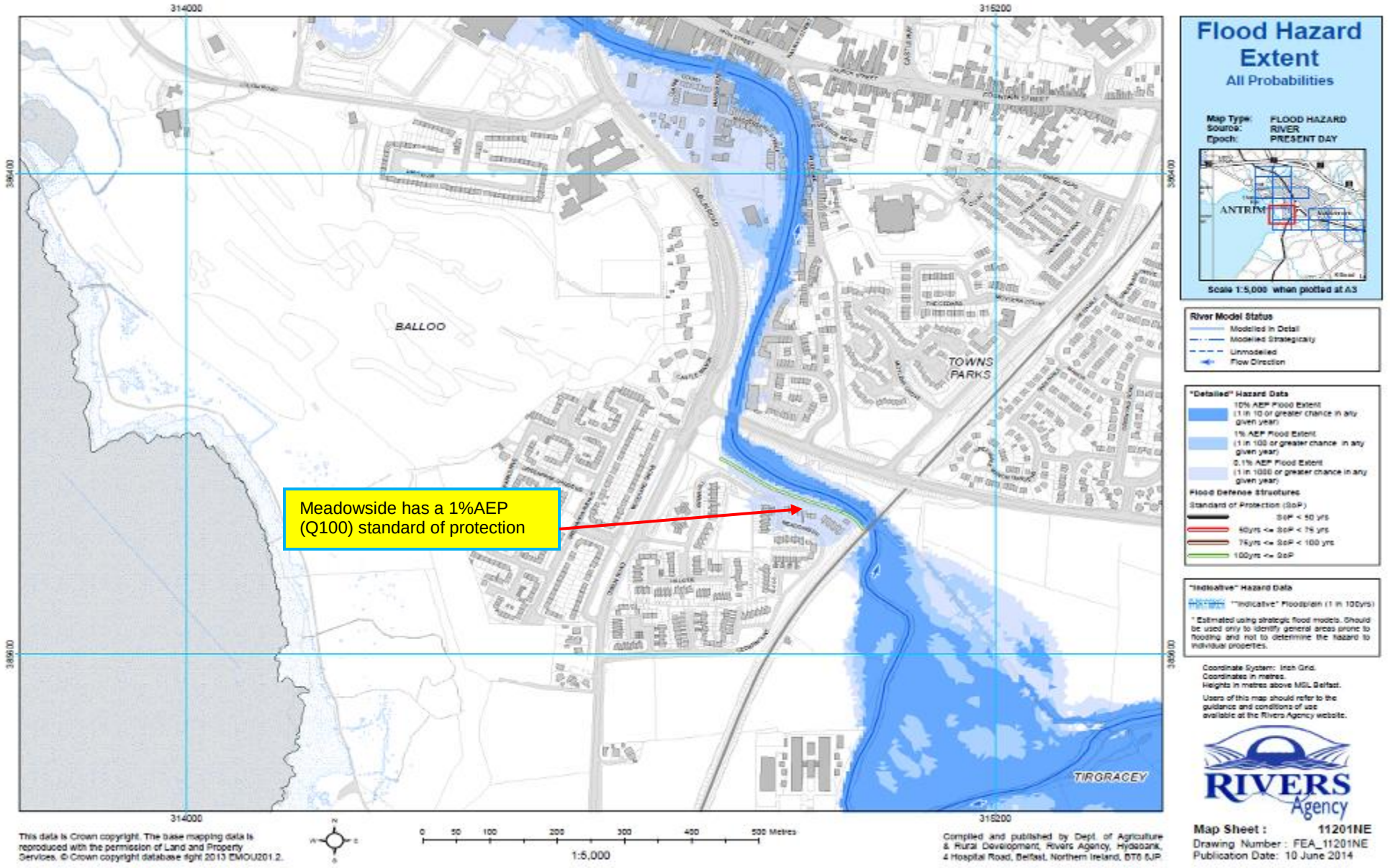


Figure 5.4.4.4 – Flood Hazard extent map for Meadowside, Antrim

Riverside & Masserence Street

Figures 5.4.4.5 and 5.4.4.6 illustrate the predicted extents of the potential fluvial flooding from the Sixmilewater in Antrim town and details of the impact of the flooding on property and key infrastructure is summarised in Table 5.4.4.2.

The model shows that at the relatively high frequency 10% AEP (Q10) flood event, floodwater is predicted to spill from Sixmilewater channel within the Riverside Development and Masserene Street and that the flood water will pond to shallow depths up to 300mm. It is estimated that **27** residential and **19** non residential properties could be flooded at this event causing damages in excess of **£398,829**.

At the more extreme 1% AEP (Q100) event the predicted flooding is generally confined to the same locations although the flood inundation areas are more extensive and deeper (up to 1m deep) particularly in the vicinity of the Masserene Street. Flooding from the 1% AEP (Q100) event is estimated to affect **58** residential and **46** non residential properties at a cost of around £**1,409,582**. The present value of the total property damages from potential future floods is calculated to be in excess of **£7.2 million.**

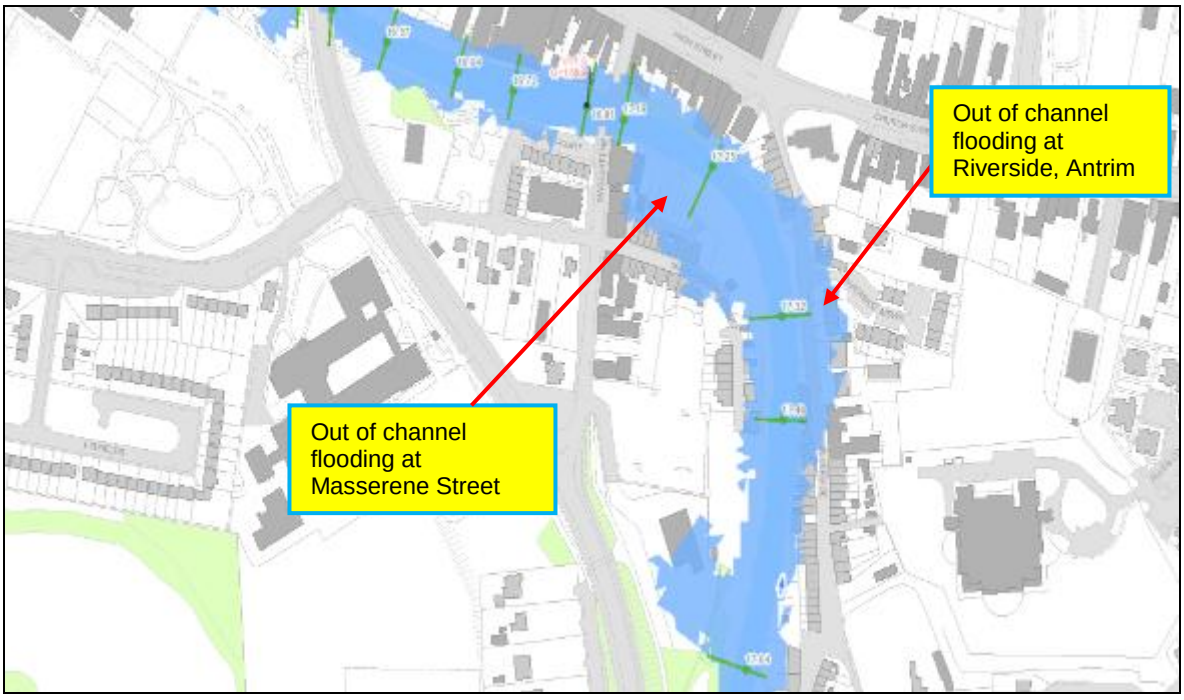


Figure 5.4.4.5 – Sixmilewater out of bank at Riverside, Antrim 1% AEP (Q100)

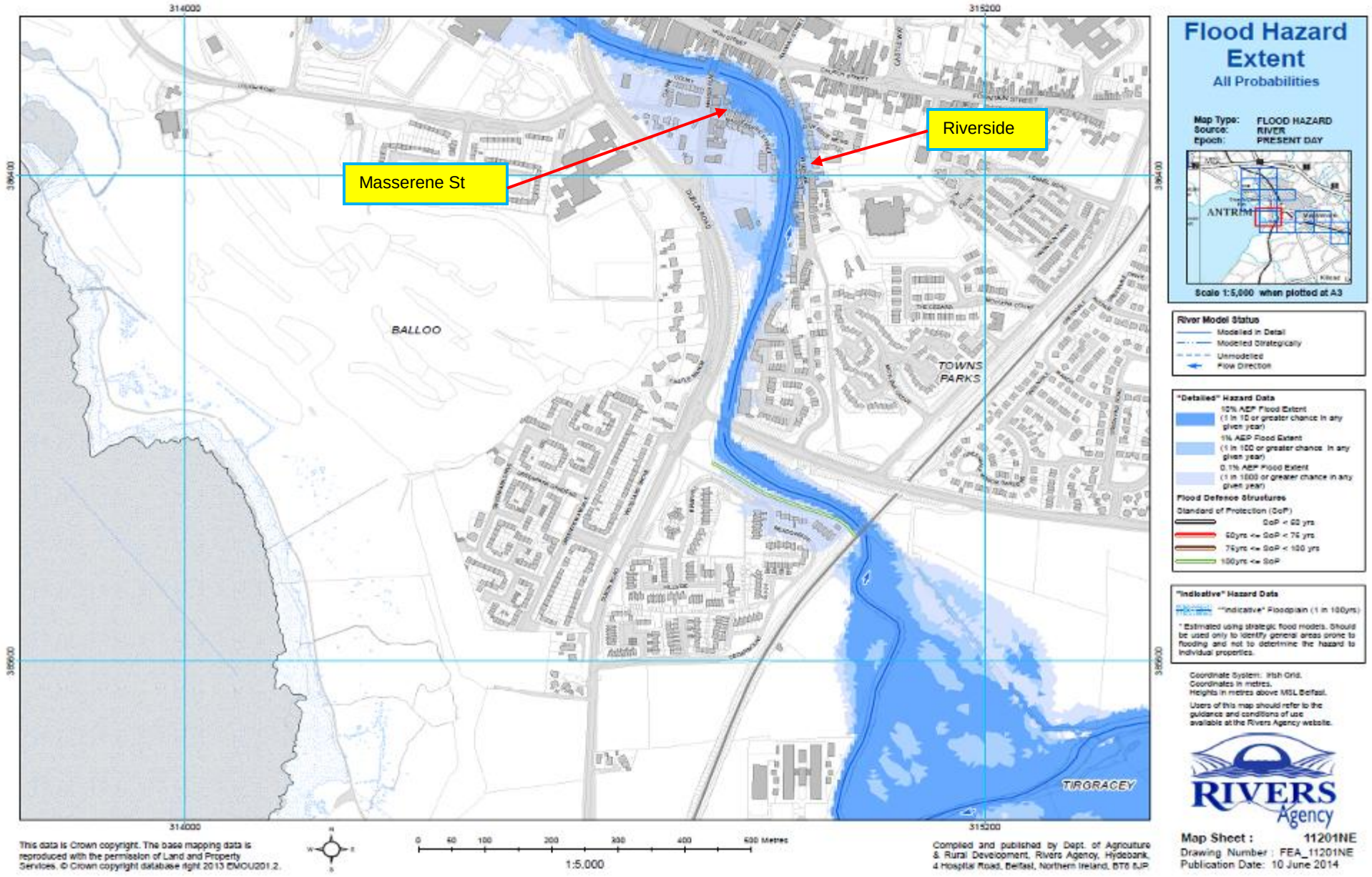


Figure 5.4.4.6 – Flood Hazard extent map for Riverside and Masserence Street, Antrim

Table 5.4.4.2 - Antrim SFRA – Riverside & Masserence St			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	**27**	**35**	**58**
Non Residential (Nr)	**19**	**25**	**46**
Economic Damage (£)	**£398,829**	**£666,660**	**£1,409,582**
Annual Average Damage (£)	**£242,215**		
Present Value (£)	**£7,266,450**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)			
Care Homes	**0**	**0**	**0**
GP Surgery's	**0**	**0**	**0**
Fire stations	**0**	**0**	**0**
Hospitals	**0**	**0**	**0**
Police Stations	**0**	**0**	**0**
Schools	**0**	**0**	**0**
Key Infrastructure (Nr)			
NIW Wastewater Treatment Works	**0**	**0**	**0**
NIW Sewage Pumping Stations	**0**	**0**	**2**
NIW Water Treatment Work	**0**	**0**	**0**
NIW Treated Water Pumping Stations	**0**	**0**	**0**
NIE Substation 6to11kV	**0**	**3**	**3**
NIE Substation 33kV	**0**	**0**	**0**
NIE Substation 275kV	**0**	**0**	**0**
NIE Substation 110kV	**0**	**0**	**0**
Road Service - Trunk Road	**0**	**2**	**2**
Environmental Designated sites (Nr)			
AONB	**0**	**0**	**0**
ASSI	**1**	**1**	**1**
Environmentally Sensitive Areas	**0**	**0**	**0**
Maritime Nature Reserve	**0**	**0**	**0**
Nature Reserve	**0**	**0**	**0**
RAMSAR	**1**	**1**	**1**
SAC	**0**	**0**	**0**
Sites of Local Nature Conservation Importance	**0**	**0**	**0**
SPA	**1**	**1**	**1**
RSPB Reserve	**0**	**0**	**0**
UWT Nature Reserve	**0**	**0**	**0**
Built Heritage sites (Nr)			
National Trust	**9**	**8**	**8**
Listed Buildings	**2**	**2**	**3**
Sites and Monuments Records	**0**	**0**	**0**
Buildings of Special Architectural or Historical Interest	**0**	**0**	**0**
Areas of Significant Archaeological Interest	**0**	**0**	**0**
Historic Gardens	**3**	**3**	**3**

5.4.5 Proposed Fluvial Flood Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Antrim it is important that the flood risk is not increased by new development in areas of known flood risk. Planning Policy Statement, PPS 15, "Planning and Flood Risk", adopts a precautionary approach to development with the primary aim "to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere".

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the "Exception" rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to "Greenfield" built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new Development Plans for Antrim, Rivers Agency will advise against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 100 year fluvial floodplain or is susceptible elsewhere to surface water flooding.

Rivers Agency shall also review the existing Development Plan for Antrim (Antrim, Ballymena, Larne) with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

The main (undeveloped) flooded areas within the Antrim area are:

- To the north west of the town and to the west of the Sixmilewater River at Baloo.
- To the north west of the town, to the west of the Sixmilewater River and north of the Randalstown Road.
- To the south of the Tully Road, to the south of the town and on both sides of the Sixmilewater River.
- Localised sites at Muckamore, Meadowside and in the centre of the town at Riverside and Masserene Street.

Planning Applications

Fluvial Areas at Risk

Rivers Agency will advise against the development of all sites that are located within the 1 in 100 year fluvial floodplain, irrespective of whether they are located within the current plan or as a single site application outside the plan area.

For those sites within the 1 in 100 year fluvial floodplain where the principle of development has been accepted by Planning NI as meeting the "Exception Test", Rivers Agency will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The main existing developed areas, amongst others, at flood risk within Antrim were re-development may be likely to take place are:

- Greenmill and Abbeyview in Muckamore,
- Meadowside
- Riverside and Masserene Street in the town centre.

Areas at risk of surface water flooding

For those sites outside the 1 in 100 year fluvial floodplain that are located in an area where there is evidence of a history of surface water flooding identified by the flood hardship payments. Rivers Agency will further consider the application through the appraisal of the accompanying Drainage Assessment that will need to demonstrate suitable flood mitigation measures.

Where there is potential for surface water flooding as indicated in the purple predicted areas on the surface water maps, Rivers Agency will advise that the applicant should assess the flood risk and drainage impact to the site himself and construct in the appropriate manner.

The main areas identified in Antrim as being at surface water flood risk are:

- Meadowside Housing Development
- Riverside and Massereene Street , Antrim Town Centre
- Muckamore Gardens

A wastewater pumping station upgrade with increased forward flow is required at the Muckamore Garden area of Antrim.

Areas at risk of flood inundation from reservoirs

For all development proposals that are located within the potential flood inundation area of a controlled reservoir we will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures. If it is a new development

proposal Rivers Agency will also need the applicant to demonstrate that the condition, management and maintenance regime of the reservoir is appropriate to provide sufficient assurance regarding reservoir safety.

Controlled reservoirs identified in the Antrim area are as follows:

- Upper Potterswall Reservoir
- Lower Potterswall Reservoir

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is, therefore, important that we continue to target investment by providing flood defence, culvert alleviation schemes and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. The **Flood Investment and Planning Group, (FIPG)**, provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a “Flood Risk Metric Tool”, (FRISM) is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total “damage avoidance benefits” that the scheme will provide to the property over the scheme’s design life. If the benefit/cost ratio is greater than 1 (Net Present Value, NPV, figure is positive) then the potential scheme will be referred to Rivers Agency’s Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely Rivers Agency’s responsibility, or is the responsibility of NI Water or Transport NI such as a local drainage or road infrastructure issue, it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a benefit cost analysis identifies a viable scheme, a scheme will be placed on a prioritisation list for works with other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take anything from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Having conducted a detailed assessment of the fluvial flood risk to Antrim, Rivers Agency has determined that potential flood alleviation schemes may be justified for the Muckamore area and Riverside areas of Antrim.

A feasibility study for the Sixmilewater River was completed in 2014 and this identified that flood alleviation schemes may be cost beneficial. The detailed design and economic appraisal for the proposed flood alleviation schemes will be prioritised shortly and will be completed in the near future. The findings of this will be taken into consideration in the final version of the FRMP (December 2015). If a flood alleviation scheme is confirmed to be economically viable then the scheme will be placed on the Rivers Agency's Capital Works Programme and undertaken in line with its prioritisation compared to viable schemes if and when resources are available.

Preparedness

In Antrim it is not possible to prevent or protect against all flooding. Indeed even where flood defences exist it is possible in an extreme event that these could be over topped and flooding could still occur.

Having recognised this fact, considerable effort in recent years has been made by emergency planners in Government Departments, Councils and the Emergency Services working together and sharing information to ensure a coordinated response.

However, despite these improvements during significant flood events the emergency response of Government Departments and the Emergency Services can become over stretched. This means that not all calls for assistance during a flood event may be responded to in a timely manner. With this in mind it is important that households and communities, subject to a known flood risk, are prepared. The detail of preparedness actions including flood warning and informing activities planned from a regional perspective, are provided in Annex E

This is not Government withdrawing from any undertaking to respond in emergencies but an additional layer of support to ensure Government Departments and the public work together to reduce the overall impacts of flooding.

From the flood risk assessment there are certain areas of Antrim which are subject to flood risk and may have flooded before. Therefore, they may benefit from the flood warning and informing proposals outlined in Annex D.

A pilot project of community engagement to deliver flood warning and informing, held in 2014, identified basic assessment formulae to assess and score areas that could potentially be a focus for flood warning and informing actions. Based on this scoring the following areas could be considered suitable for being included in a programme of community engagement to deliver flood warning and informing initiatives:

- Abbeyview and Alexandra Park, Muckamore.
- Riverside and Masserence Street, Antrim.

Key activities that could be undertaken are:

- Explaining the potential and limitations of Community Resilience
- Briefing communities on information available, particulary from the Met Office
- The facilitation of self-help initiatives, including remote sandbag storage; and
- Reviewing and validating all elements of the Community Engagement Plan to help the community communicate effectively in an emergency and work together.

A table in Annex J shows how this community ranks in the overall context of the 20 SFRAs in this Plan. It should be noted that this is an indicative assessment which may change subject to further information on flood risk becoming available.

The rollout of this work is dependent on funding being available.

5.5 Ballymena SFRA – Braid Water

The core boundary of the Ballymena SFRA, which has been determined through the PFRA, is located within the Braid Water Local Management Area and illustrated in Figure 5.5. below.

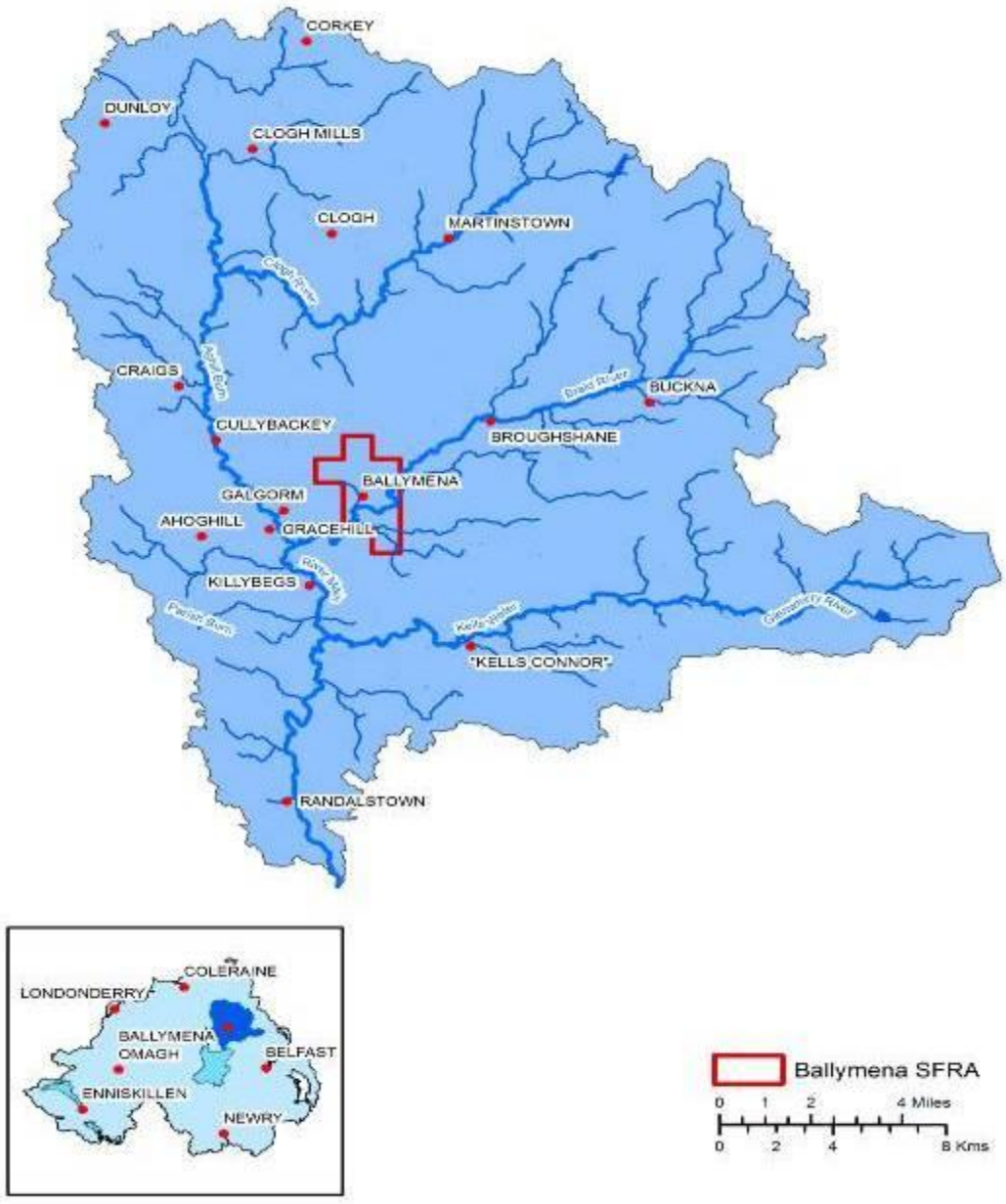


Figure 5.5 - Braid Water LFMA and Ballymena SFRA

5.5.1 Flooding History

The severity of past flooding on both the River Maine and River Braid, in both urban and rural environments, has provided impetus to protect the most vulnerable reaches. A newspaper report at the time of a severe flood on 1 November 1968 stated that 'flooding had occurred in spite of the extensive river drainage scheme undertaken some years ago by the Ministry of Agriculture on river reaches below the town. This was the first time the Braidwater Mill was flooded since the scheme was completed. Previously identified occasions when the Braidwater flooded was in 1949 and 1952.

A further scheme was carried out on the Braid in 1994/95 to construct new flood walls and flood banks to alleviate the flooding problem on Toome Road. The gauging station at Ballee is downstream from these works and peak flows could be influenced by alteration of storage and conveyance in the catchment. Certainly, urban areas in Ballymena that were severely flooded in historical events are no longer subject to the same risk. Direct comparison of levels and flood extent achieved in 2008 and historical floods does not seem feasible.

Below is a list of all occurrences of significant flooding on the River Maine and River Braid catchments and on neighboring catchments from 1880 to present sourced from local newspapers:

Date and Source	Weather and general flood background	Neighbouring catchment flooding	Maine and Braid flooding
8 Dec 1886 Belfast N'letter Ballymena Observer	The main newspaper reference is to the impact of a severe gale which caused severe shipping losses in the Irish Sea and on the north coast of Antrim and damage on land mainly in Northern Ireland.	High river level was reported in the Bann at Coleraine. Ballymoney – land flooded but little damage done.	The Braid and Maine were reported to be swollen to an unusual height and large areas of low-lying land submerged in the townlands of Glarryford and Kellswater. Severe property flooding occurred in Ballymena from the river Braid Many houses in the vicinity of Galgorm Road, Galgorm Street, Railway Street, James Street and parts of Harryville and Ballymoney Road were flooded to as much as 6 feet .
8 Nov 1890 Belfast N'letter Ballymena Observer	Rainfall 2.35 inches in 24 hours at Ballymena Gale with heavy rain over the greater part of Britain including Wales, Scotland and Ireland, SW England with shipping losses.	Flooding reported on the River Bush, lower Bann at Coleraine, River Strule in Omagh, the Coagh River at Stewartstown.	Braid and Maine in high flood with houses in Harryville and Ballymoney Road flooded to a depth of 6 feet. Braidwater Spinning Mill and Lisnafillan Bleaching Works flooded and work temporarily stopped.

Date and Source	Weather and general flood background	Neighbouring catchment flooding	Maine and Braid flooding
5 Dec 1948 Ballymena Weekly Telegraph	Single NI heavy rainfall listed in British Rainfall at Foffany (Mournes) of 3.02 inches (76.7 mm). No information on weather or broad extent of flooding	Houses also flooded in the Milltown area Ballymoney. (Balnamore Road to a depth of 3 feet), with a dozen houses affected. At Roddenfoot where houses had been previously flooded (no date stated) the water reached the doors but did not enter.	Ballymena flooding said to be the worst for the last 20 years with many houses and businesses flooded from the Ballee Burn at Kinhilt and Glengorm Street and Ballymoney Road. Severe flooding occurred in the Queen Street- Toome Road area with neighbouring grassland covered to a depth of six feet in places. Fifteen families on Toome Road were affected. About 200-300 yards of Queen Street were under water.
25 Oct 1949 Ballymena Weekly Telegraph Belfast N'letter Larne Times	Widespread easterly gales and flooding in eastern counties of Northern Ireland. Belfast rainfall 2 inches in 18 hours. Aldergrove 1.4 inches daily rainfall. Daily rainfall at Ballymena 1.29 inches (32.8 mm) Shipping losses and damage to boats in harbours on the Irish Sea.	Sixmilewater damaged Ballyclare Paper Mill. The water burst through heavy steel doors causing flooding to a depth of 3 feet.	Said to be the worst flooding in Ballymena for a quarter century. At Ballymena the River Braid overflowed and flooded Braidwater Spinning Mill to a depth of 3 to 4 feet; 1000 employees paid off and not expected to return for a few weeks. Water level in the Phoenix Factory at its highest in 35 years. 50 houses flooded in Ballymena. The 6 foot high wall adjoining Harryville Bridge was swept away. Houses in the Clonavon and Galgorm Street were flooded to 2-3 feet. The opinion was expressed that flooding in Toome Road was caused by the Ballee Burn rather than the River Braid.
9 Aug 1952 Belfast N'letter Larne Times	Daily rainfall second highest for Braidwater Mill with 2.08 inches (52.8) mm compared with 2.35 inches (59.7) mm in Nov 1890	Severe flooding in Belfast from surface runoff and overflow from Blackstaff River – 2000 houses affected. Strabane Main Street flooded for the first time in 40 years; flooding also at Glenarm and from the River Bush Flooding on the Tow River at Ballycastle.	Braidwater Spinning Mill under 1 foot of water from River Braid. Ballymena houses and shops flooded mainly from surface runoff. Wellington Street in the town centre was flooded for the first time in many years and residents in the Ballymoney road were seriously threatened when a three foot breach was made in a flood bank. Also affected were Galgorm Road, Queen Street and Toome Road.

Date and Source	Weather and general flood background	Neighbouring catchment flooding	Maine and Braid flooding
1 Nov 1968 **Belfast N'letter** **Ballymena Observer** **East Antrim Times** **Irish News**	Strong winds and heavy rainfall were reported throughout NI. Record daily rainfall for NI at Tollmore Park Newcastle with 6.36 inches: 161.5 mm. Ballymena daily rainfall was 1.67 inches: 42.4 mm	Flooding reported in Derry from the River Foyle and in Fermanagh. Randalstown – the bridge from Neilsbrook to Old Bleach Works as badly damaged.	Severe flooding from the River Braid was reported in Ballymena. The Braidwater Spinning Mill was flooded and shift work was interrupted. A new gas plant with a retaining wall built to contain previously known floods with 18 inch freeboard was overtopped. Gallagher's tobacco factory at Lisnafillan had water in the boiler room but the rest of the factory was unaffected.
21 Oct 1987 **Ballymena Times** **Belfast Newsletter**	Slow moving depression moving up to Ireland from the bay of Biscay. Aldergrove rainfall 2 inches (50.8 mm recorded in 15 hours.	The Newsletter gives comprehensive coverage of flood hit areas throughout the province.	Flooding of roads reported in Ballymena but no homes. Residents at Toome Road Ballymena were not flooded and stated an ongoing drainage scheme aimed at easing the burden of Ballee Burn may have helped. A resident stated that he had been flooded 10 times in 40 years.
16-18 Aug 2008 **Climatological Observers Link** **Antrim Guardian** **Ballymena Times**	In Northern Ireland it was the wettest August since 1985 and many stations had their wettest August on record (250% of normal in mid Antrim). More than two inches (55-65 mm) of rain fell widely across many central and eastern parts of Northern Ireland. Highest official rainfall total was 74.8 mm (at Portglenone (12 km W from Ballymena) in 12 hours — a one-in-90-year event. An unofficial rain gauge in Ballyclare recorded a 24-hour total of 88.9 mm, a one-in-150-year event	Flooding was reported from across Northern Ireland, especially Belfast where a landslide caused a train to derail. Two bridges collapsed and 37 major roads were shut down, including part of the M1 motorway. Extensive flooding on the Sixmilewater at Antrim, Muckamore and Templepartick	In Ballymena Ballee Burn, on the Antrim Road side, overflowed. Queen Street had water knee deep in houses on one side but the houses on the other side escaped. Toome Road had water up to waist deep.

Table 5.5.1.1 - Accounts of flooding in Ballymena

Existing Flood Defences

The severity of past flooding on both the River Maine and River Braid, in both urban and rural environments has provided impetus to protect the most vulnerable reaches. The earliest work appears to have been carried out on the River Braid. A newspaper report at the time of a severe flood on 1 November 1968 stated that 'flooding had occurred in spite of the extensive river drainage scheme undertaken some years ago by the Ministry of Agriculture on river reaches below the town. This was the first time the Braidwater Mill was flooded since the scheme was completed'. Previous identified occasions when the Braidwater Mill was

flooded were in 1949 and 1952 so the work was done between 1952 and 1968 and presumably some years before 1968 given the uncertain reference to ‘some years ago’. A further scheme was carried out on the Braid in 1994/95 to construct new flood walls and length of flood bank to alleviate the flooding problem on Toome Road. The gauging station at Ballee is downstream from these works and peak flows could be influenced by alteration of storage and conveyance in the catchment. Certainly, urban areas in Ballymena that were severely flooded in historical events are no longer subject to the same risk. Direct comparison of levels and flood extent achieved in 2008 and historical floods does not seem feasible.

Reference in newspapers was also made in 1968 to the extensive flooding of 2500 acres (1012 ha) of land in the Glaryford area of the Upper Maine with lobbying from affected farmers. The River Maine arterial drainage scheme was proposed in 1969 and was subject to a Public Inquiry in 1971 (Hutton, 1972, Wilcock, 1982). The scheme was started in the mid 1970s but the main channelisation occurred upstream from Dunminning in April 1984 and the scheme was completed in 1987. It involved channel widening, deepening and straightening over 26 km of river between Dunloy and the confluence with the River Braid. At Dunminning where the early gauging station was located, an old weir was removed and the channel deepened by about 3 m. Between Dunminning and Dunloy channel deepening was progressively reduced until at Dunloy it was about 1 metre. As described in Wilcock and Essery (1991) the scheme aimed to provide drainage benefit to 4300 ha and to reduce flooding on 730 ha of agricultural land.

A before and after study of the channelisation scheme on the catchment to Dunminning (a short distance upstream from the present Dromona gauging station) commenced in 1978 and Wilcock and Essery reported on the results of the effects on components of the water balance in several papers though not specifically on flood flows.

Channelisation occurred along the River Maine downstream from Dunminning as far as the confluence with the River Braid but no information is available on changes to the Lower Maine (either as part of the same scheme or as a separate scheme). Given the fact that a significant area of overbank storage was withdrawn and channel conveyance and velocity was increased, a significant impact on flood peaks downstream from the affected reach is to be expected. The impact of upstream channelisation is likely to persist to the mouth of the Maine at Lough Neagh.
A flood storage area is present on the Deerfin Burn which attenuates flood water from the Deerfin Burn in park land adjacent to the watercourse which has been lowered to provide additional flood storage.

There have been several schemes put in place along the watercourses in the River Maine catchment. These range from river channelisation and realignment with raised defences, to formal storage areas.

Watercourse	Defences	Included in model
River Maine	Flood storage area at Dunminning	Yes
River Maine	Concrete defence walls at Cullybackey. Right bank upstream and downstream of bridge	Yes
River Maine	Piled defences on both banks between Corbally Road Bridge and Gracehill Bridge (known as Galgorm Defences)	Yes
River Maine	Downstream of Gracehill Bridge	Yes
River Maine	Randalstown left bank concrete wall.	Yes
River Braid (Left Bank)	Concrete flood walls through town from Sainsburys to Harryville Bridge	Yes
River Braid (Right Bank)	Concrete flood walls through town from Sainsburys (upstream) to fire station (downstream). Tied into railway viaduct.	Yes
Deerfin Burn	Concrete flood walls, sheet piled embankments and flood storage area.	Yes

Table 5.5.1.2 - Existing flood defences in the Ballymena Model

5.5.2 PFRA – Identification of Potentially Significant Flood Sources

According to the Preliminary Flood Risk Assessment (Dec 2011) the town of Ballymena, in terms of the potential adverse consequences of flooding, is ranked 9th of the twenty SFRA within Northern Ireland (see figure 4.1). On the basis of this initial assessment, which was undertaken using the strategic flood maps, the predominant flood risk to the town was considered to arise from fluvial flooding.

It should be noted that the PFRA flagged up the potential for significant fluvial flooding at Ballymena because the national assessment is based on strategic 'undefended' flood models which ignore the presence of existing flood defence systems such as the Ballee Burn Flood Walls. Therefore, the assessment is in effect based on the worst case scenario, as it assumes there is no benefit from the defences. This precautionary approach was taken because at the time of the assessment there was a degree of uncertainty about the level of protection that each of the existing flood defence systems provides. By adopting this approach, the urban areas that are located behind existing flood defence structures were determined to be SFRA by default and as a consequence detailed Flood Hazard/Risk Maps had to be prepared in compliance with the requirements of the EU Floods Directive. This provided the opportunity to undertake the detailed structural assessments

and flood modelling necessary to remove the uncertainty and establish the actual level of protection offered by these defences.

To facilitate a more robust assessment of the level of flood risk to Ballymena from fluvial flooding, Rivers Agency developed detailed predictive flood models for each of these sources. It is considered that the flood hazard maps produced from these models will give a more accurate prediction of the flooded areas which may have been over or under estimated by the strategic flood maps. Details of the models and their output are described in the following sections.

5.5.3 Catchment Description

The River Braid catchment is a sub catchment of the River Maine catchment and is located in County Antrim. The River Maine catchment is largely rural with Ballymena and Randalstown the largest urban areas; smaller urban areas of Broughshane, Cullybackey and Kells are also located in the catchment.

The River Maine rises on the Antrim hills to the north of the village of Dunloy, flowing in a southerly direction to its outfall in Lough Neagh at Mainwater Foot. The main tributary is the River Braid with headwaters in the hills to the east of Broughshane from where it flows in a westerly direction through Ballymena to join the River Maine west of Tullaghgarley Bridge.

The catchment geology is predominantly basalt, overlain by till, with alluvium and sands and gravels along valleys. The Maine catchment has an annual rainfall (SAAR) value of 1150mm.

5.5.4 Fluvial Flood Risk Assessment

Flood Model

The Preliminary Flood Risk Assessment has identified areas of potential significant flood risk within the River Maine catchment. There have been several previous studies along the tributaries of the Rivers Maine and Braid, but a new study was commissioned for the whole catchment to fully understand the nature of the flood risk in the catchment. HEC-RAS models existed for the Devenagh Burn and Conor Burn and Infoworks-RS models existed of Broughshane and a small section of the Kells Water.

All these models have been incorporated into the existing study. The HEC-RAS models have been georeferenced and converted to Infoworks-RS format and are now included in the River Maine models. The existing Infoworks-RS models have also been included in the new Infoworks-RS models.

A detailed hydrological assessment along the study reach has been carried out to derive inflows to the hydraulic model. Flow estimates have been derived for return periods between the 2 and 1,000-year events. Hydraulic models have been developed in the Infoworks suite of software, the floodplain has been

represented using 2D domains in areas of complex floodplain flow routes. The models have been run for return periods of 10, 100 and 1,000-years, additionally the effects of climate change on flood flows have been assessed by increasing the 100-year flows by 20%.

Fluvial Flooding Mechanisms

Ballee Burn

Rivers Agency flood hazard maps indicate flooding in the Pennybridge Industrial estate in Ballymena. This is illustrated on the next page, which shows the predicted extents of the potential fluvial flooding from the Ballee Burn in Ballymena. Details of the impact of the flooding on property and key infrastructure is summarised in Table 5.5.4.1.

Photo 5.5.4.1 Twin 1500mm dia foot bridge on Ballee Burn

The model shows that at the relatively high frequency 10% (Q10) AEP flood event, floodwater is predicted to spill from the open watercourse known as Ballee Burn within the Pennybrigde Industrial Estate. The flood water ponds to depths of 300mm in the low lying areas, most notably in the FYFES motor factors and Slemish College areas. This may be due to an accommodation bridge on the Ballee Burn consisting of twin 1200mm dia culverts. It is estimated that **4** non residential properties could be flooded at this event causing damages in excess of **£2,566.**

At the more extreme 1% AEP (Q100) event the predicted flooding is generally confined to the same locations although the flood inundation areas are more extensive (up to 300mm deep) particularly in the vicinity of the Dale Farm Factory. Flooding from the 1% AEP (Q100) event is estimated to affect **12** residential and **26** non residential properties at a cost of around **£219,767**. The present value of the total property damages from potential future floods is calculated to be in excess of **£770k.**

Photo 5.5.4.2 Entrance to Slemish College

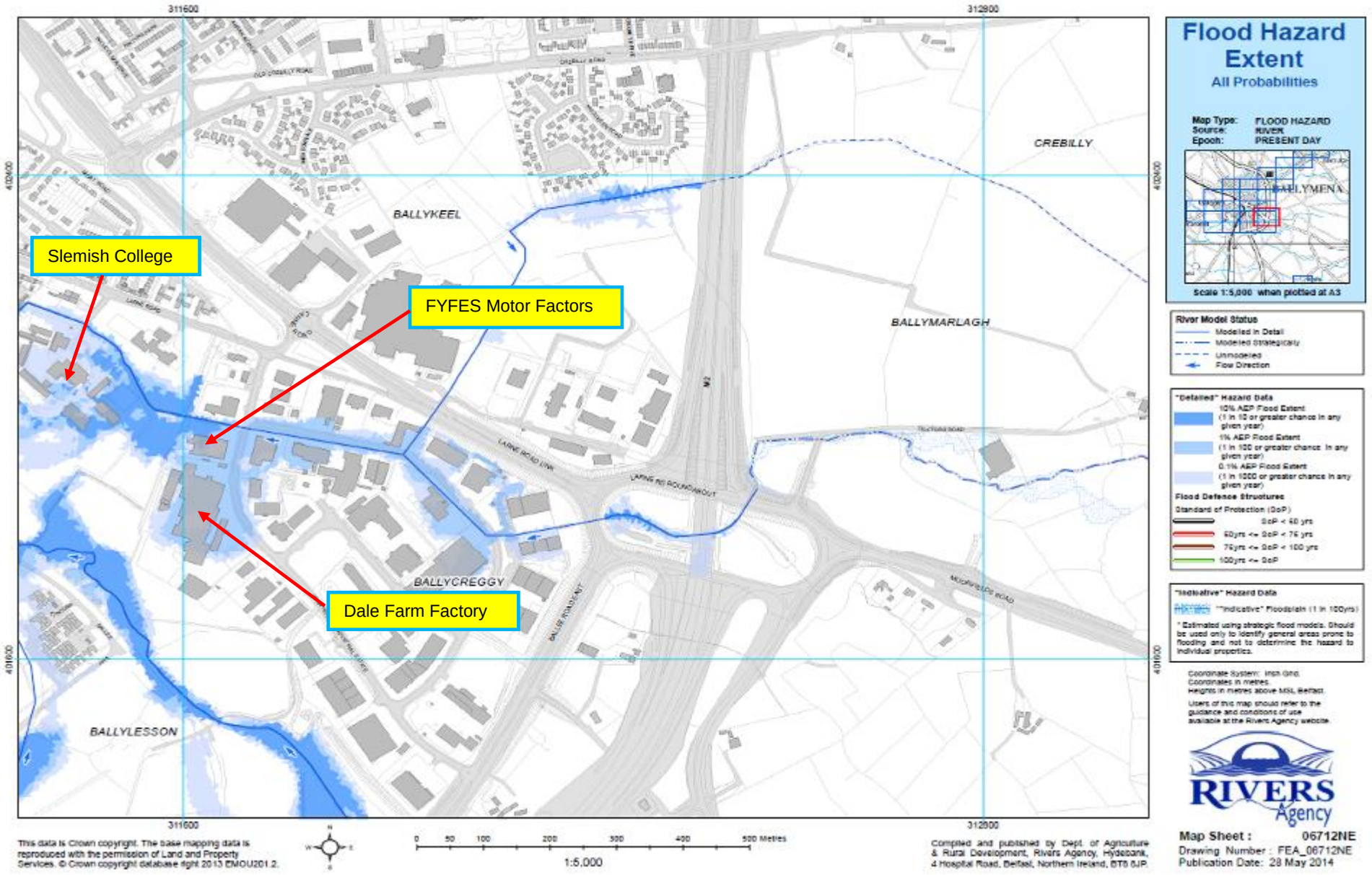


Figure 5.5.4.1 – Flood Hazard extent map for Pennybridge Industrial Estate, Ballymena

Table 5.5.4.1 - Ballymena SFRA – Ballee Burn			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	**0**	**0**	**12**
Non Residential (Nr)	**4**	**6**	**26**
Economic Damage (£)	**£2,566**	**£32,855**	**£219,767**
Annual Average Damage (£)	**£25,634**		
Present Value (£)	**£769,020**		
IPPC sites (Nr)	**0**	**1**	**1**
Community Assets (Nr)			
Care Homes	**0**	**0**	**0**
GP Surgery's	**0**	**0**	**0**
Fire stations	**0**	**0**	**0**
Hospitals	**0**	**0**	**0**
Police Stations	**0**	**0**	**0**
Schools	**0**	**0**	**0**
Key Infrastructure (Nr)			
NIW Wastewater Treatment Works	**0**	**0**	**0**
NIW Sewage Pumping Stations	**0**	**0**	**0**
NIW Water Treatment Work	**0**	**0**	**0**
NIW Treated Water Pumping Stations	**0**	**0**	**0**
NIE Substation 6to11kV	**0**	**0**	**0**
NIE Substation 33kV	**0**	**0**	**0**
NIE Substation 275kV	**0**	**0**	**0**
NIE Substation 110kV	**0**	**0**	**0**
Road Service - Trunk Road	**2**	**2**	**2**
Environmental Designated sites (Nr)			
AONB	**0**	**0**	**0**
ASSI	**0**	**0**	**0**
Environmentally Sensitive Areas	**0**	**0**	**0**
Maritime Nature Reserve	**0**	**0**	**0**
Nature Reserve	**0**	**0**	**0**
RAMSAR	**0**	**0**	**0**
SAC	**0**	**0**	**0**
Sites of Local Nature Conservation Importance	**0**	**0**	**0**
SPA	**0**	**0**	**0**
RSPB Reserve	**0**	**0**	**0**
UWT Nature Reserve	**0**	**0**	**0**
Built Heritage sites (Nr)			
National Trust	**0**	**0**	**0**
Listed Buildings	**0**	**0**	**0**
Sites and Monuments Records	**0**	**0**	**0**
Buildings of Special Architectural or Historical Interest	**0**	**0**	**0**
Areas of Significant Archaeological Interest	**0**	**0**	**0**
Historic Gardens	**0**	**0**	**0**

Ballykeel Area

The Ballykeel area is located to the south of Ballymena on the right bank of the River Braid. The flood model shows that at the relatively high frequency 10% AEP (Q10) flood event, floodwater is predicted to spill from the River Braid at certain locations. The flood water ponds to depths of up to 300mm in the low lying areas, most notably in the Phoenix Fields housing development (See Point B in Figure 5.5.4.2) off Railway Street and the Council Depot on Waveney Road (See point A in Figure 5.5.4.2). It is estimated that **14** residential and **12** non residential properties could be flooded at this event causing damages in excess of **£90,005.**

Further downstream the flood model shows that the old playing fields along the right bank of the River Braid, are inundated with flood water between the 2% AEP (Q50) and the 1% AEP (Q100) flood event when the existing earth embankment is overtopped. The floodwater is predicted to inundate a number of properties in the Leighinmohr Avenue and Leighinmohr Crescent housing developments. (See point C in Figure 5.5.4.2)

At the 1% AEP (Q100) flood event the predicted flooding is generally confined to the same locations as the 10%AEP (Q10) although the flood inundation areas are more extensive (300mm – 1m deep) particularly in the vicinity of Leighinmohr Crescent. Flooding from the 1% AEP (Q100) flood event is estimated to affect **30** residential and **17** non residential properties at a cost of around **£477,996** in the Ballykeel area. The present value of the total property damages from potential future floods is calculated to be in excess of **£1.9 million.**

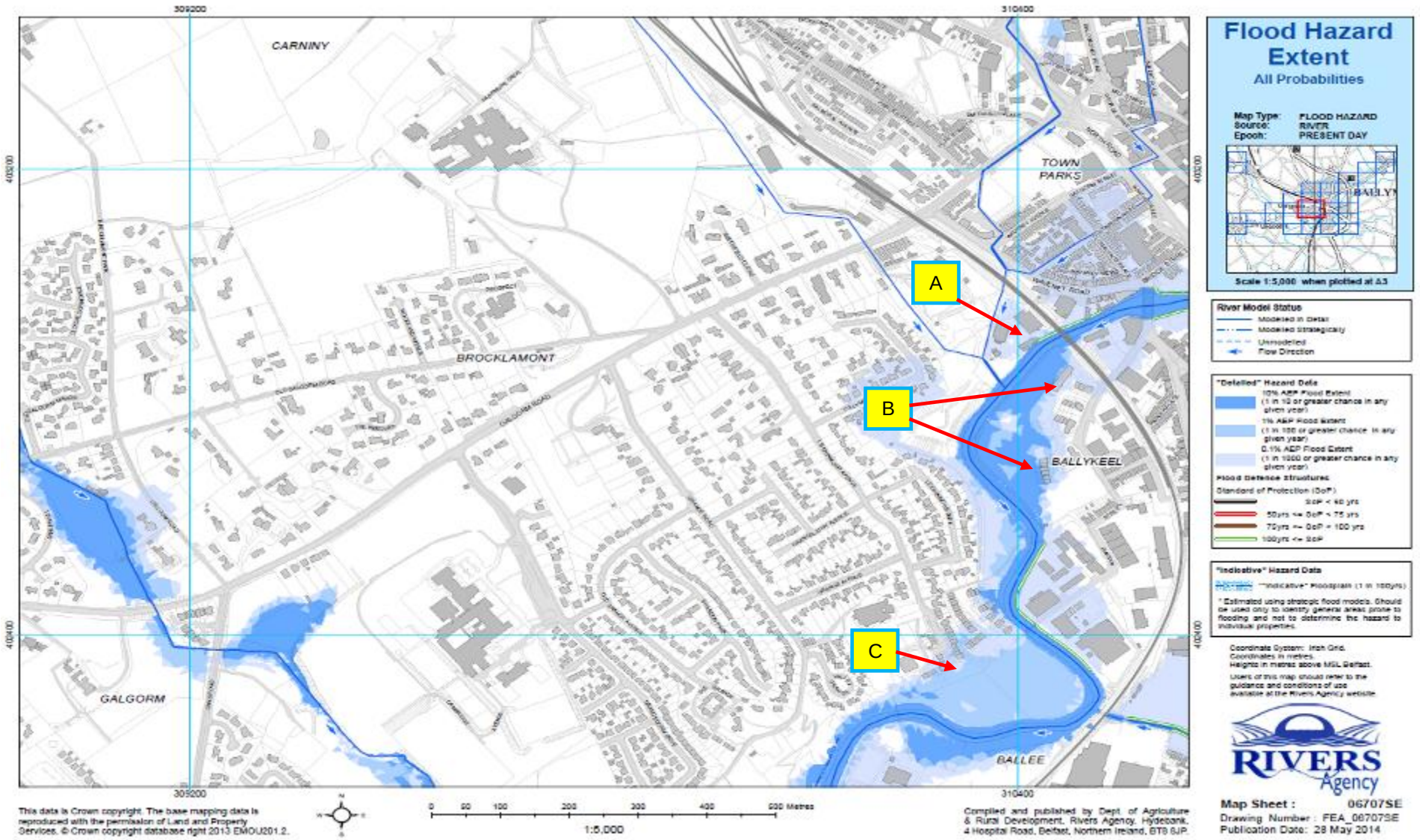
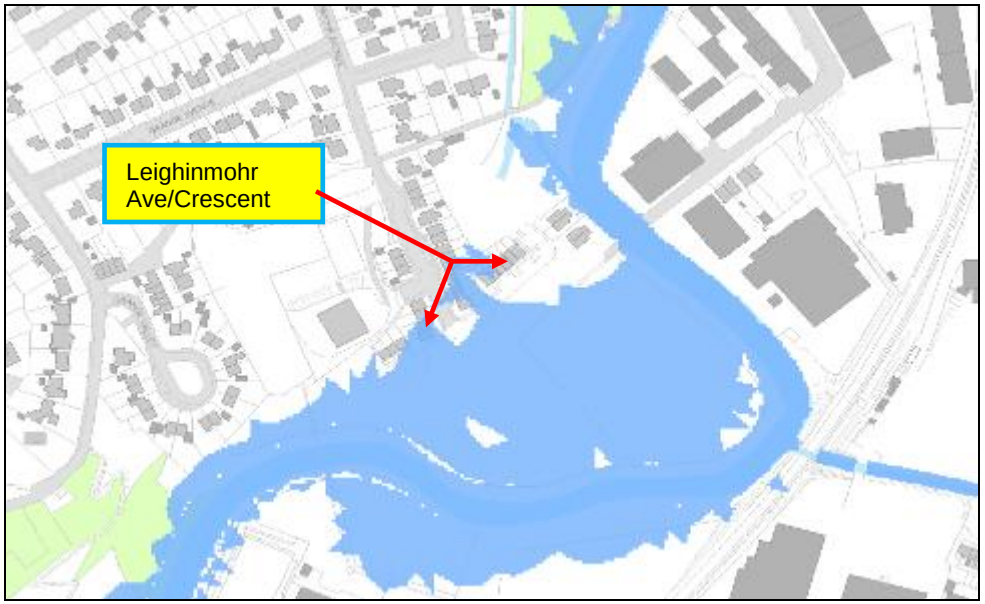


Figure 5.5.4.2 – Flood Hazard map for the Ballykeel area, Ballymena



12 Residential properties flooded at the 1% AEP (Q100) in the Leighinmohr Ave/Crescent area

14 Residential properties in Phoenix Fields and 1 non residential in Ballymena Council Depot flooded at 1% AEP (Q100) event

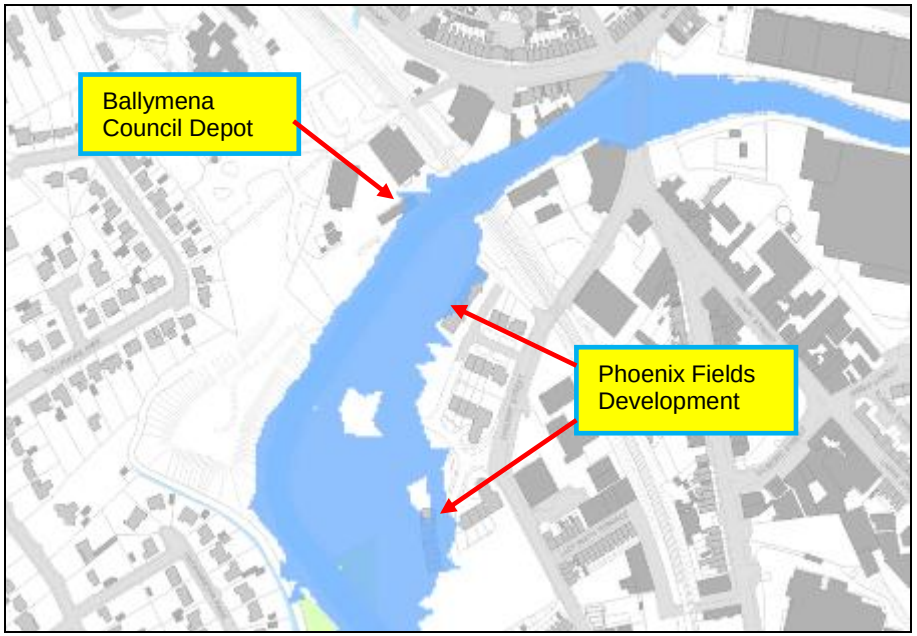


Table 5.5.4.2 - Ballymena SFRA – Ballykeel			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	**14**	**16**	**30**
Non Residential (Nr)	**12**	**13**	**17**
Economic Damage (£)	**£91,005**	**£126,341**	**£477,996**
Annual Average Damage (£)	**£62,731**		
Present Value (£)	**£1,881,930**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)			
Care Homes	**0**	**0**	**0**
GP Surgery's	**0**	**0**	**0**
Fire stations	**0**	**0**	**0**
Hospitals	**0**	**0**	**0**
Police Stations	**0**	**0**	**0**
Schools	**0**	**0**	**0**
Key Infrastructure (Nr)			
NIW Wastewater Treatment Works	**0**	**0**	**0**
NIW Sewage Pumping Stations	**1**	**1**	**1**
NIW Water Treatment Work	**0**	**0**	**0**
NIW Treated Water Pumping Stations	**0**	**0**	**0**
NIE Substation 6to11kV	**1**	**1**	**3**
NIE Substation 33kV	**0**	**0**	**0**
NIE Substation 275kV	**0**	**0**	**0**
NIE Substation 110kV	**0**	**0**	**0**
Road Service - Trunk Road	**0**	**0**	**0**
Environmental Designated sites (Nr)			
AONB	**0**	**0**	**0**
ASSI	**0**	**0**	**0**
Environmentally Sensitive Areas	**0**	**0**	**0**
Maritime Nature Reserve	**0**	**0**	**0**
Nature Reserve	**0**	**0**	**0**
RAMSAR	**0**	**0**	**0**
SAC	**0**	**0**	**0**
Sites of Local Nature Conservation Importance	**0**	**0**	**0**
SPA	**0**	**0**	**0**
RSPB Reserve	**0**	**0**	**0**
UWT Nature Reserve	**0**	**0**	**0**
Built Heritage sites (Nr)			
National Trust	**0**	**0**	**0**
Listed Buildings	**0**	**0**	**0**
Sites and Monuments Records	**0**	**0**	**0**
Buildings of Special Architectural or Historical Interest	**0**	**0**	**0**
Areas of Significant Archaeological Interest	**0**	**0**	**0**
Historic Gardens	**1**	**1**	**1**

Mill Layde Lower and Mill Layde (Line 4) *(Town Center)*

Rivers Agency flood hazard maps indicate flooding in the Parkway Road area of Ballymena. This is illustrated in Figure 5.5.4.3, which shows the predicted extents of the potential fluvial flooding from two local watercourses known as Mill Layde Lower and Mill Layde (Line 4). Details of the impact of the flooding on property and key infrastructure is summarised in Table 5.5.4.3.

Rivers Agency current asset records indicate that there are a number of Grade 4 and 5 defects with Mill Layde (Line 4) and Mill Layde Lower in Ballymena. These defects range from broken pipes, broken joints, root intrusions to obstructions in the pipe. These defects add to the risk of flooding in this area as the main reason of flooding appears to be that both culverts are under capacity. Initial flooding takes place at manhole number U2602/26 located at No 8 Greenmount Avenue and manhole number U2602/25 located in the car park adjacent to Twickenham House at the 20% AEP (Q5) event.

The model shows that at the relatively high frequency 10% AEP (Q10) flood event, floodwater is predicted to spill from the Mill Layde Lower culvert within the Parkway Road area. The flood water ponds to depths of 300mm in the low lying areas, most notably in the Ballymoney Road, Mount Street and Meadow Street areas. This is due to the under capacity of both culverts. It is estimated that **24** residential and **4** non residential properties could be flooded at this event causing damages in excess of **£20,076**.

At the more extreme 1% AEP (Q100) event the predicted flooding is generally confined to the same locations although the flood inundation areas are more extensive. Flooding from the 1% AEP (Q100) event is estimated to affect **30** residential and **12** non residential properties at a cost of around **£43,503**. The present value of the total property damages from potential future floods is calculated to be in excess of **£440,000.**

Inlet grille to Mill Layde Lower

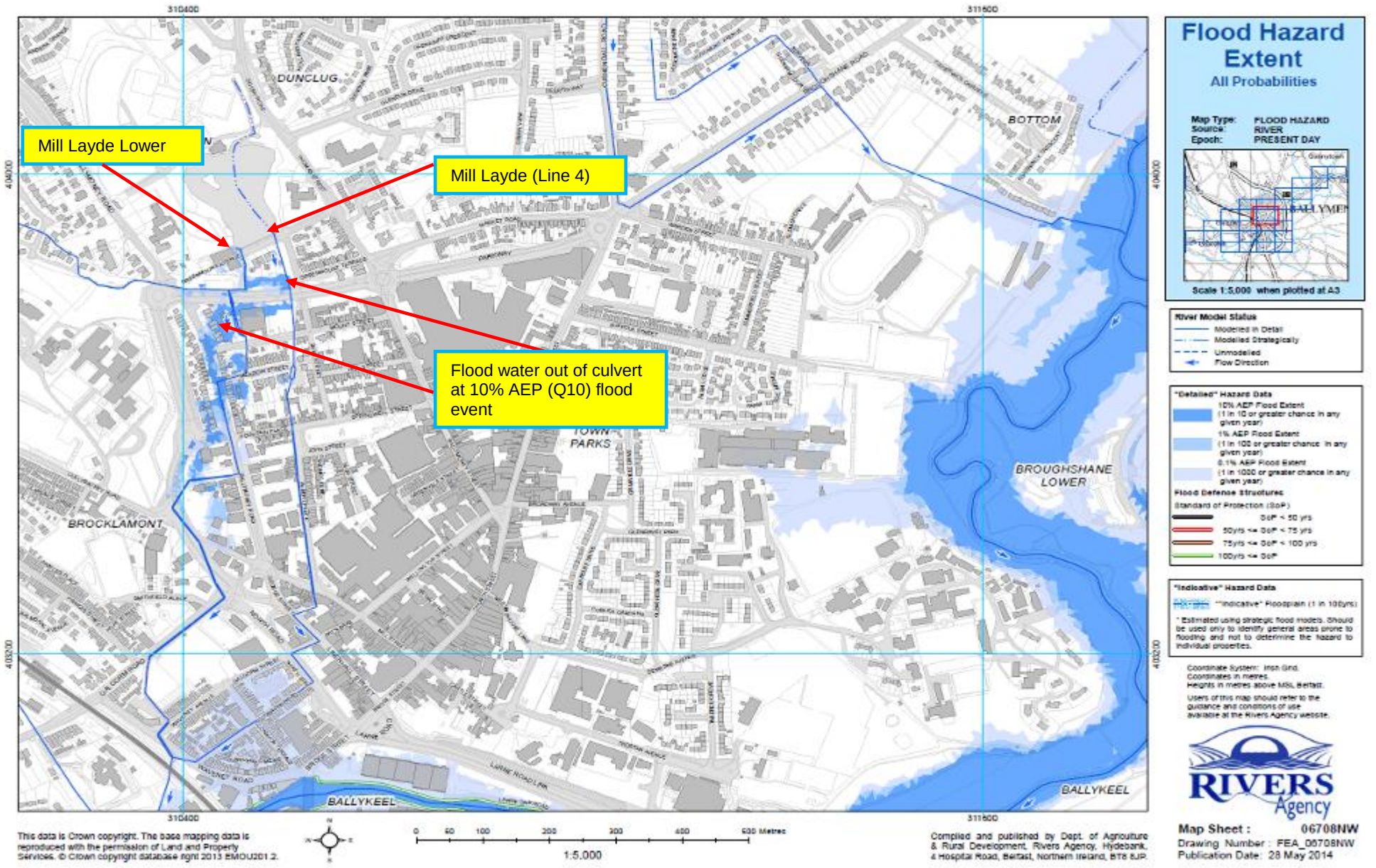


Figure 5.5.4.3 – Flood Hazard extent map for Mill Layde area, Ballymena

Table 5.5.4.3 - Ballymena SFRA – Mill Layde Lower & (Line4)			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	**24**	**24**	**30**
Non Residential (Nr)	**4**	**8**	**12**
Economic Damage (£)	**£20,076**	**£24,766**	**£43,503**
Annual Average Damage (£)	**£14,656**		
Present Value (£)	**£439,680**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)			
Care Homes	**0**	**0**	**0**
GP Surgery's	**0**	**0**	**0**
Fire stations	**0**	**0**	**0**
Hospitals	**0**	**0**	**0**
Police Stations	**0**	**0**	**0**
Schools	**0**	**0**	**0**
Key Infrastructure (Nr)			
NIW Wastewater Treatment Works	**0**	**0**	**0**
NIW Sewage Pumping Stations	**0**	**0**	**0**
NIW Water Treatment Work	**0**	**0**	**0**
NIW Treated Water Pumping Stations	**0**	**0**	**0**
NIE Substation 6to11kV	**0**	**0**	**0**
NIE Substation 33kV	**0**	**0**	**0**
NIE Substation 275kV	**0**	**0**	**0**
NIE Substation 110kV	**0**	**0**	**0**
Road Service - Trunk Road	**0**	**0**	**0**
Environmental Designated sites (Nr)			
AONB	**0**	**0**	**0**
ASSI	**0**	**0**	**0**
Environmentally Sensitive Areas	**0**	**0**	**0**
Maritime Nature Reserve	**0**	**0**	**0**
Nature Reserve	**0**	**0**	**0**
RAMSAR	**0**	**0**	**0**
SAC	**0**	**0**	**0**
Sites of Local Nature Conservation Importance	**0**	**0**	**0**
SPA	**0**	**0**	**0**
RSPB Reserve	**0**	**0**	**0**
UWT Nature Reserve	**0**	**0**	**0**
Built Heritage sites (Nr)			
National Trust	**0**	**0**	**0**
Listed Buildings	**0**	**0**	**0**
Sites and Monuments Records	**0**	**0**	**0**
Buildings of Special Architectural or Historical Interest	**0**	**0**	**0**
Areas of Significant Archaeological Interest	**0**	**0**	**0**
Historic Gardens	**0**	**0**	**1**

5.5.5 Proposed Fluvial Flood Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Ballymena it is important that the flood risk is not increased by new development in areas of known flood risk. Planning Policy Statement, PPS 15, "Planning and Flood Risk", adopts a precautionary approach to development with the primary aim "to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere".

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the "Exception" rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to "Greenfield" built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new Development Plans for Ballymena, Rivers Agency will advise against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 100 year fluvial floodplain or is susceptible elsewhere to surface water flooding.

Rivers Agency will also review the existing Development Plan for Ballymena (Northern Area Plan) with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

The main (undeveloped) flooded areas within the Ballymena area are:

- The John Simpson Memorial Playing Fields
- The old playing fields adjacent to Leighinmohr Crescent
- The Ballee area to the west of Toome Road
- The area to the south of Slemish College
- The area to the south of Balleeway
- Areas north and south of the Galgorm Road near junction with Dans Road
- The area on the left bank of the River Braid adjacent to Phoenix Fields

Planning Applications

Fluvial areas at risk

Rivers Agency will advise against the development of all sites that are located within the 1 in 100 year fluvial floodplain, irrespective of whether they are located within the current plan or as a single site application outside the plan area.

For those sites within the 1 in 100 year fluvial floodplain where the principle of development has been accepted by Planning NI as meeting the "Exception Test", Rivers Agency will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The main existing developed areas, amongst others, at flood risk within Ballymena were re-development may be likely to take place are:

- Pennybridge Industrial Estate
- Ballykeel
- Ballymoney Road area

Areas at risk of surface water flooding

For those sites outside the 1 in 100 year fluvial floodplain that are located in an area where there is evidence of a history of surface water flooding identified by the flooding hardship payments. Rivers Agency will further consider the application through the appraisal of the accompanying Drainage Assessment that will need to demonstrate suitable flood mitigation measures.

Where there is potential for surface water flooding as indicated in the purple predicted areas on the surface water maps, Rivers Agency will advise that the applicant should assess the flood risk and drainage impact to the site himself and construct in the appropriate manner.

The main area identified in Ballymena as being at surface water flood risk is:

- Toome Road

Areas at risk of flood inundation from reservoirs

For all development proposals that are located within the potential flood inundation area of a controlled reservoir we will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures. If it is a new development proposal Rivers Agency will also need the applicant to demonstrate that the condition, management and maintenance regime of the reservoir is appropriate to provide sufficient assurance regarding reservoir safety. There are no controlled reservoirs identified in the Ballymena SFRA.

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is, therefore, important that we continue to target investment by providing flood defence, culvert alleviation schemes and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. The **Flood Investment and Planning Group, (FIPG)**, provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a “Flood Risk Metric Tool” (FRISM) is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total “damage avoidance benefits” that the scheme will provide to the property over the scheme’s design life. If the benefit/cost ratio is greater than 1 (Net Present Value, NPV, figure is positive) then the potential scheme will be referred to Rivers Agency’s Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely Rivers Agency’s responsibility, or is the responsibility of NI Water or Transport NI such as a local drainage or road infrastructure issue, it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a benefit cost analysis identifies a viable scheme, a scheme will be placed on a prioritisation list for works with other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Within the Ballymena area the following potential schemes have been identified and will be referred to the appropriate bodies for further investigation or detailed feasibility study.
List of possible schemes in Ballymena SFRA.

Ballykeel Area, River Braid

- Fluvial flooding from the River Braid

- Flood damage avoidance figure of £ 1.8 million

Ballymena Town Centre, Mill Layde Lower and Mill Layde Line 4

- Fluvial and surface water flooding
- Flood damage avoidance figure of £ 440k

Ballee Area, Ballee Burn

- Fluvial flooding from the Ballee Burn
- Flood damage avoidance figure of £ 770k

Preparedness

In Ballymena it is not possible to prevent or protect against all flooding. Indeed even where flood defences exist it is possible in an extreme event that these could be over topped and flooding could still occur.

Having recognised this fact, considerable effort in recent years has been made by emergency planners in Government Departments, Councils and the Emergency Services working together and sharing information to ensure a coordinated response.

However, despite these improvements during significant flood events the emergency response of Government Departments and the Emergency Services can become over stretched. This means that not all calls for assistance during a flood event may be responded to in a timely manner. With this in mind it is important that households and communities, subject to a known flood risk, are prepared. The detail of preparedness actions, including flood warning and informing activities planned from a regional perspective, are provided in Annex E.

This is not Government withdrawing from any undertaking to respond in emergencies but an additional layer of support to ensure Government Departments and the public work together to reduce the overall impacts of flooding.

From the flood risk assessment there are certain areas of Ballymena which are subject to flood risk and may have flooded before. Therefore, they may benefit from the flood warning and informing proposals outlined in Annex D.

A pilot project of community engagement to deliver flood warning and informing, held in 2014, identified basic assessment formulae to assess and score areas that could potentially be a focus for flood warning and informing actions. Based on this scoring the following areas could be considered suitable for being included in a programme of community engagement to deliver flood warning and informing initiatives:

- Ballymoney Road area.

- Leighinmohr Avenue / Phoenix Fields area.

Key activities that could be undertaken are:

- Explaining the potential and limitations of Community Resilience
- Briefing communities on information available, particulary from the Met Office
- The facilitation of self-help initiatives, including remote sandbag storage; and
- Reviewing and validating all elements of the Community Engagement Plan to help the community communicate effectively in an emergency and work together.

A table in Annex J shows how this community ranks in the overall context of the 20 SFRAs in this Plan. It should be noted that this is an indicative assessment which may change subject to further information on flood risk becoming available.

The rollout of this work is dependent on funding being available.

5.6 Newry SFRA – Newry and Mourne

The core boundary of the Newry SFRA, which has been determined through the PFRA, is located within the Newry and Mourne Local Management Area and illustrated in Figure 5.6 below.

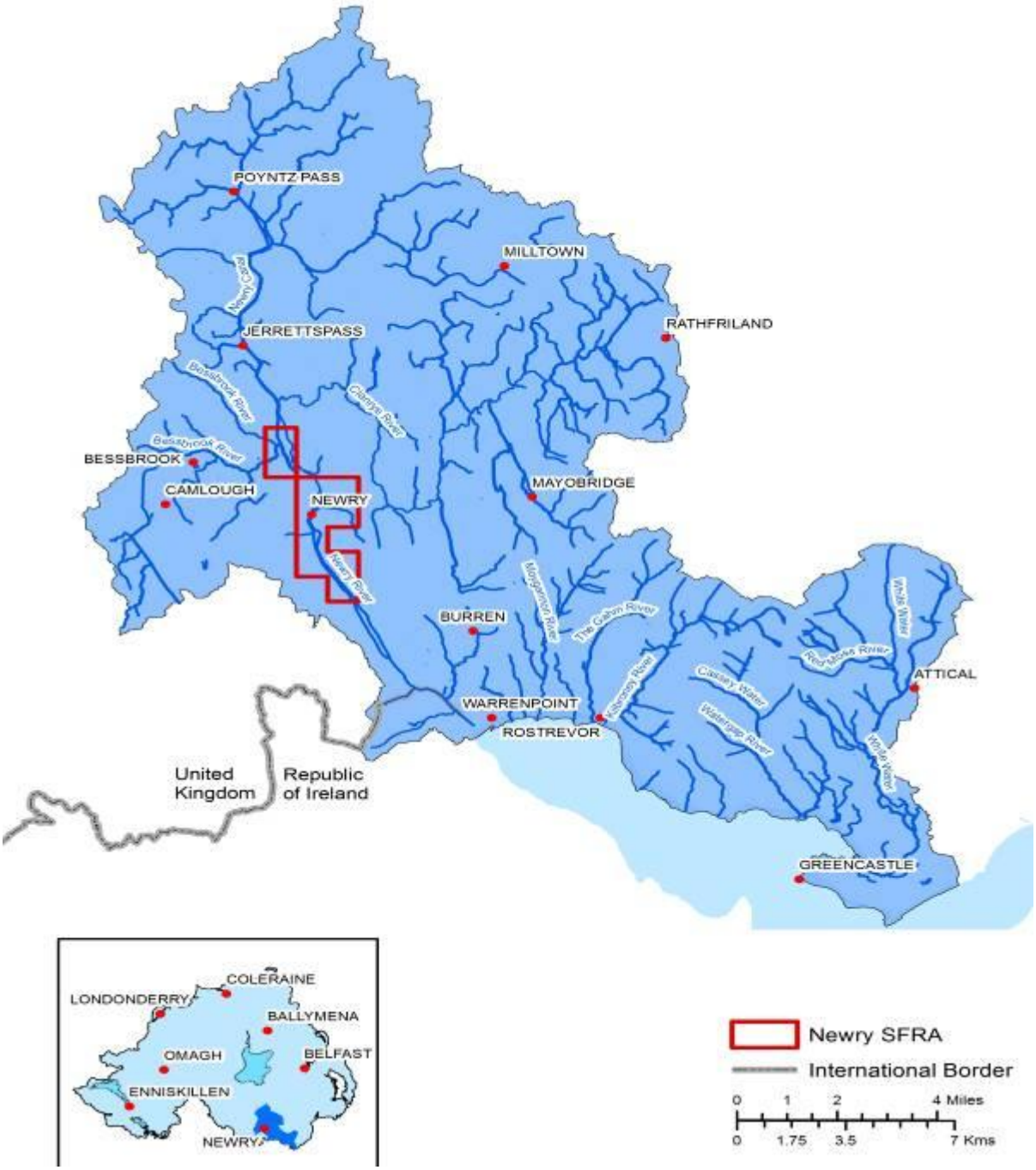


Figure 5.6 - Newry and Mourne LFMA and Newry SFRA

5.6.1 Flooding history

In the past the low-lying areas of St Mary's Street and The Mall in the city were the most vulnerable to flooding from the Newry River. Roadways were flooded on a regular basis. Buildings in The Mall were affected on average twice per decade with St Mary's Street being affected more frequently. Parts of Kilmorey Street were similarly affected but on a less frequent basis.

Flooding, caused by the Newry River rising, initially appeared as water backing up through the local storm system. This is followed, at higher river levels, by water escaping through gaps in the masonry walls and buildings, which convey the watercourse through the city centre. At St Mary's Street, where buildings are adjacent to the river, floodwater has risen through the floors on previous occasions. The footbridge opposite O'Hagan Street is lower than the adjacent river walls and its access is sandbagged in times of flood to try and contain the river. During the high flows water has also been observed seeping through joints in the one hundred-year-old walls.

This flooding problem has been since alleviated through a scheme that was carried out in the early 2000s by Rivers Agency.

Newry was also affected by the 2008 flood event and had recorded the Rank 1, 2 and 4 highest floods in the three gauging stations in the area. Interestingly, though, minimal flooding was recorded in the media, which is perhaps an indication of the actual flood risk posed to Newry. Alternatively, it could also be, or reflective of, the how serious the flooding was elsewhere in Northern Ireland on this day thus focussing attention away from Newry.

A summary of the most notable flooding incidents is indicated in Table 5.6.1.1.

Date and Source	Flooding Account
28 September 1875 The Northern Whig	The area's most affected included: Queen Street, Talbot Street, Sandy Street, Bridge Street, Kilmorey Street and Corn Market. The extensive flooding forced residents of the affected areas to seek refuge in the upper stories of their houses or vacate the houses and stay with more fortunate friends and acquaintances.
28 September 1875 The Belfast Newsletter	The article described the severe flooding experienced in Newry following three days of heavy rain and violent gales. The oldest inhabitants of the town could not recall a stormequal in "*severity or destructive effects*".
28 August 1905 The Belfast Newsletter	The town of Newry is said to have felt the full force of the 46 hours of continuous rainfall. Although areas around the country are said to have suffered flooding, Newry was spared extensive flood damage due to the fact that the water level in the Canal was very low throughout the summer, when the rains came the surface runoff was allowed to drain away and after the rainfall the water level was once again restored to the

Date and Source	Flooding Account
	high level mark.
19 January 1973	24 hour rainfall total of 66.1mm Flooding at Sugar Island/Basin Walk due to river overflowing into canal. Flooding at Mary Street and adjacent street.
22 November 1981	24 hour rainfall total of 46.8 mm. Flooding at St Mary's, Kilmorey, River and Quay Streets, Home Avenue and Warrenpoint Road, cause not specified.
January/February 1990	Series of high tides. Flooding to St Mary's Street and the Mall. Back up from local drainage a factor but also river was sufficiently high to flow directly into Mary Street properties and over footbridge at O'Hagan Street. The flooding persisted for several days, as there were insufficient outlets to allow the water to drain away between tides.
9 November 2000 Newry Reporter	Despite the Clanrye River rising to alarming heights, Newry managed to escape flooding due to the fact that tides were not high and aided by the construction of the retaining wall along the river banks, the town would have suffered a fate similar to the floods of the early 1970s
18 July 2003 Belfast Telegraph	Newry suffered 70mm of rainfall the annual average for the entire month of July. Water had to be pumped away from Daisy Hill Hospital. "Monaghan Street was a no go area". The main A1 from the Mourne. Sandy Street and Talbot Street had water and raw sewage floating on them as the system failed to cope with heavy surface water
16th Aug 2008	No Information on Aug 2008.
October 2011	Rivers Agency records indicate that approximately 10 residential properties flooded and a similar number of commercial properties flooded in Bridge Street due to a heavy rainfall event
13th Nov 2014	Number of residential and commercial properties flooded in Bridge Street due to intense rainfall event in the Dromalane Catchment.

Table 5.6.1.1 – List of flooding events in Newry

Photo 5.6.1.1 - Bridge Street, Newry 13th Nov 2014

Photo 5.6.1.2 - Bridge Street, Newry 13th Nov 2014

Bridge Street

Rivers Agency records indicate that there have been a number of occasions where Bridge Street in Newry has flooded. The Flooding Hardship Payment scheme shows that 10 residential properties and a similar number of commercial properties flooded at this location in October 2011 and November 2014. (See Figure 5.6.1.1) This area of Newry flooded from the Glen River system and the Dromalane Stream on both occasions.

Figure 5.6.1.1 - Rivers Agency record of Flooding Hardship Payments for flooded properties in Bridge Street, Newry, Oct 2011

A post flood investigation was carried out by Rivers Agency after the 2008 flooding, which saw Rivers Agency and N.I Water working to alleviate the flooding problem in Bridge Street. The post flood investigation found that the flood problem arose from an un-adopted culverted watercourse known as The Railway Drain. The Railway Drain commences at an attenuation tank in a car park off Monaghan Street and discharges into a designated watercourse known as the Glen River Overflow. (See Figure 5.6.1.2 on the next page)

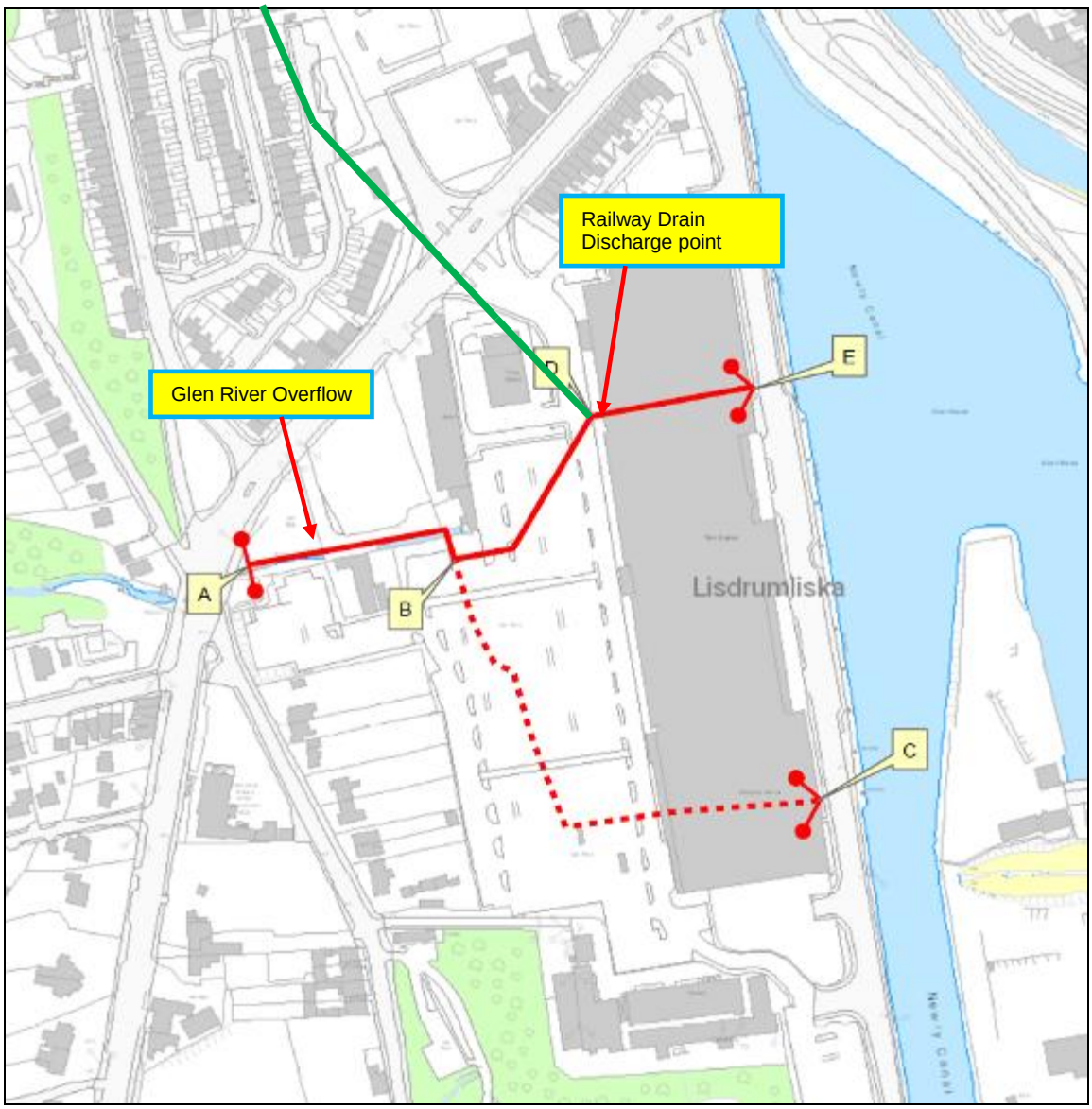


Figure 5.6.1.2 – Map showing where Railway drain discharges into the Glen River Overflow

Rivers Agency agreed to survey the undesignated section of the Glen River Overflow point D to point E in Figure 5.6.1.2 which was altered during construction stage of the Quays Shopping Centre during the late 1990s. A new culvert was laid (B-D) to the existing undesignated culvert (D-E) with the open channel and culverts (B-C) abandoned.

Since the culvert, inlet structure, silt trap and open channel (A-B-D-E) were now in the line of the watercourse it was proposed that Rivers Agency:

- de-designate the line B-C
- designate the line B-E

It was also discovered during the post flood investigation that, during construction of The Quays Shopping Centre, a new culvert was also laid from point (B-D-C) on the Lower reach of the Glen River and the existing culvert reach from point (B-C) was abandoned. Since this new culvert, inlet structure, and open channel (A-B-D-C) was in line of the watercourse it is proposed that the Rivers Agency:

- de-designate the line B-C in figure 5.6.1.3
- designate the line B-D-C in figure 5.6.1.3

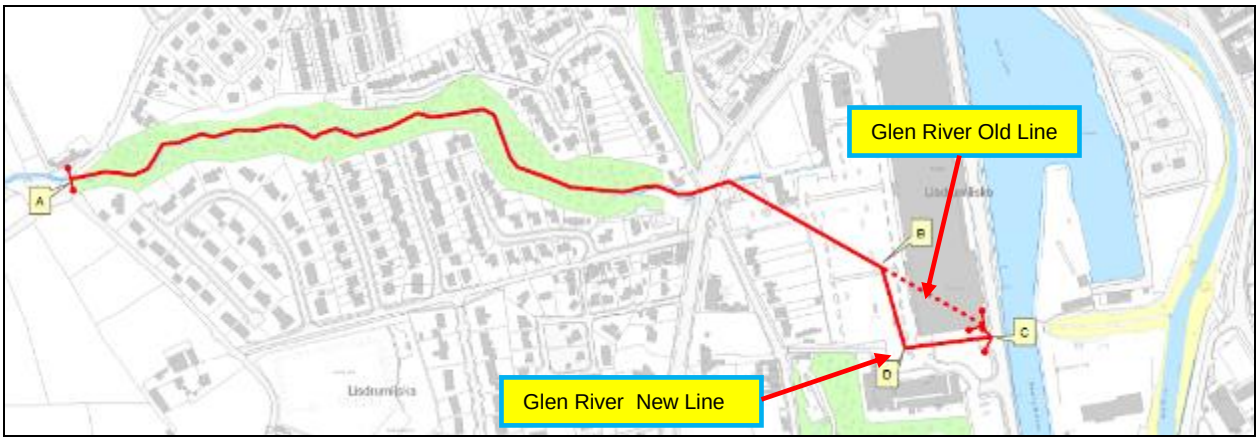


Figure 5.6.1.3 -Map showing the old and new line of the Glen River

Existing River Defences

Part of the city of Newry lies in the floodplain of the tidal Newry/Clanrye River. The area was historically protected from flooding by a masonry river wall which was over 100 years old.

Rivers Agency carried out a feasibility study which considered the hydrology of the catchment, the relationship between tidal and river flow conditions, the risk of failure of the old wall, and the benefit/cost of the works. The report recommended that the old wall should be replaced.

The construction work was carried out in 3 separate contracts in order to minimise disruption in the city centre and the main works included:

- Reinforced concrete retaining wall along the edge of the river, with the exposed faces clad with local Newry granite to retain the character of the area.

- The rising of upstream and downstream flood banks.

- New trunk sewer behind the floodwall as part of N.I Water's overall improvement of the sewerage system, which collects combined storm overflows and other outfalls to the river and conveys the flow to a new pumping station.

Photo 5.6.1.3 - Flood walls in Newry Town centre after construction in 2003

Photo 5.6.1.4 - Earth flood bank that separates the Newry Canal and the Newry River that was raised in 2001

Knox Peebles drain flood defence

The Knox Peebles Drain is a designated watercourse that runs along the eastern edge of the Greenbank Industrial Estate and discharges into the Newry River at the Sea Defence Rampart. (See figure 5.6.1.4) The outlet is fitted with a tideflex valve.

After a feasibility study was completed in 2001 it was proposed that a scheme be carried out on the reach of open watercourse opposite the factory occupied by FM Systems Ltd in the Greenbank Industrial Estate. This would raise a 250m section of the right bank using a king post wall comprising of vertical steel columns with horizontally spanning sheeting piles. This work cost approximately £90,000.

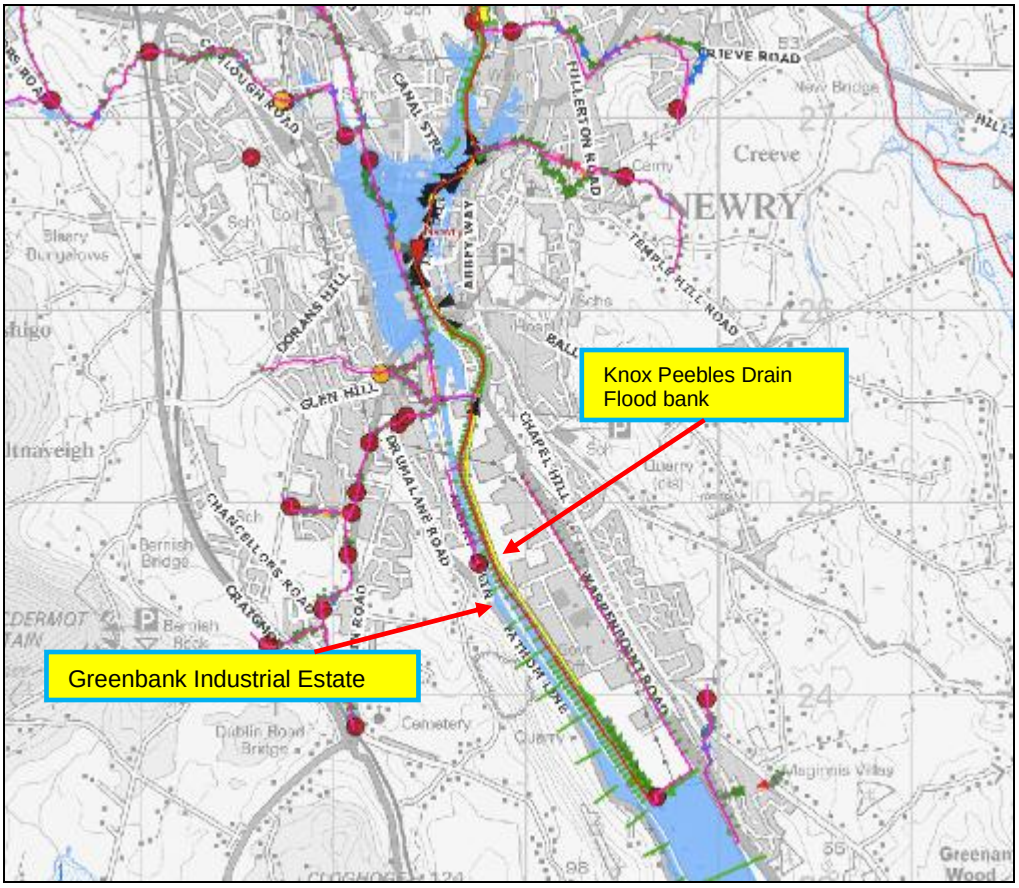


Figure 5.6.1.4 - Knox Peebles Drain located to the east of Greenbank Industrial Estate

Derrybeg System

The Derrybeg system is a designated watercourse which is culverted through a low lying area of Monaghan Street/ Upper Edward Street and Corn Market. The entire length of the culvert from Upper Edward Street/ Railway Avenue to its outfall to the Newry River received a number of improvements after a feasibility study was carried out in 1991. The feasibly study highlighted that in times of heavy rain flood water would back up through the system and spill from the manholes located in the Monaghan Street area. The recommendation from the feasibility study consisted of:

- Installing a flap valve at the outfall
- Installing a penstock

- Pressurised lids on all manholes
- Diverting storm connections to the Bridge street pumping station where possible and installed flap valves to any connections which remained.

Photo 5.6.1.5 - Inlet Structure on Derrybeg River

Existing Coastal Defences

Greenbank Earth Bank

This is a high earthen flood bank, which protects a large industrial estate from direct inundation from the adjacent Newry River. (See points A to B in figure 5.6.1.5). The embankment was found to be in reasonable condition and calculations generally yield satisfactory factors of safety for possible modes for failure such as piping (water seeping through the embankment), rotational slip, settlement, overtopping and erosion.

The Rampart

The Rampart is the seaward face of the flood defences protecting the Greenbank Industrial Estate (See point C below). Whilst the profile of the Rampart is inappropriate for wave energy dissipation, the likelihood of an extensive failure which would release sufficient water to endanger the developed part of the Estate is considered slight. Any failure is likely to be as a result of waves overtopping the crest and/or displacing pitching and causing failure by scour action.

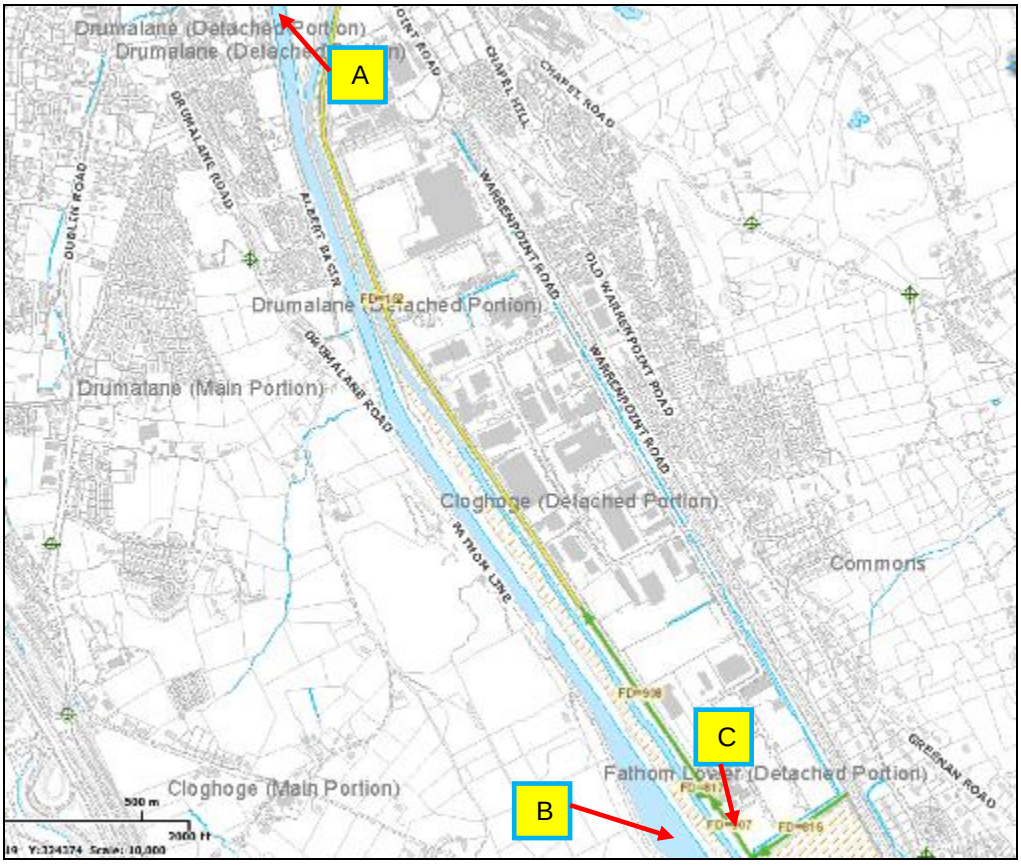


Figure 5.6.1.5 - Greenbank Industrial Estate Sea Defence

5.6.2 PFRA – Identification of Potentially Significant Flood Sources

According to the Preliminary Flood Risk Assessment (Dec 2011) the city of Newry, in terms of the potential adverse consequences of flooding, is ranked 2nd of the twenty SFRA within Northern Ireland (see Figure 4.1). On the basis of this initial assessment, which was undertaken using the strategic flood maps, the predominant flood risk to the city was considered to arise from fluvial flooding with some risk of coastal flooding.

It should be noted that the PFRA flagged up the potential for significant fluvial flooding at Newry because this national assessment is based on strategic 'undefended' flood models which ignore the presence of existing flood defence systems such as Newry city flood walls and the Greenbank Sea Defence. Therefore, the assessment is in effect based on the worst case scenario, as it assumes there is no benefit from the defences. This precautionary approach has been taken because at the time of the assessment there was a degree of uncertainty about the level of protection that each of the existing flood defence systems provides. By adopting this approach, the urban areas that are located behind existing flood defence structures were determined to be SFRA by default and as a consequence detailed Flood Hazard/Risk Maps had to be

prepared in compliance with the requirements of the EU Floods Directive. This provided the opportunity to undertake the detailed structural assessments and flood modelling necessary to remove the uncertainty and establish the actual level of protection offered by these defences.

To facilitate a more robust assessment of the level of flood risk to Newry from fluvial and coastal flooding, Rivers Agency developed detailed predictive flood models for each of these sources. It is considered that the flood hazard maps produced from these models will give a more accurate prediction of the flooded areas which may have been over or under estimated by the strategic flood maps. Details of the models and their output are described in the following sections.

5.6.3 Catchment Description

Newry is a thriving commercial city straddling the Newry River/Clanrye River at the North Western limit of the narrow inlet of Carlingford Lough.

The Clanrye, Bessbrook and Jerettspass tributaries drain the Newry River catchment; the catchment size is 902 km^2. The Newry Canal runs adjacent to the river through the city and drains a catchment near to but separate from the river catchment. However during high flow conditions the canal can overflow into the river significantly increasing its flow.

The river is tidal from Carlingford Lough through the city to Thompson's Weir. The tide is the main influencing factor over this stretch with the river being dominant upstream of the weir. When high flows in the river coincide with high tides low-lying areas of the city, especially its centre, are vulnerable to flooding. The route of the river through the city and the extent of the potential flood plain for a 1: 100 year event are indicated on Maps No 2 and 3 respectively.

The Greenbank Industrial Estate, to the south of the town, is protected from direct inundation from the river by a high earth floodbank. The river through the town is bounded by buildings and masonry walls, which provide varying degrees of, flood protection to adjacent low-lying areas.

Newry Canal

The Newry canal was opened in 1742 with the first lock connecting it to the Newry River being constructed at the location of the present Albert Basin. The canal has now been abandoned for commercial purposes, in stages, starting with the inland section in 1949, followed by the section through the city in 1956 and finally the section from Albert Basin to Victoria Lock, known as the ship canal in 1974. Newry & Mourne District Council assumed ownership of the canal, within its boundary, in 1986 with the intention of utilizing its recreation potential.

The Canal is a designated watercourse, upstream of Dublin Bridge and serves a drainage function in the rural area but through the main urban area a base flow is provided and limited by a 900mm diameter culvert. Sluice gates at Victoria Lock are operated by the lock keeper depending on the weather conditions. (See photo 5.6.3.1). The canal has been used in a storage capacity in previous flood events.

Photo 5.6.3.1 - Victoria Lock Gates on the Newry Canal

5.6.4 Coastal Flood Risk Assessment

Model

Rivers Agency's new detailed coastal hazard map indicates that Newry city is also at risk from coastal flooding as it is fluvial flooding. The 0.5% AEP (Q200) flood level for Newry was obtained from the Irish Surge and Tidal Model that is used to determine extreme sea levels around the non-estuarine coastline of Ireland. This coastal model indicates that there is a significant risk of flooding to Newry city in particular the old Warrenpoint Road at the entrance to Greenbank Industrial estate.

Due to the complex nature of Carlingford Lough, detailed modelling was required to establish extreme water levels at Newry. Although Newry is within Carlingford Lough, it is in the upper reaches. Therefore, Rivers Agency did not have sufficient bathymetry or calibration data to adequately model the channel that far upstream. A more reliable prediction point was chosen to represent the Newry extreme tidal boundaries. This

also had the advantage of being independent of fluvial conditions and, therefore, suited to the provision of boundary conditions for further modelling. The location of this point (6.262°W, 54.099°N) can be seen in Figure 5.6.4.1.

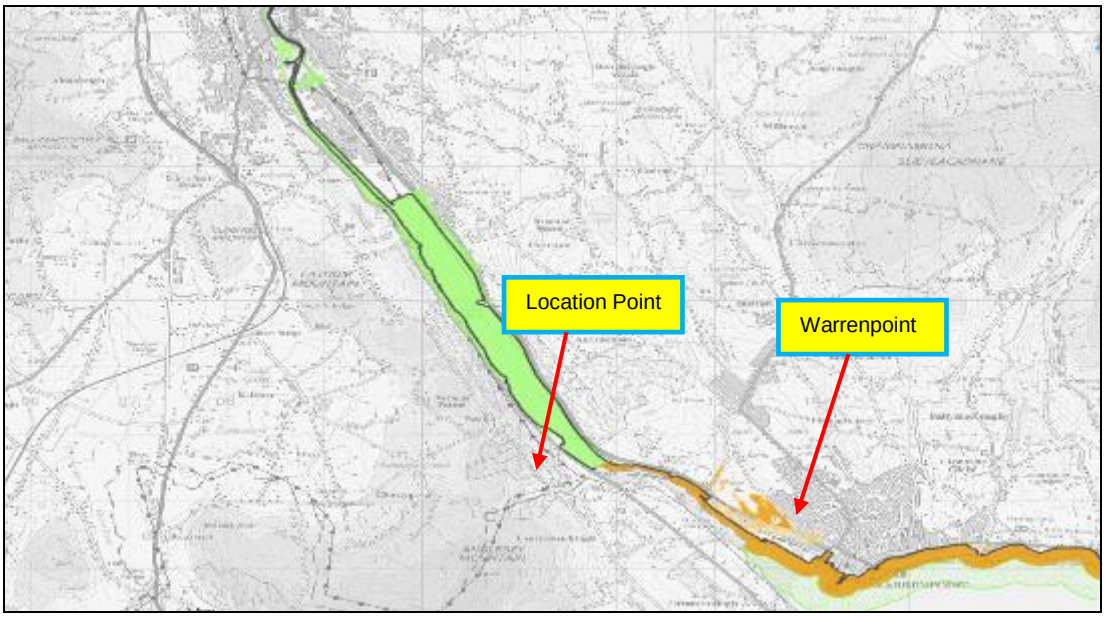


Figure 5.6.4.1 - Location point in the Newry Coastal model

Coastal Flooding Mechanisms

The model shows that, at the more extreme 0.5% AEP (Q200) flood event, floodwater is predicted to inundate the north end of Greenbank Industrial Estate and the Old Warrenpoint Road. (See Figure 5.6.4.2). The flood water will pond to depths of up to 300mm in the low lying areas, most notably in the north end of the Greenbank Industrial Estate. It is estimated that **16** non residential properties could be flooded at this event causing damages in excess of **£347,302**

Return Period	Water Level (OD)
2	**2.75 m**
10	**3.078 m**
25	**3.389 m**
50	**3.466 m**
75	**3.520 m**
100	**3.650 m**
200	**3.950 m**

Table 5.6.4.1 - Predicted Coastal Levels for Present Day at Newry

Photo 5.6.4.1 - Newry city came close to flooding January 2014 from a coastal event

Table 5.6.4.2 - Newry SFRA – Greenbank Industrial Estate Potential Adverse Consequences – Coastal Flooding			
	Flood Event % AEP		
	10% AEP	4% AEP	0.5% AEP
Residential (Nr)	0	0	0
Non Residential (Nr)	0	0	16
Economic Damage (£)	0	0	£347,302
Annual Average Damage (£)	£8,726		
Present Value (£)	£261,780		
IPPC sites (Nr)	0	0	1

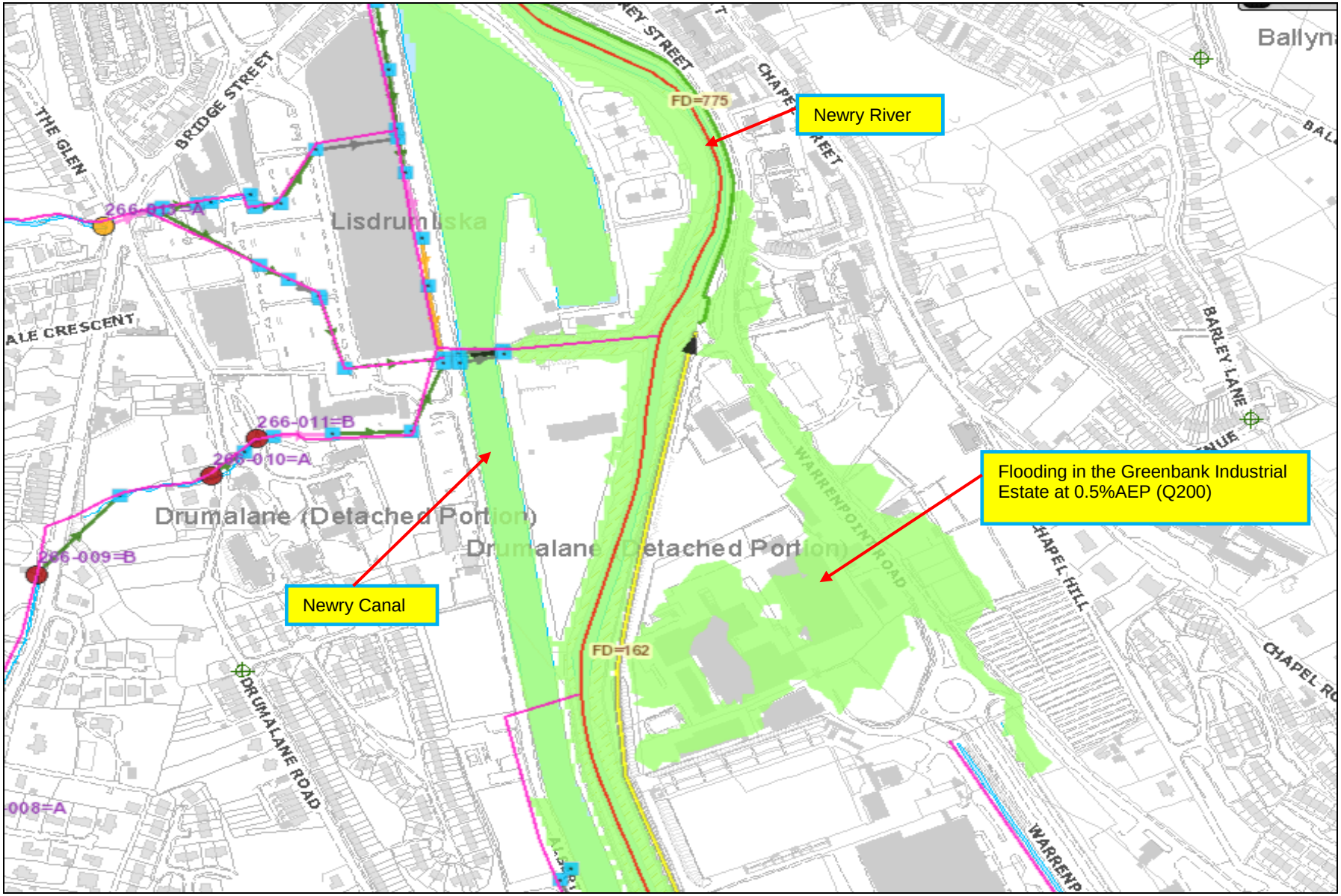


Figure 5.6.4.2 - Detailed Coastal Flood Extent map for Greenbank Industrial Estate in Newry City 0.5 %AEP (Q200)

5.6.5 Proposed Coastal Flood Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Newry it is important that the flood risk is not increased by new development in areas of known flood risk. Planning Policy Statement, PPS 15, "Planning and Flood Risk", adopts a precautionary approach to development with the primary aim "to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere".

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the "Exception" rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to "Greenfield" built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new Development Plans for Newry Rivers Agency will advise against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 200 year coastal floodplain.

Rivers Agency will also review the existing Development Plan for Newry (Banbridge, Newry and Mourne Area Plan) with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

Planning Applications

Coastal areas at risk

Rivers Agency will advise against the development of all sites that are located within the 1 in 200 year coastal floodplain, irrespective of whether they are located within a current development plan or as a single site application outside the plan area.

For those sites within the 1 in 200 year coastal floodplain where the principle of development has been accepted by Planning NI as meeting the "Exception Test", Rivers Agency will further consider the application through the appraisal of an accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The main existing developed areas, amongst others, at coastal flood risk within Newry where re-development may be likely to take place are:

- Greenbank Industrial Estate on the old Warrenpoint Road

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is, therefore, important that we continue to target investment by providing flood defence, culvert alleviation schemes and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. The **Flood Investment and Planning Group, (FIPG)**, provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a "Flood Risk Metric Tool" (FRISM) is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total "damage avoidance benefits" that the scheme will provide to the property over the scheme's design life. If the benefit/cost ratio is greater than 1 (Net Present Value, NPV, figure is positive) then the potential scheme will be referred to Rivers Agency's Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely, Rivers Agency's responsibility, or is the responsibility of NI Water or Transport NI such as a local drainage or road infrastructure issue, it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a benefit cost analysis identifies a viable scheme, a scheme will be placed on a prioritisation list for works with other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Having conducted a detailed assessment of the coastal flood risk to the Greenbank Industrial Estate in Newry, Rivers Agency has determined that potential flood alleviation schemes may be justified for this location.

Rivers Agency has commissioned a feasibility study including an economic appraisal under their Engineering Services Framework to assess the Greenbank Sea Defence in Newry. The expected completion date for

this feasibly study is early summer 2015. The outcome of this feasibility report will be reflected in the final Flood Risk Management Plan in December 2015.

Preparedness

Coastal flooding has the potential to have a significant impact in terms of risk to life. This is mainly due to the rate of inundation from the sea at the height of the tidal cycle. In light of this the emergency response to significant coastal flooding with a risk to life will be led by PSNI and evacuation of potentially affected areas will be a real consideration.

To ensure a coordinated approach local, tactical Coastal Flooding Emergency Response Plans are being developed for Newry. This will link to a strategic Coastal Flooding Emergency Response Plan.

The Coastal Flood Response Plan aims to provide a pre-planned response to a warning of coastal flooding and outline the graduated incident and coordinated inter-agency response to a potential or actual coastal flooding event.

The objectives of the plan are to:

- Identify activation triggers for responding to a coastal flood warning or incident.
- Document the actions to be taken on receipt of a coastal flood warning.
- Set out the process for a coordinated response including the graduated incident management of a potential or actual coastal flooding event.
- Ensure a common understanding of the potential impacts of a coastal flooding event in each area and act as a reference document for all the agencies involved to provide a pre-planned response at various levels of coastal flood risk.

5.6.6 Fluvial Flood Risk Assessment

Flood Model

The modelled constructed for the Newry SFRA extends from Jerettspass to beyond Victoria Lock a reach of approximately 14km and includes 92 topographical survey cross-sections. There were 13 bridges along this reach that affected the hydrodynamic characteristics of the river and were included in the model along with all surveyed weirs. In order to increase the accuracy of the model, and particularly the linkage between the 1D and 2D domains of the model a number of interpolated sections were added. The Newry Canal runs adjacent to the Newry River and was included in the same Infoworks model network so that interactions between the canal and river could be modelled.

InfoWorks ICM was used for rivers flowing through urban areas. In addition to survey data, the Rivers Agency InfoNet database provided data for the ICM models. Eight InfoWorks ICM 1D/2D hydrodynamic

models were prepared for the Newry study. The downstream boundary conditions for each of the ICM models were extracted from the model of the river into which it discharges, providing a stage/time boundary to simulate backwater effects.

Fluvial Flooding Mechanisms

City Centre

Figures 5.6.6.3 and 5.6.6.4 illustrates the predicted extents of the potential fluvial flooding from the Newry River and details of the impact of the flooding on property and key infrastructure is summarised in Table 5.6.6.1.

The model constructed for Newry city indicates the first breach point is located just downstream of Thompsons Weir on the Newry River. The model indicates that flood water begins to breach at this location around the 10% AEP (Q10) event. Once out of channel the flood water makes it way towards Downshire Road and then further onto Sandy's Street. (See Figure 5.6.6.1)

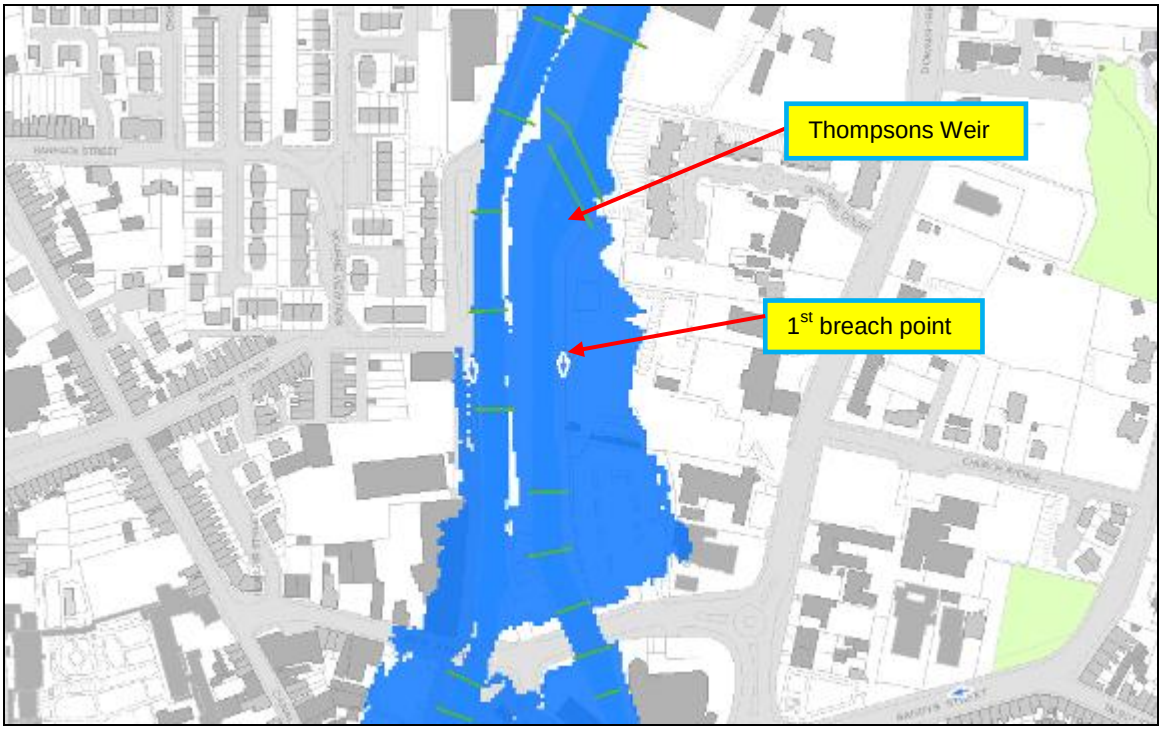


Figure 5.6.6.1 - First breach point on the Newry River

Shortly after flood water as spilled at Thompson's weir it then begins to overtop the flood wall on the right bank located in front of Newry Town Hall at the old war memorial. (See Figure 5.6.6.1 & photo 5.6.6.2). Flood water from this location then makes its way into the Newry Canal.

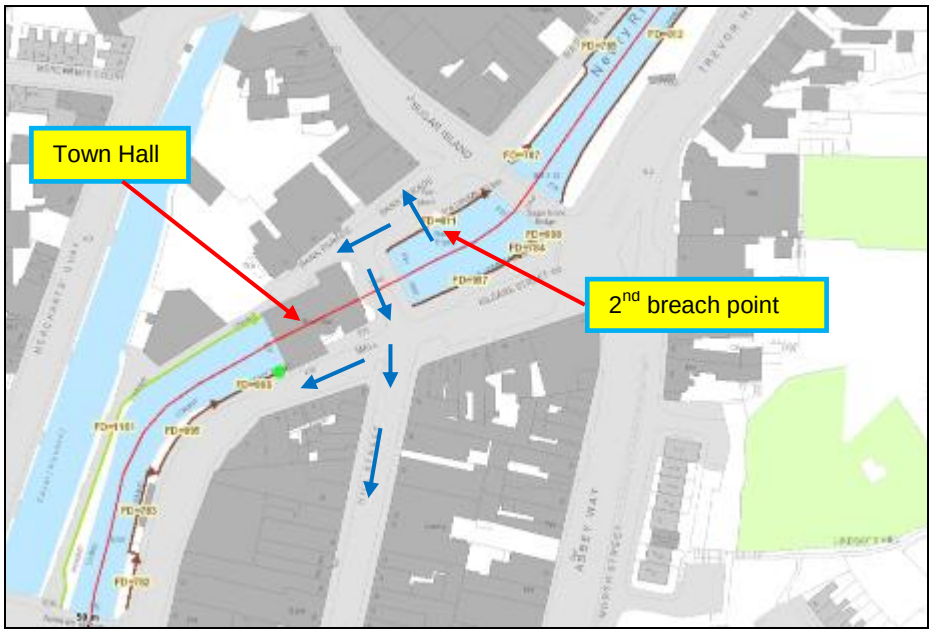


Figure 5.6.6.2 - Second breach point in Newry city - Town Hall

It is estimated that **136** residential and **290** non residential properties could be flooded at the 10% AEP (Q10) event causing damages in excess of **£4,848,000**.

At the more extreme 1% AEP (Q100) event the predicted flooding is generally confined to the same locations although the flood inundation areas are more extensive and deeper (up to 1m deep) particularly in the Sugar Island and Monaghan Street. Flooding from the 1% AEP (Q100) event is estimated to affect **305** residential and **697** non residential properties at a cost of around **£11,198,000**.

The present value of the total property damages from potential future floods is calculated to be in excess of **£19.2 million.**

However, there is some uncertainty regarding these flood extents for Newry city. A number of concerns have been raised regarding the model outputs and these have been sent for further investigation. The outcome of this further investigation is likely to reduce the flood extents and associated damages in the Monaghan Street and Francis Street areas of Newry at the lower return periods. Any changes from this further investigation will be reflected in the final Flood Risk Management Plan in December 2015.

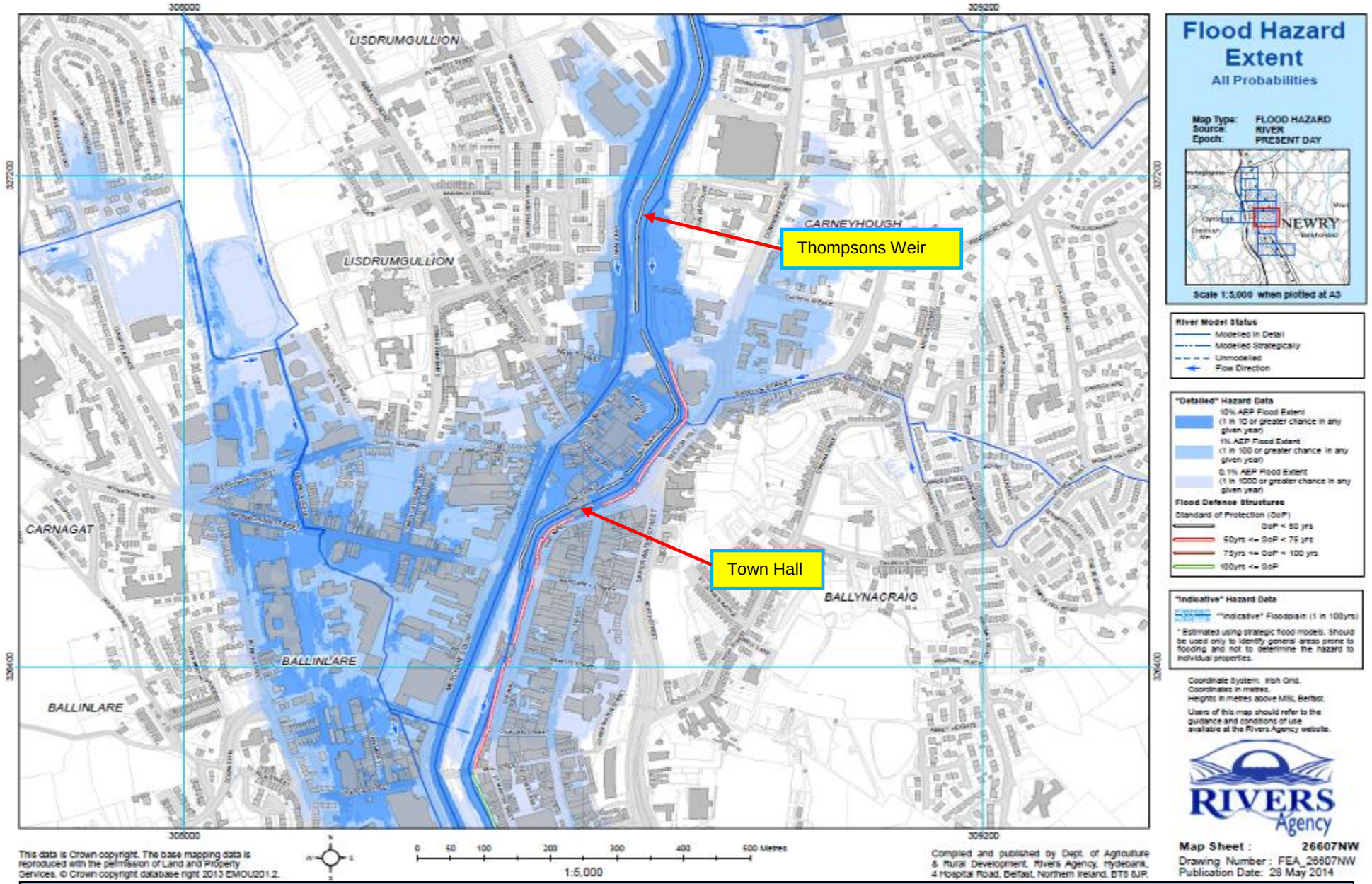


Figure 5.6.6.3 – Flood Hazard extent map for Newry Area

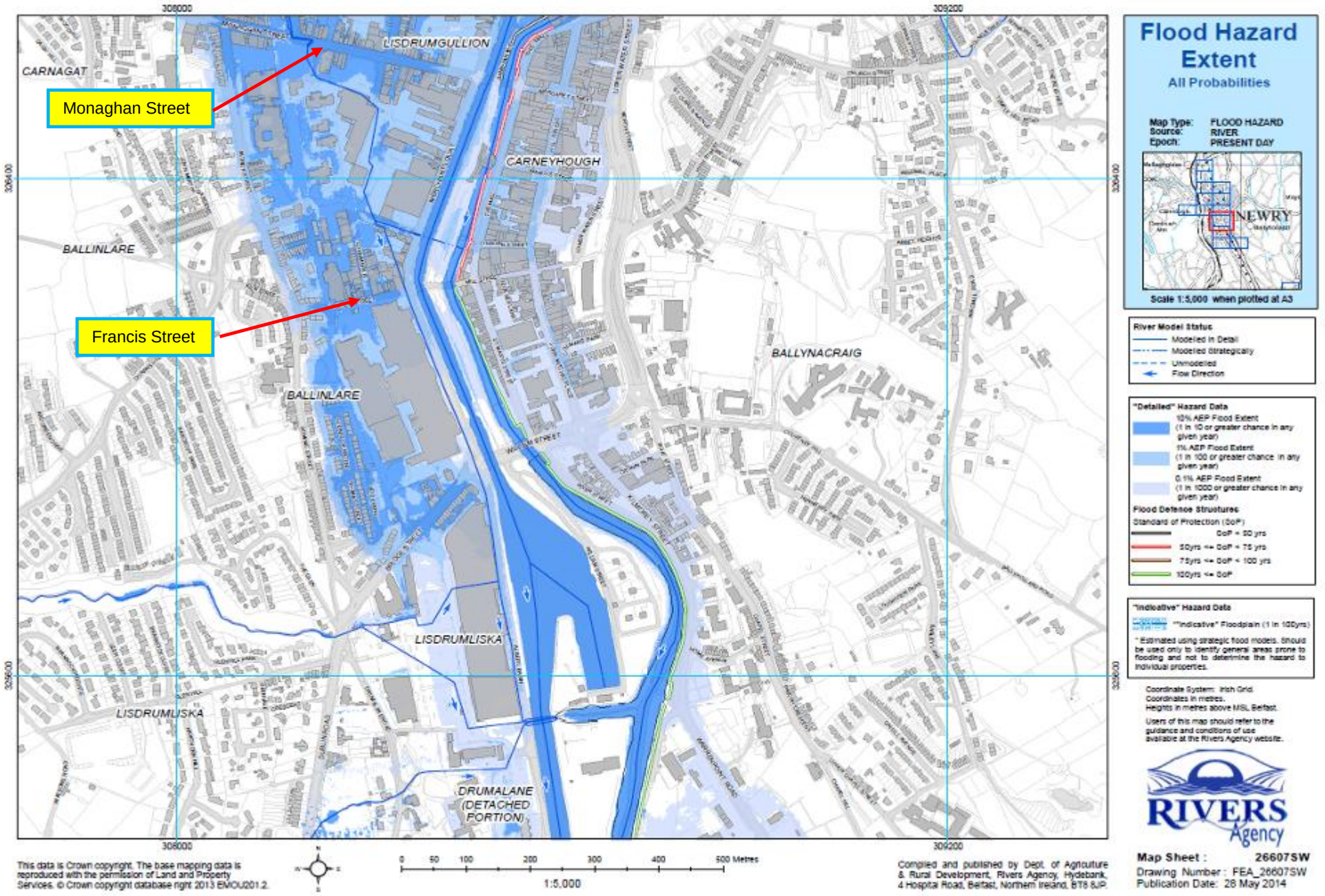


Figure 5.6.6.4 – Flood Hazard extent map for Newry Area

Photo 5.6.6.1 - Second breach point in Newry – Upstream of Newry Town Hall at the War Memorial

Table 5.6.6.1 - Newry SFRA – Town Centre			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	136	210	305
Non Residential (Nr)	290	430	697
Economic Damage (£)	£4,840,000	£7,260,000	£11,198,000
Annual Average Damage (£)	£639,870		
Present Value (£)	£19,196,100		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)			
Care Homes	**0**	**0**	**0**
GP Surgery's	**0**	**0**	**0**
Fire stations	**0**	**0**	**0**
Hospitals	**0**	**0**	**0**
Police Stations	**0**	**0**	**0**
Schools	**0**	**0**	**0**
Key Infrastructure (Nr)			
NIW Wastewater Treatment Works	**0**	**0**	**0**
NIW Sewage Pumping Stations	**0**	**0**	**0**
NIW Water Treatment Work	**0**	**0**	**0**
NIW Treated Water Pumping Stations	**0**	**0**	**0**
NIE Substation 6to11kV	**0**	**0**	**0**
NIE Substation 33kV	**0**	**0**	**0**
NIE Substation 275kV	**0**	**0**	**0**
NIE Substation 110kV	**0**	**0**	**0**
Road Service - Trunk Road	**0**	**0**	**0**
Environmental Designated sites (Nr)			
AONB	**0**	**0**	**0**
ASSI	**0**	**0**	**0**
Environmentally Sensitive Areas	**0**	**0**	**0**
Maritime Nature Reserve	**0**	**0**	**0**
Nature Reserve	**0**	**0**	**0**
RAMSAR	**0**	**0**	**0**
SAC	**0**	**0**	**0**
Sites of Local Nature Conservation Importance	**0**	**0**	**0**
SPA	**0**	**0**	**0**
RSPB Reserve	**0**	**0**	**0**
UWT Nature Reserve	**0**	**0**	**0**
Built Heritage sites (Nr)			
National Trust	**0**	**0**	**0**
Listed Buildings	**0**	**0**	**0**
Sites and Monuments Records	**0**	**0**	**0**
Buildings of Special Architectural or Historical Interest	**0**	**0**	**0**
Areas of Significant Archaeological Interest	**0**	**0**	**0**
Historic Gardens	**0**	**0**	**0**

5.6.7 Proposed Fluvial Flood Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Newry it is important that the flood risk is not increased by new development in areas of known flood risk. Planning Policy Statement, PPS 15, "Planning and Flood Risk", adopts a precautionary approach to development with the primary aim "to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere".

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the "Exception" rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to "Greenfield" built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new Development Plans for Newry, Rivers Agency will advise against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 100 year fluvial floodplain or is susceptible elsewhere to surface water flooding.

Rivers Agency shall also review the existing Development Plan for Newry (Banbridge, Newry and Mourne are plan) with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

Planning Applications

Fluvial areas at risk

Rivers Agency will advise against the development of all sites that are located within the 1 in 100 year fluvial floodplain, irrespective of whether they are located within a current development plan or as a single site application outside the plan area.

For those sites within the 1 in 100 year fluvial floodplain where the principle of development has been accepted by Planning NI as meeting the "Exception Test", Rivers Agency will further consider the application through the appraisal of an accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The main existing developed areas, amongst others, at flood risk within Newry where re-development may be likely to take place are:

- Hill Street
- Sugar Island area
- Downshire Road
- Sandy Street

Areas at Risk of Surface Water flooding

For those sites outside the 1 in 100 year fluvial floodplain that are located in an area where there is evidence of a history of surface water flooding identified by the flooding hardship payments. Rivers Agency will further consider the application through the appraisal of the accompanying Drainage Assessment that will need to demonstrate suitable flood mitigation measures.

Where there is potential for surface water flooding as indicated in the 'purple' predicted areas on the surface water maps we will advise that the applicant should assess the flood risk and drainage impact to the site and construct in an appropriate manner.

The main areas identified in Newry as being at surface water flood risk are:

- Bridge Street

Area's at Risk of Flood Inundation from reservoirs

For all development proposals that are located within the potential flood inundation area of a controlled reservoir we will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures. If it is a new development proposal Rivers Agency will also need the applicant to demonstrate that the condition, management and maintenance regime of the reservoir is appropriate to provide sufficient assurance regarding reservoir safety.

Controlled reservoirs identified in the Newry area are as follows:

- Camlough

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is, therefore, important that we continue to target investment by providing flood defence, culvert alleviation schemes and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. The **Flood Investment and Planning Group, (FIPG)**, provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a "Flood Risk Metric Tool" (FRISM) is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total "damage avoidance benefits" that the scheme will provide to the property over the scheme's design life. If the benefit/cost ratio is greater than 1 (Net Present Value, NPV, figure is positive) then the potential scheme will be referred to Rivers Agency's Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely Rivers Agency's responsibility, or is the responsibility of NI Water or Transport NI such as a local drainage or road infrastructure issue, it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a benefit cost analysis identifies a viable scheme, a scheme will be placed on a prioritisation list for works with other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take anything from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Having conducted a detailed assessment of the fluvial flood risk to Newry, Rivers Agency has determined that potential flood alleviation schemes may be justified for Newry city.

Rivers Agency is currently undertaking a feasibility study for Newry city which is programmed for completion in 2015. If this feasibility study identifies that a potential flood alleviation scheme is likely to be economically viable, Rivers Agency may, subject to resources and pressures from other potential schemes,

commence the detailed design in 2015/2016. The final version of the Flood Risk Management Plan in December 2015 will contain firm details as to whether or not an engineering solution to the flooding from this watercourse is likely to be undertaken.

Preparedness

In Newry it is not possible to prevent or protect against all flooding. Indeed even where flood defences exist it is possible in an extreme event that these could be over topped and flooding could still occur.

Having recognised this fact, considerable effort in recent years has been made by emergency planners in Government Departments, Councils and the Emergency Services working together and sharing information to ensure a coordinated response.

However despite these improvements during significant flood events the emergency response of Government Departments and the Emergency Services can become over stretched. This means that not all calls for assistance during a flood event may be responded to in a timely manner. With this in mind it is important that households and communities, subject to a known flood risk, are prepared. The detail of preparedness actions, including flood warning and informing activities planned from a regional perspective, are provided in Annex E.

This is not Government withdrawing from any undertaking to respond in emergencies but an additional layer of support to ensure Government Departments and the public work together to reduce the overall impacts of flooding.

From the flood risk assessment there are certain areas of Newry which are subject to flood risk and may have flooded before. Therefore, they may benefit from the flood warning and informing proposals outlined in Annex D.

A pilot project of community engagement to deliver flood warning and informing, held in 2014, identified basic assessment formulae to assess and score areas that could potentially be a focus for flood warning and informing actions. Based on this scoring the following area could be considered suitable for being included in a programme of community engagement to deliver flood warning and informing initiatives:

- Bridge Street / Cleary Crescent area.

Key activities that could be undertaken are:

- Explaining the potential and limitations of Community Resilience
- Briefing communities on information available, particulary from the Met Office
- The facilitation of self-help initiatives, including remote sandbag storage; and

- Reviewing and validating all elements of the Community Engagement Plan to help the community communicate effectively in an emergency and work together.

A table in Annex J shows how this community ranks in the overall context of the 20 SFRAs in this Plan. It should be noted that this is an indicative assessment which may change subject to further information on flood risk becoming available.

The rollout of this work is dependent on funding being available.

5.7 Banbridge SFRA – Upper Bann

The core boundary of the Banbridge SFRA, which has been determined through the PFRA, is located within the Upper Bann Local Management Area and illustrated in Figure 5.7 below.

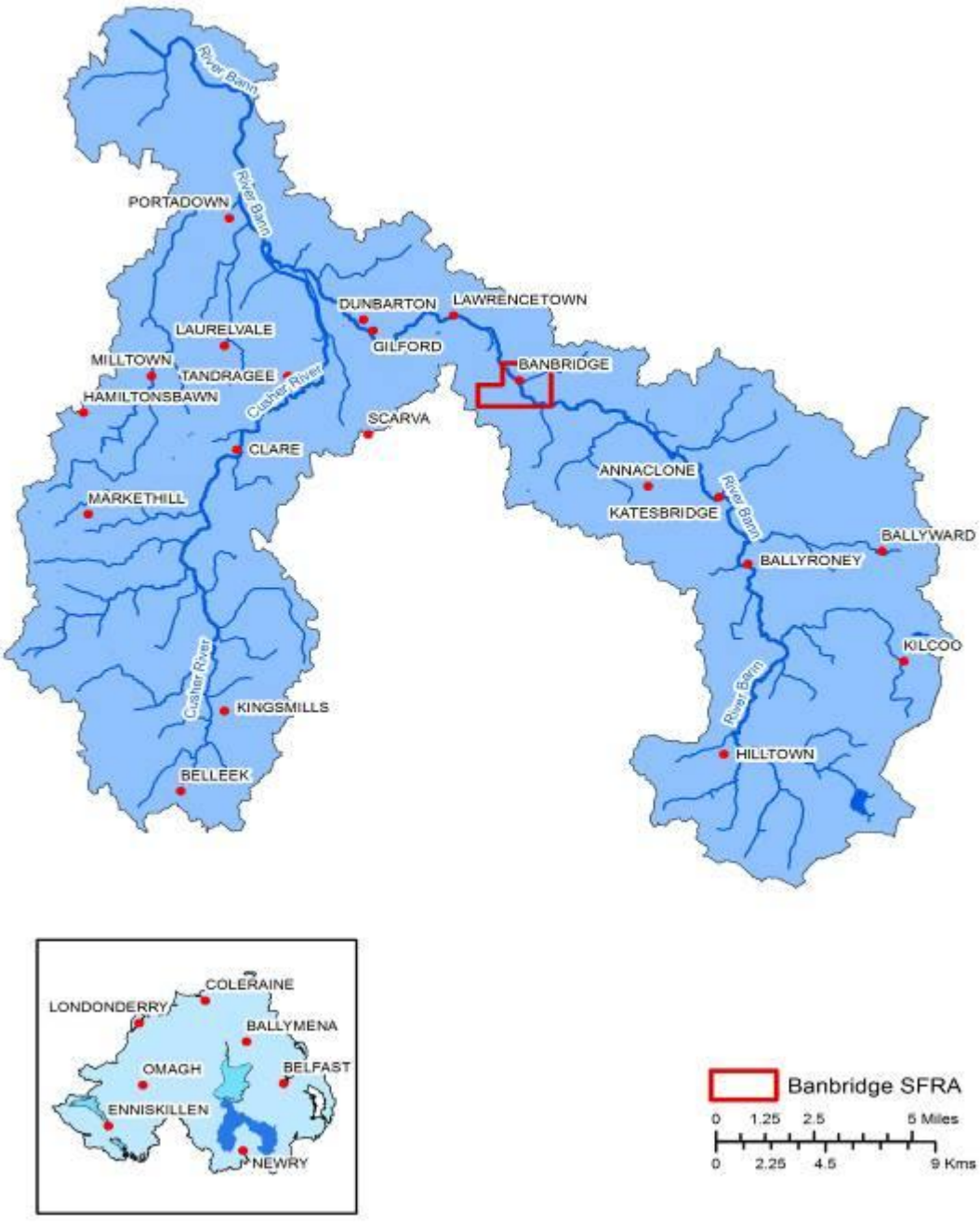


Figure 5.7 - Upper Bann LFMA and Banbridge SFRA

5.7.1 Flooding History

Rivers Agency records show that extensive flooding occurred along the Showground's Stream on the 16th August 2008. Information gathered after the event by Rivers Agency indicated that 12 houses on the Burnview Terrace and 8 houses in Willow Grove/Avenue flooded. A further 12 houses could have been affected along Burnview Terrance, if it were not for the sand bags that were deployed by Rivers Agency.

Initial investigations indicated that the flooding emanated from N.I Water and Rivers Agency culverts. There had been no previous incidents of flooding from this infrastructure recorded prior to the 16th August 2008 event.

Rivers Agency has no previous records of any flooding from Banbridge town culvert, Rifle Park Stream and Brookfield Stream.

However, Rivers Agency did carry out a culvert renovation scheme in 2004 to repair 343m of structurally defective culvert on the Rifle Park Stream, within the Maryville Estate. The existing pipeline was refurbished by installing a cured-in-place liner along much of its length at a cost of approximately £350k.

5.7.2 PFRA – Identification of Potentially Significant Flood Sources

According to the Preliminary Flood Risk Assessment (PRFA) (Dec 2011) the town of Banbridge, in terms of the potential adverse consequences of flooding, is ranked 13th of the twenty Significant Flood Risk Areas within Northern Ireland (see Figure 4.1). On the basis of this initial assessment, which was undertaken using the strategic flood maps, the predominant flood risk to the town was considered to arise from fluvial flooding.

It should be noted that the PFRA flagged up the potential for significant fluvial flooding at Banbridge because this national assessment is based on strategic 'undefended' flood models which do not take account of existing flood defence systems. Therefore, the assessment was in effect based on the worst case scenario, as it assumes there is no benefit from the defences. This precautionary approach was taken because at the time of the assessment there was a degree of uncertainty about the level of protection that each of the existing flood defence systems provides. By adopting this approach, the urban areas that are located behind existing flood defence structures were determined to be SFRA by default and as a consequence detailed Flood Hazard/Risk Maps were prepared in compliance with the requirements of the EU Floods Directive. This provided the opportunity to undertake the detailed structural assessments and flood modelling necessary to remove the uncertainty and establish the actual level of protection provided by these defences.

To facilitate a more robust assessment of the level of flood risk to Banbridge from fluvial flooding, Rivers Agency developed detailed predictive flood models for each of these sources. It is considered that the flood hazard maps produced from these models give a more accurate prediction of the flooded areas which may

have been over or under estimated by the strategic flood maps. Details of the models and their output are described in the following sections.

5.7.3 Catchment Description

The Upper Bann Local Management Area (LMA) is part of the Neagh Bann River Basin District which drains into Lough Neagh at Bannfoot and covers an area of 397 km². The main river is the Upper Bann, with the Cusher River as a major tributary. The Upper Bann rises in the Mourne Mountains from several tributaries including the Leitrim River, the Muddock River, the Rocky River and the Upper Bann reach. It flows northwards through Banbridge and joins with the Cusher River south of Portadown.

The main towns in the Upper Bann LMA are Craigavon and Banbridge. There are also many small towns in the area including Tandragee, Markethill and Rathfriland. The main land use in the area is given over to improved grassland plus some arable horticulture and forestry.

The LMA supports a wide variety of natural habitats, several of which are protected. The river also supports a range of recreational activities such as angling, walking and canoeing.

5.7.4 Fluvial Flood Risk Assessment

Flood Model

The Banbridge flood model was constructed using InfoWorks RS 1D/ 2D (Version 13) and InfoWorks ICM 1D/ 2D (Version 3.5) modelling software. InfoWorks RS is an integrated hydrological and hydraulic modelling package developed by Innovyze. It includes full solution modelling of open channels, floodplains, embankments and hydraulic structures. InfoWorks ICM (Integrated Catchment Modelling) is an integrated modelling platform which incorporates both urban and river catchments. It provides the ability to model the complete drainage system both natural and engineered above and below-ground, including sewers, surface water, river and floodplains.

Fluvial Flooding Mechanisms

Showground's Stream

The Showground's Stream, a tributary of the River Upper Bann, flows through the eastern section of Banbridge and has a predominantly rural catchment outside the model area. Showground's Stream is approximately 4.8km long and originates in the hills near Drumneth, Co Down. It then flows in a south westerly direction before discharging into the River Bann. The catchment area is approximately 5.6km² with the upper reaches being mainly rural while the lower reaches comprise a mainly urbanised area of Banbridge.

Figure 5.7.4.1 illustrates the predicted extents of the potential fluvial flooding from the Showgroundss Stream in Banbridge and details of the impact of the flooding on property and key infrastructure is summarised in Table 5.7.4.1.

The model shows that at the low frequency 1% AEP (Q100) flood event the floodwater is predicted to spill from the Showground's Stream culvert within the Willow Grove, Willow Avenue, Burnview Terrace and Castlewellan Road areas with the resulting surface water ponding to shallow depths up to 300mm in the low lying areas most notably at Castlewellan Road reach. It is estimated that **45** residential and **20** non residential properties could potentially be flooded in such a flood causing damages in excess of **£800,000**. The present value of the total property damages from potential future floods is calculated to be in excess of **£1.65 million.**

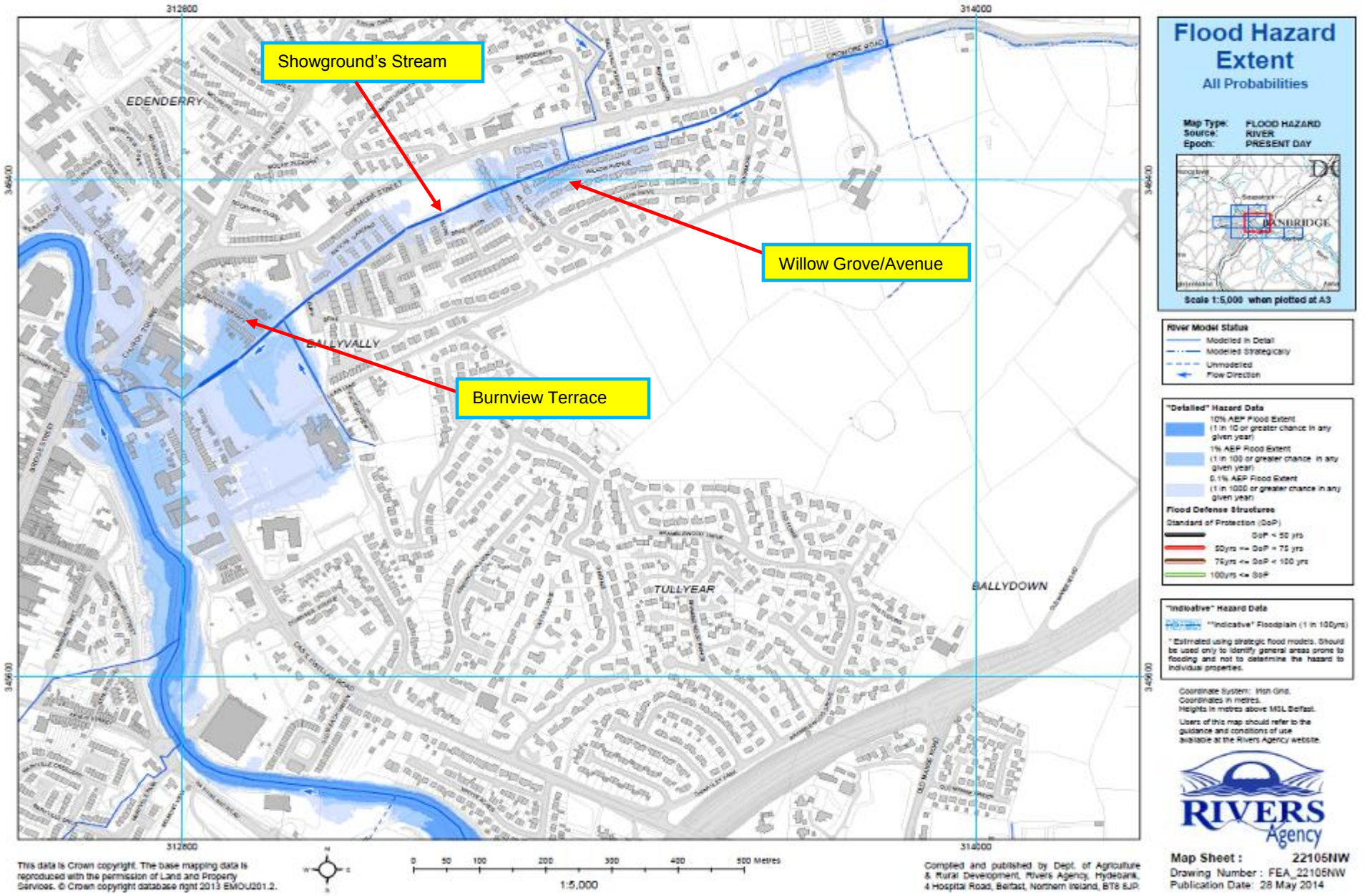


Figure 5.7.4.1 - Flood extent map for Showground's Stream, Banbridge

Table 5.7.4.1 - Banbridge SFRA – Showground's Stream			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	**0**	**0**	**45**
Non Residential (Nr)	**0**	**0**	**20**
Economic Damage (£)	**0**	**0**	**£800,000**
Annual Average Damage (£)	**£55,000**		
Present Value (£)	**£1,650,000**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)			
Care Homes	**0**	**0**	**0**
GP Surgery's	**0**	**0**	**1**
Fire stations	**0**	**0**	**0**
Hospitals	**0**	**0**	**0**
Police Stations	**0**	**0**	**1**
Schools	**0**	**0**	**0**
Key Infrastructure (Nr)			
NIW Wastewater Treatment Works	**0**	**0**	**0**
NIW Sewage Pumping Stations	**0**	**0**	**0**
NIW Water Treatment Work	**0**	**0**	**0**
NIW Treated Water Pumping Stations	**0**	**0**	**0**
NIE Substation 6to11kV	**0**	**0**	**0**
NIE Substation 33kV	**0**	**0**	**0**
NIE Substation 275kV	**0**	**0**	**0**
NIE Substation 110kV	**0**	**0**	**0**
Road Service - Trunk Road	**0**	**0**	**2**
Environmental Designated sites (Nr)			
AONB	**0**	**0**	**0**
ASSI	**0**	**0**	**0**
Environmentally Sensitive Areas	**0**	**0**	**0**
Maritime Nature Reserve	**0**	**0**	**0**
Nature Reserve	**0**	**0**	**0**
RAMSAR	**0**	**0**	**0**
SAC	**0**	**0**	**0**
Sites of Local Nature Conservation Importance	**0**	**0**	**0**
SPA	**0**	**0**	**0**
RSPB Reserve	**0**	**0**	**0**
UWT Nature Reserve	**0**	**0**	**0**
Built Heritage sites (Nr)			
National Trust	**0**	**0**	**0**
Listed Buildings	**0**	**0**	**0**
Sites and Monuments Records	**0**	**0**	**0**
Buildings of Special Architectural or Historical Interest	**0**	**0**	**0**
Areas of Significant Archaeological Interest	**0**	**0**	**0**
Historic Gardens	**0**	**0**	**0**

Brookfield Stream

Figure 5.7.4.3 illustrates the predicted extents of the potential fluvial flooding from the Brookfield Stream in Banbridge and details of the impact of the flooding on property and key infrastructure is summarised in Table 5.7.4.2. The Brookfield Stream is located to the north of Banbridge on the western side of the Upper Bann River. Its catchment area at the upstream extents of the model is 0.86km^2. The predictive model indicates that there is one primary flood risk location existing within the Brookfield Stream.

The model shows that at the very frequent 10% AEP (Q10) flood event, floodwater begins to spill from the Brookfield Stream designated grille which is located directly behind No73 Ravenswood. (See figure 5.7.4.2 below and figure 5.7.4.3). Once the flood water enters the grille it flows through a 1200mm dia concrete culvert to an open section of watercourse approximately 95m downstream. The model shows a Q100 discharge flow of 1.7m^3/s. A standard 1200mm diameter culvert has the ability to vent up to a 2.15m^3/s flow, therefore it is unclear what is causing this predicted flooding in this area. There is also no evidence of any historic flooding in this area from Rivers Agency flood records. Flooding from the 1% AEP (Q100) flood event is estimated to affect **14** residential properties at a cost of around **£91,000**. The present value of the total property damages from potential future floods is calculated to be in excess of **£210k.**

The model requires further investigation to determine the cause of the flooding or indeed if there is any likelihood of flooding in the Ravenswood Development area of Banbridge.

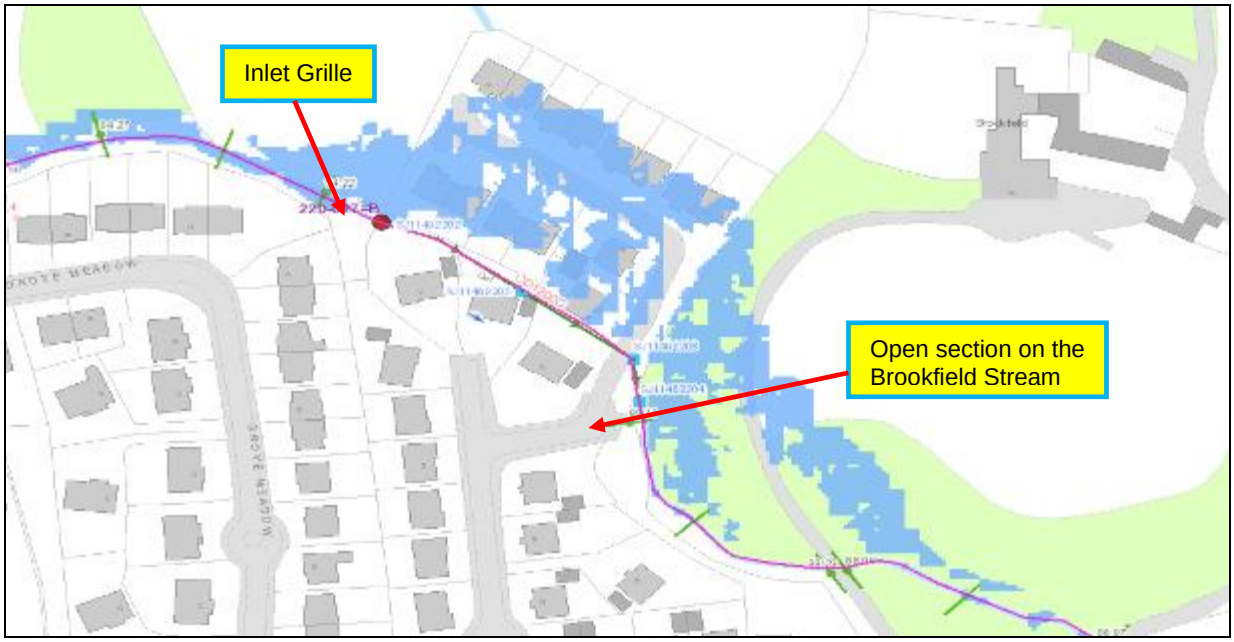


Figure 5.7.4.2 - Location of designated grille and open section on Brookfield Stream, Banbridge

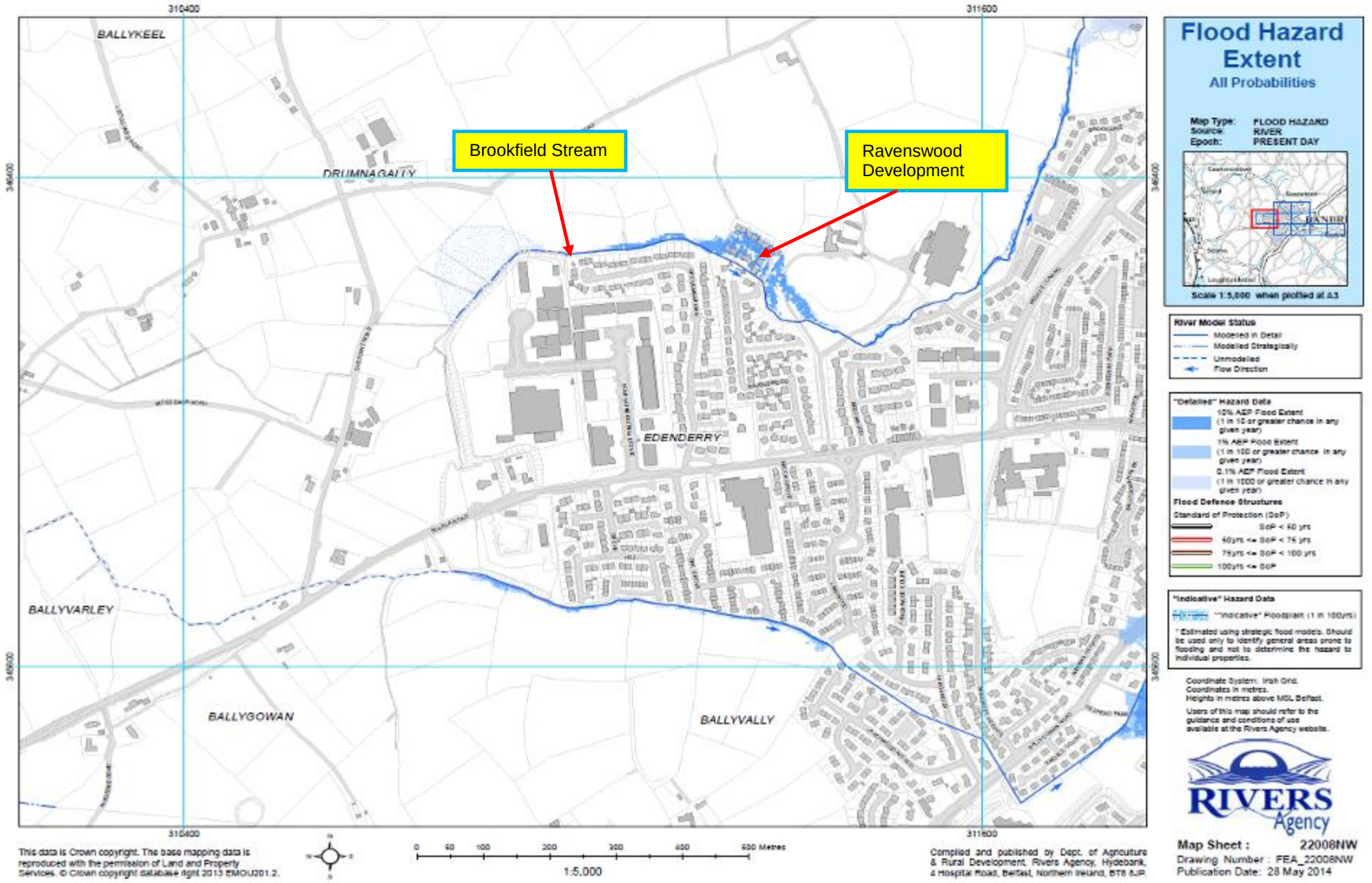


Figure 5.7.4.3 - Flood extent map for Brookfield Stream, Banbridge

Table 5.7.4.2 - Banbridge SFRA – Brookfield Stream			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	**14**	**14**	**14**
Non Residential (Nr)	**0**	**0**	**0**
Economic Damage (£)	**£91,000**	**£91,000**	**£91,000**
Annual Average Damage (£)	**£7,000**		
Present Value (£)	**£210,000**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)			
Care Homes	**0**	**0**	**0**
GP Surgery's	**0**	**0**	**0**
Fire stations	**0**	**0**	**0**
Hospitals	**0**	**0**	**0**
Police Stations	**0**	**0**	**0**
Schools	**0**	**0**	**0**
Key Infrastructure (Nr)			
NIW Wastewater Treatment Works	**0**	**0**	**0**
NIW Sewage Pumping Stations	**0**	**0**	**0**
NIW Water Treatment Work	**0**	**0**	**0**
NIW Treated Water Pumping Stations	**0**	**0**	**0**
NIE Substation 6to11kV	**0**	**0**	**0**
NIE Substation 33kV	**0**	**0**	**0**
NIE Substation 275kV	**0**	**0**	**0**
NIE Substation 110kV	**0**	**0**	**0**
Road Service - Trunk Road	**0**	**0**	**0**
Environmental Designated sites (Nr)			
AONB	**0**	**0**	**0**
ASSI	**0**	**0**	**0**
Environmentally Sensitive Areas	**0**	**0**	**0**
Maritime Nature Reserve	**0**	**0**	**0**
Nature Reserve	**0**	**0**	**0**
RAMSAR	**0**	**0**	**0**
SAC	**0**	**0**	**0**
Sites of Local Nature Conservation Importance	**0**	**0**	**0**
SPA	**0**	**0**	**0**
RSPB Reserve	**0**	**0**	**0**
UWT Nature Reserve	**0**	**0**	**0**
Built Heritage sites (Nr)			
National Trust	**0**	**0**	**0**
Listed Buildings	**0**	**0**	**0**
Sites and Monuments Records	**0**	**0**	**0**
Buildings of Special Architectural or Historical Interest	**0**	**0**	**0**
Areas of Significant Archaeological Interest	**0**	**0**	**0**
Historic Gardens	**0**	**0**	**0**

Banbridge Town Culvert

The Fort Stream and Banbridge Town Culvert flow through the western section of Banbridge, draining a large part of Banbridge town, before discharging to the Upper Bann River. The computational model had two upstream boundaries and one downstream boundary. The predictive model indicates that there is one primary flood risk location existing within the Banbridge Town Culvert.

The model shows that at the very frequent 10% AEP (Q10) flood event, floodwater begins to spill from a designated grille which is located to the south of Hillhead Park road opposite a N.I Water pumping station. (See figure 5.7.4.3 below and figure 5.7.4.5). Once the flood water enters the grille it then flows through a 750mm diameter concrete culvert. The principle restriction is at the inlet grille to the culvert under the Hillhead Park Road until the culvert increases in size to a 1500mm diameter to the rear of No 14 Ballygowan Road.

Although this section of the Banbridge Town Culvert is typically 1500mm diameter it is linked into an existing 750mm diameter culvert directly upstream, crossing under the Hillhead Park Road which severely inhibits its hydraulic capacity. It is estimated that floodwater will pond to a depth of up to 300mm and 1 N.I Water pumping station may suffer internal flooding at the 10% AEP (Q10) event. At the more extreme 1% AEP (Q100) flood event the predicted flooding is generally confined to the same locations although the flood inundation areas are more extensive. Flooding from the 1% AEP (Q100) flood event is estimated to affect **2** residential and **2** non residential properties at a cost of around **£40,000**.

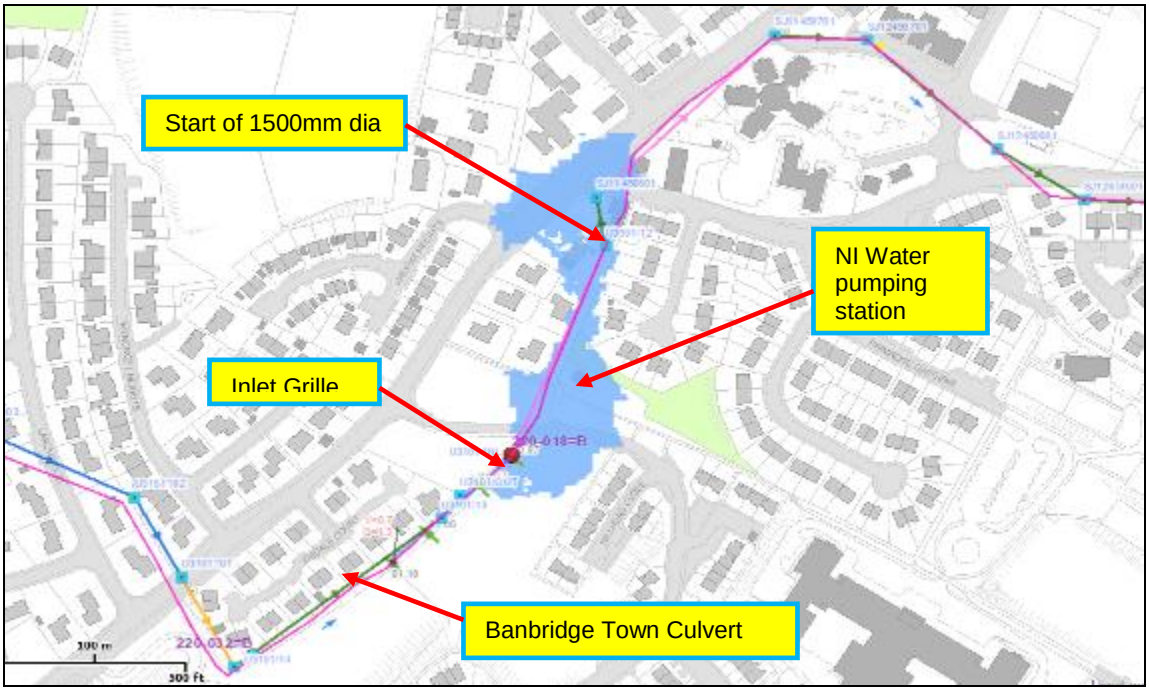


Figure 5.7.4.3 - Location of designated grille on Banbridge Town Culvert (1%AEP)

Rifle Park Stream

The Rifle Park Stream, a tributary of the Upper Bann River, is located at the southern end of Banbridge, running along the boundary of Banbridge Rugby Club (Rifle Park). The total length of the modelled river is 900m and is completely culverted through the study area. The watercourse drains a small rural catchment to the south east of the A1. The predictive model indicates that there is one primary flood risk location existing within the Rifle Park Stream.

The model shows that at the very frequent 10% AEP (Q10) flood event, floodwater begins to spill from a designated manhole on the Rifle Park Stream located to the west of Banbridge Rugby Club. (See figure 5.7.4.4 below and figure 5.7.4.5). Once the flood water spills from the manhole it flows in a northerly direction towards Iveagh Veterinary Services. The principle restriction is at the manhole located opposite the Iveagh Veterinary Services building where the culvert reduces from a 525mm diameter down to a 225mm diameter road crossing culvert then returns to a 525mm diameter culvert. The reducing in this section of the culvert size severely inhibits its hydraulic capacity causing the flood water to back up and spill from the manhole located beside the Rugby Clubhouse. It is estimated that floodwater will pond to a depth of up to 300mm with the Rugby Clubhouse being potentially damaged at this flood event causing damages in excess of **£15,000**

At the more extreme 1% AEP (Q100) flood event the predicted flooding is generally confined to the same locations although the flood inundation areas are more extensive. Flooding from the 1% AEP (Q100) flood event is estimated to affect **2** non residential properties at a cost of around **£30,000**. The present value of the total property damages from potential future floods is calculated to be in excess of **£60,000.**

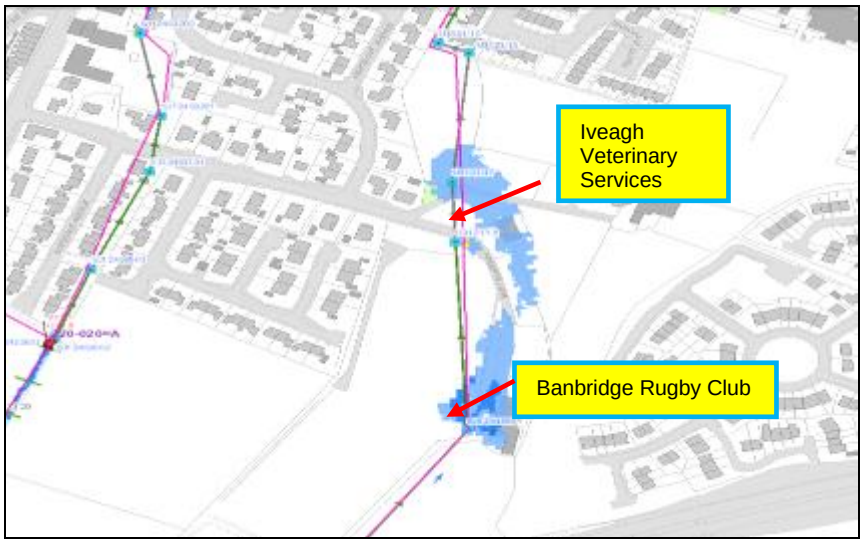


Figure 5.7.4.4 - Location of flooding on Rifle Park Stream, Banbridge

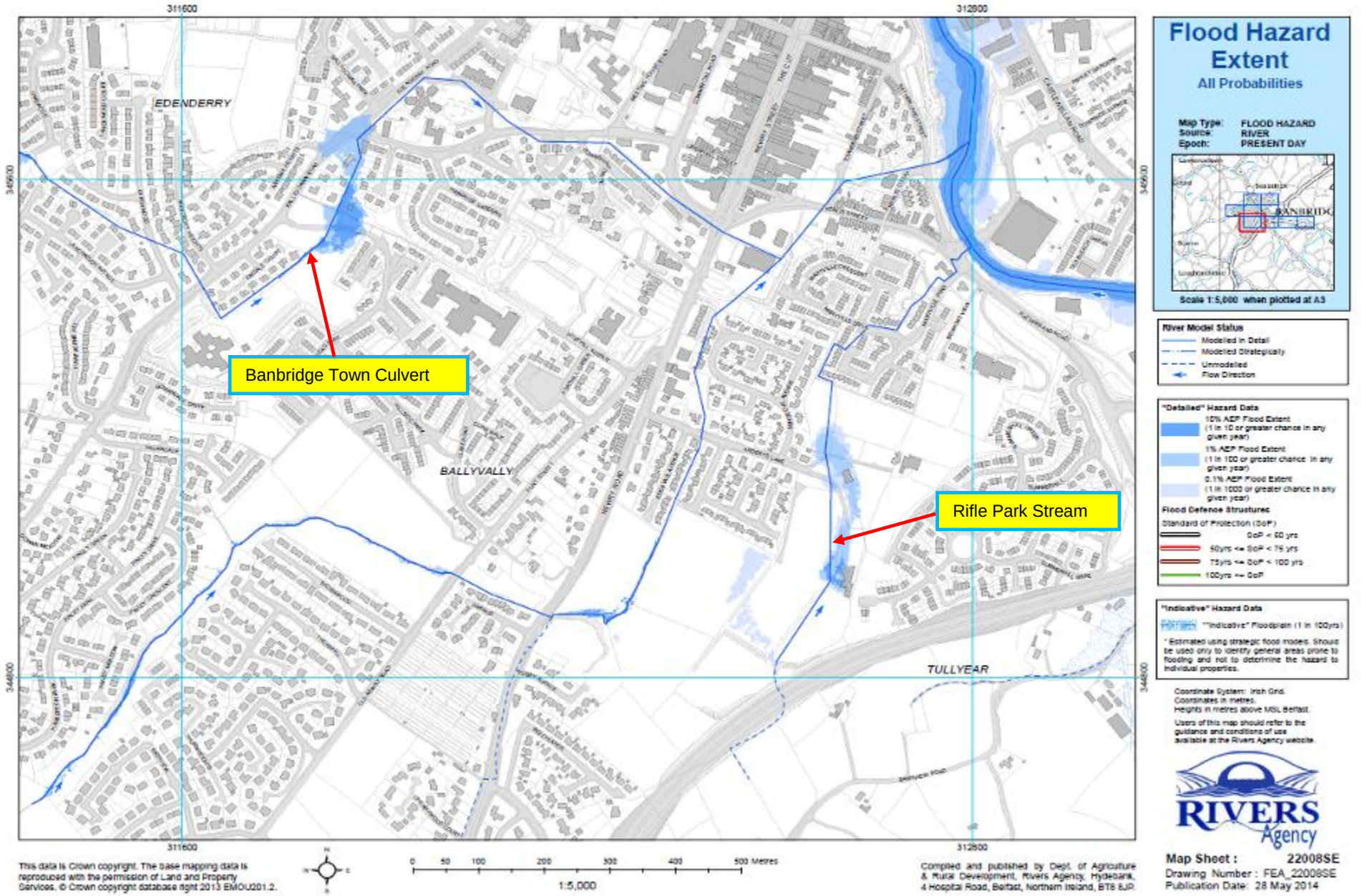


Figure 5.7.4.5 - Flood extent map for Banbridge Town Culvert and Rifle Park Stream, Banbridge

Table 5.7.4.3 - Banbridge SFRA – Banbridge Town Culvert			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	**0**	**2**	**2**
Non Residential (Nr)	**1**	**1**	**2**
Economic Damage (£)	**£10,000**	**£30,000**	**£40,000**
Annual Average Damage (£)	**£3,000**		
Present Value (£)	**£90,000**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)			
Care Homes	**0**	**0**	**0**
GP Surgery's	**0**	**0**	**0**
Fire stations	**0**	**0**	**0**
Hospitals	**0**	**0**	**0**
Police Stations	**0**	**0**	**0**
Schools	**0**	**0**	**0**
Key Infrastructure (Nr)			
NIW Wastewater Treatment Works	**0**	**0**	**0**
NIW Sewage Pumping Stations	**1**	**1**	**1**
NIW Water Treatment Work	**0**	**0**	**0**
NIW Treated Water Pumping Stations	**0**	**0**	**0**
NIE Substation 6to11kV	**0**	**0**	**0**
NIE Substation 33kV	**0**	**0**	**0**
NIE Substation 275kV	**0**	**0**	**0**
NIE Substation 110kV	**0**	**0**	**0**
Road Service - Trunk Road	**0**	**0**	**0**
Environmental Designated sites (Nr)			
AONB	**0**	**0**	**0**
ASSI	**0**	**0**	**0**
Environmentally Sensitive Areas	**0**	**0**	**0**
Maritime Nature Reserve	**0**	**0**	**0**
Nature Reserve	**0**	**0**	**0**
RAMSAR	**0**	**0**	**0**
SAC	**0**	**0**	**0**
Sites of Local Nature Conservation Importance	**0**	**0**	**0**
SPA	**0**	**0**	**0**
RSPB Reserve	**0**	**0**	**0**
UWT Nature Reserve	**0**	**0**	**0**
Built Heritage sites (Nr)			
National Trust	**0**	**0**	**0**
Listed Buildings	**0**	**0**	**0**
Sites and Monuments Records	**0**	**0**	**0**
Buildings of Special Architectural or Historical Interest	**0**	**0**	**0**
Areas of Significant Archaeological Interest	**0**	**0**	**0**
Historic Gardens	**0**	**0**	**0**

Table 5.7.4.4 - Banbridge SFRA – Rifle Park Stream			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	**0**	**0**	**0**
Non Residential (Nr)	**1**	**2**	**2**
Economic Damage (£)	**£15,000**	**£25,000**	**£30,000**
Annual Average Damage (£)	**£2,025**		
Present Value (£)	**£60,750**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)			
Care Homes	**0**	**0**	**0**
GP Surgery's	**0**	**0**	**0**
Fire stations	**0**	**0**	**0**
Hospitals	**0**	**0**	**0**
Police Stations	**0**	**0**	**0**
Schools	**0**	**0**	**0**
Key Infrastructure (Nr)			
NIW Wastewater Treatment Works	**0**	**0**	**0**
NIW Sewage Pumping Stations	**0**	**0**	**0**
NIW Water Treatment Work	**0**	**0**	**0**
NIW Treated Water Pumping Stations	**0**	**0**	**0**
NIE Substation 6to11kV	**0**	**0**	**0**
NIE Substation 33kV	**0**	**0**	**0**
NIE Substation 275kV	**0**	**0**	**0**
NIE Substation 110kV	**0**	**0**	**0**
Road Service - Trunk Road	**0**	**0**	**0**
Environmental Designated sites (Nr)			
AONB	**0**	**0**	**0**
ASSI	**0**	**0**	**0**
Environmentally Sensitive Areas	**0**	**0**	**0**
Maritime Nature Reserve	**0**	**0**	**0**
Nature Reserve	**0**	**0**	**0**
RAMSAR	**0**	**0**	**0**
SAC	**0**	**0**	**0**
Sites of Local Nature Conservation Importance	**0**	**0**	**0**
SPA	**0**	**0**	**0**
RSPB Reserve	**0**	**0**	**0**
UWT Nature Reserve	**0**	**0**	**0**
Built Heritage sites (Nr)			
National Trust	**0**	**0**	**0**
Listed Buildings	**0**	**0**	**0**
Sites and Monuments Records	**0**	**0**	**0**
Buildings of Special Architectural or Historical Interest	**0**	**0**	**0**
Areas of Significant Archaeological Interest	**0**	**0**	**0**
Historic Gardens	**0**	**0**	**0**

5.7.5 Proposed Fluvial Flood Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Banbridge it is important that the flood risk is not increased by new development in areas of known flood risk. Planning Policy Statement, PPS 15, "Planning and Flood Risk", adopts a precautionary approach to development with the primary aim "to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere".

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the "Exception" rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to "Greenfield" built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new Development Plans for Banbridge, Rivers Agency will advise against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 100 year fluvial floodplain or is susceptible elsewhere to surface water flooding.

Rivers Agency will also review the existing Development Plan for Banbridge (Banbridge, Newry and Mourne Area Plan) with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

The main (undeveloped) flooded areas within the Banbridge area are:-

- The Crothers Memorial Playing Fields
- The area south east to the Banbridge by-pass where it crosses the Upper Bann River

Planning Applications

Fluvial areas at risk

Rivers Agency will advise against the development of all sites that are located within the 1 in 100 year fluvial floodplain, irrespective of whether they are located within the current plan or as a single site application outside the plan area.

For those sites within the 1 in 100 year fluvial floodplain where the principle of development has been accepted by Planning NI as meeting the "Exception Test", Rivers Agency will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The main existing developed areas, amongst others, at flood risk within Banbridge where re-development may be likely to take place are:

- Castlewellan Road area along the right bank of the Upper Bann River

Areas at risk of surface water flooding

For those sites outside the 1 in 100 year fluvial floodplain that are located in an area where there is evidence of a history of surface water flooding identified by the flooding hardship payments. Rivers Agency will further consider the application through the appraisal of the accompanying Drainage Assessment that will need to demonstrate suitable flood mitigation measures.

Where there is potential for surface water flooding as indicated in the purple predicted areas on the surface water maps we will advise that the applicant should assess the flood risk and drainage impact to the site himself and construct in the appropriate manner.

Areas at risk of flood inundation from reservoirs

For all development proposals that are located within the potential flood inundation area of a controlled reservoir we will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures. If it is a new development proposal Rivers Agency will also need the applicant to demonstrate that the condition, management and maintenance regime of the reservoir is appropriate to provide sufficient assurance regarding reservoir safety.

Controlled reservoirs identified in the Banbridge area are as follows:

- Corbet Lough

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is, therefore important, that we continue to target investment by providing flood defence, culvert alleviation schemes and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. The **Flood Investment and Planning Group, (FIPG)**, provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a “Flood Risk Metric Tool” (FRISM) is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total “damage avoidance benefits” that the scheme will provide to the property over the scheme’s design life. If the benefit/cost ratio is greater than 1 (Net Present Value, NPV, figure is positive) then the potential scheme will be referred to Rivers Agency’s Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely Rivers Agency’s responsibility, or is the responsibility of NI Water or Transport NI such as a local drainage or road infrastructure issue it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a benefit cost analysis identifies a viable scheme, a scheme will be placed on a prioritisation list for works with other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Within the Banbridge area the following potential schemes have been identified and will be referred to the appropriate bodies for further investigation or detailed feasibility study.

Having conducted a detailed assessment of the fluvial flood risk to Banbridge, Rivers Agency has determined that potential flood alleviation schemes may be justified for the Banbridge Town Culvert, Showground’s Stream, and, to a lesser extent, the Brookfield Stream areas.

Showground's Stream

A feasibility study for the Showground's Stream was completed in 2014 and this identified that a flood alleviation scheme may be cost beneficial. The detailed design and economic appraisal for the proposed flood alleviation scheme has commenced and shall be completed in 2015. The findings of this will be taken into consideration in the final version of the FRMP (December 2015). If a flood alleviation scheme is confirmed to be economically viable the scheme will be placed on the Rivers Agency's Capital Works Programme and undertaken in line with its prioritisation compared to viable schemes if and when resources are available.

Banbridge Town Culvert

Rivers Agency is undertaking a culvert upgrade scheme on the Banbridge Town Culvert. The proposed scheme consisted of upgrading the existing undersized and defect culvert with 80m of new 1200mm diameter concrete pipe. However, the scheme has now halted as a result of unforeseen ground conditions and has now been referred to Central Procurement Directive (CPD) for a full ground investigation.

Brookfield Stream

From onsite inspection this development does not seem likely to flood. A quick pipe check indicates that the 1200mm diameter culvert has the capability of venting a flow of 2.2m³/s. The model shows a Q100 discharge flow of about 1.8m³/s in the Brookfield stream at the Q100. Therefore, the culvert seems to be adequately sized. Further investigation is required at this location.

Preparedness

In Banbridge it is not possible to prevent or protect against all flooding. Indeed even where flood defences exist it is possible in an extreme event that these could be over topped and flooding could still occur.

Having recognised this fact, considerable effort in recent years has been made by emergency planners in Government Departments, Councils and the Emergency Services working together and sharing information to ensure a coordinated response.

However, despite these improvements during significant flood events the emergency response of Government Departments and the Emergency Services can become over stretched. This means that not all calls for assistance during a flood event may be responded to in a timely manner. With this in mind it is important that households and communities, subject to a known flood risk, are prepared. The detail of preparedness actions, including flood warning and informing activities planned from a regional perspective, are provided in Annex E.

This is not Government withdrawing from any undertaking to respond in emergencies but an additional layer of support to ensure Government Departments and the public work together to reduce the overall impacts of flooding.

From the flood risk assessment there are certain areas of Banbridge which are subject to flood risk and may have flooded before. Therefore, they may benefit from the flood warning and informing proposals outlined in Annex D.

A pilot project of community engagement to deliver flood warning and informing, held in 2014, identified basic assessment formulae to assess and score areas that could potentially be a focus for flood warning and informing actions. As part of this pilot project, community engagement has been carried out with the community in Ballyvalley / Burnview area / Willow Grove area. Based on this scoring of the other areas, these did not score high enough to be placed within the top 20 communities to be offered a programme of community engagement during the period of this plan. However, if communities want to become more resilient, the Department is committed to providing assistance were possible to develop the consistent approach to resilience. The NI Direct website www.nidirect.gov.uk/ will host further information and advice on what to do in advance of flooding, what to do during flooding and how to recover after flooding. The website will also contain templates for communities wishing to develop their own plan.

5.8 Portadown SFRA – Upper Bann

The core boundary of the Portadown SFRA, which has been determined through the PFRA, is located within the Upper Bann Local Management Area and illustrated in Figure 5.8 below.

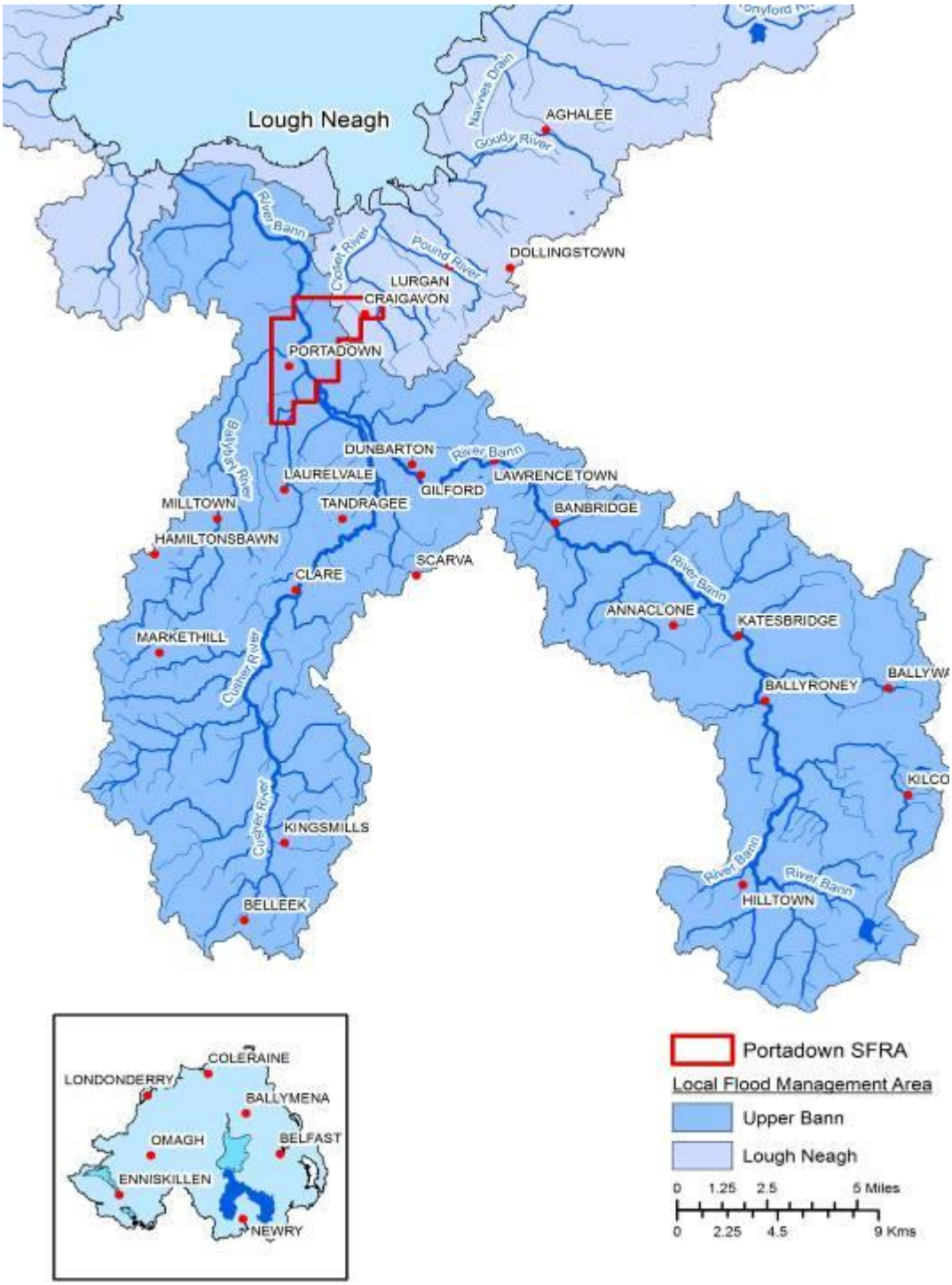


Figure 5.8 - Upper Bann LFMA and Portadown SFRA

5.8.1 Flooding history

A search of flood records in the Portadown area has revealed very limited information on historic flooding along the Upper Bann River, or elsewhere, with only very brief accounts for the years 2000, 2008, 2011 and 2014.

Since the introduction of the flooding hardship payment scheme in 2007 there have been 3 payments issued to homeowners in the Portadown SFRA. The majority of these payments (2 Nr) relate to the flooding in October 2011 which affected large parts of the province. The properties affected during this particular event where mainly in the vicinity of the Annagh Industrial Estate. The number of payments that relate to the flooding that occurred in November 2014 in the Portadown area is not yet been made available.

Figure 5.8.2.1 - Flooding in Portadown 2000

Photo 5.8.2.1 - Portadown Railway line flooded in Oct 2011

Photo 5.8.2.2 - Ashgrove Road, Portadown flooded in Nov 2014

Not all Information available for the draft Flood Risk Management Plan but will be included in the final Flood Risk Management Plan.

Existing Flood Defences

The only existing flood defences in Portadown are low-level earth embankments which are located to the north and south of Portadown on both banks of the Upper Bann River (See figure 5.8.2.2 below). These low-level earth embankments are constructed from a cohesive clay and provide an approximate standard of protection of 1:5 years to low laying agriculture land.

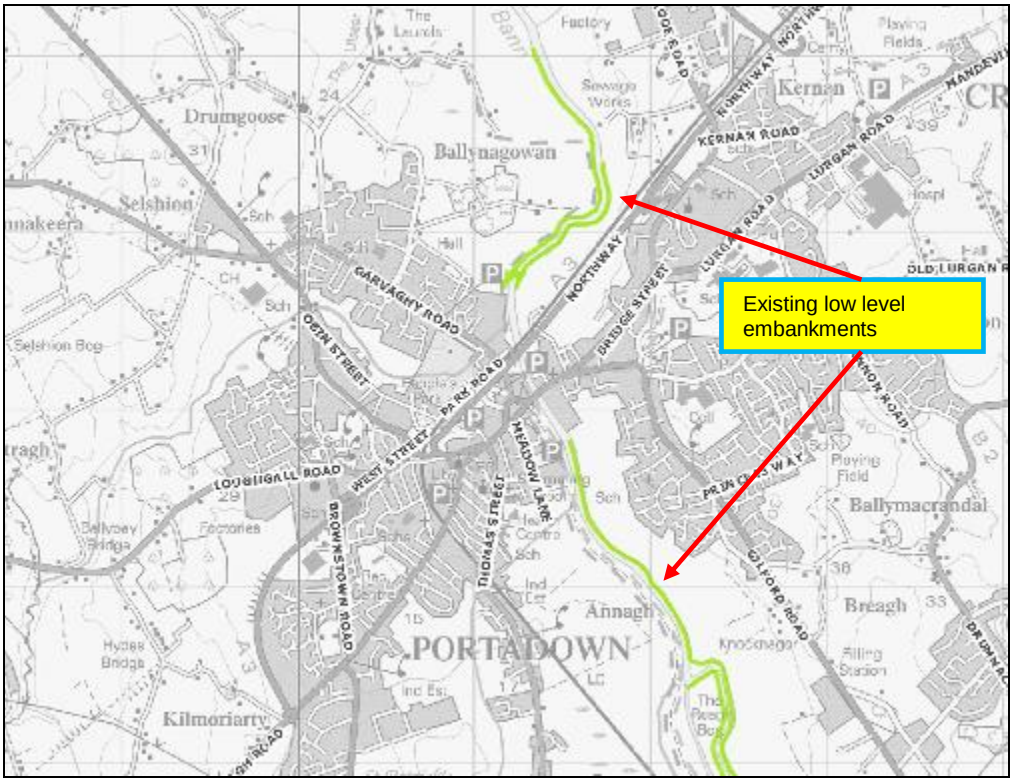


Figure 5.8.2.2 - Existing low level-flood earth embankments in Portadown

A flood alleviation scheme was proposed for the lower reach of the Ballybay River in the Garvaghey Road area in the early 2000s. However, this proposal was rejected by Craigavon Borough Council at the time.

5.8.2 PFRA – Identification of Potentially Significant Flood Sources

According to the Preliminary Flood Risk Assessment (Dec 2011) Portadown, in terms of the potential adverse consequences of flooding, is ranked 5th of the twenty SFRA within Northern Ireland (see figure 4.1). On the basis of this initial assessment, which was undertaken using the strategic flood maps, the predominant flood risk to the town was considered to arise from fluvial flooding.

It should be noted that the PFRA flagged up the potential for significant fluvial flooding at Portadown because this national assessment is based on strategic 'undefended' flood models which ignore the presence of existing flood defence systems. Therefore, the assessment is in effect based on the worst case scenario, as it assumes there is no benefit from the defences. This precautionary approach has been taken because at the time of the assessment there was a degree of uncertainty about the level of protection that each of the existing flood defence systems provides. By adopting this approach, the urban areas that are located behind existing flood defence structures were determined to be SFRA by default and as a consequence detailed Flood Hazard/Risk Maps had to be prepared in compliance with the requirements of the EU Floods Directive. This provided the opportunity to undertake the detailed structural assessments and flood modelling necessary to remove the uncertainty and establish the actual level of protection provided by these defences.

To facilitate a more robust assessment of the level of flood risk to Portadown from fluvial flooding, Rivers Agency developed detailed predictive flood models for each of these sources of flooding. It is considered that the flood hazard maps produced from these models will give a more accurate prediction of the flooded areas which may have been over or under estimated by the strategic flood maps. Details of the models and their output are described in the following sections.

5.8.3 Catchment Description

The Upper Bann is part of the Neagh Bann River Basin District and drains into Lough Neagh at Bannfoot and covers an area of 397 km². The main river is the Upper Bann, with the Cusher River as a major tributary. The Upper Bann rises in the Mourne Mountains from several tributaries including the Leitrim River, the Muddock River, the Rocky River and the Upper Bann reach. It flows northwards through Banbridge and joins with the Cusher River south of Portadown.

The main towns in Upper Bann are Craigavon, Banbridge and Portadown. The main land use in the area is given over to improved grassland plus some arable horticulture and forestry. The river also supports a range of recreational activities such as angling, walking and canoeing. The twin forks of the upper reaches of the Upper Bann and the Cusher River border on the Mourne Area of Outstanding Natural Beauty, and the Ring of Gullion Area of Outstanding Natural Beauty, respectively.

5.8.4 Fluvial Flood Risk Assessment

Flood Model

An InfoWorks RS 1D/2D Hydrodynamic model was prepared for the Upper Bann River. The model for the Upper Bann River stretches from Milltown Corbet to its discharge point at Lough Neagh. The total length of the modelled section is 51km and includes 439 topographical survey cross sections.

There are 27 bridges along this length that affect the hydrodynamic characteristics of the river and have been included in the model along with all surveyed weirs. In order to increase the accuracy of the modelling and particularly the linkage between the 1D and 2D domains of the model a number of interpolated sections were added.

The Upper Bann River flows through a relatively steep sided valley between Banbridge and Portadown with only localised areas of expansive floodplain along this reach. This stretch of the river was modelled predominantly using 1D modelling only, with 2D modelling as required. From the Moyallan townland the floodplain expands rapidly with a large pondage area upstream of Portadown. From this location to the downstream boundary with Lough Neagh the model is 1D/2D constructed with a triangular flexible mesh generated using either LiDAR data to define the floodplains. Where buildings are present in the floodplain the mesh size is automatically reduced to more accurately represent the ground levels and flow paths in the vicinity of the buildings. The mesh has been forced to delineate roads and railways by introducing break lines based on OSNI GIS layers. This ensures that the mesh takes account of raised road and rail embankments which pass through the floodplain.

InfoWorks ICM was used for rivers flowing through urban areas. In addition to survey data, the Rivers Agency InfoNet database provided data for the ICM models. Ten InfoWorks ICM 1D/2D Hydrodynamic models were prepared for the Upper Bann River study and each of these is discussed in more detail below. The downstream boundary conditions for each of the ICM models was extracted from the model of the river into which it discharges, providing a stage/time boundary to simulate backwater effects.

Fluvial Flooding Mechanisms

Rivers Agency's flood model initially predicts flooding to begin in the Portadown pondage area from the Cusher River along the reach just to the south of Whitecoat Point as highlighted in Figure 5.8.4.1. The flooding from the Cusher then spreads north with flooding from the main Upper Bann channel overtopping the small agricultural embankments increasing the flood levels. Initial flooding to the west of the railway embankment is through the Annagh and Annagh Bypass railway bridges marked A and B respectively on Figure 5.8.4.1. Flood water eventually overtops the railway line along a section adjacent to the Cusher River. The pondage area of Brackagh Bog ultimately becomes completely inundated with properties potentially

being at risk of flooding in the Tandragee Road, Maghon and Clownagh areas of Portadown as illustrated in Figure 5.8.4.1.

Flood waters spread throughout the floodplain reaching the boundaries of housing developments along the Gilford Road. However, the properties are constructed on land higher than the 1% AEP (Q100) flood level and do not get inundated.

Much of Portadown Golf Course becomes affected initially from flood water spreading from the north and then by over topping of the banks at the peak of the flood.

Ballybay River

The Ballybay River discharges to the Upper Bann River on the downstream side of Portadown near the railway bridge. The modelled reach of the river begins on the outskirts of Portadown and flows through the Corcrain and Garvaghy areas of Portadown to its confluence with the Upper Bann River as shown in Figure 5.8.4.2.

Much of central Portadown is higher than the 1% AEP (Q100) flood level. However, there are industrial properties such as the Ulster Carpet Factory located along the banks of the Ballybay River and Upper Bann River which are potentially at risk during a 10%AEP (Q10) flood event, as can be seen in Figure 5.8.4.2. The Ballybay River also causes flooding to properties during the 1% AEP (Q100) flood event, some of which are residential properties immediately upstream of the Ulster Carpet Factory on Park Road, Garvaghy Road and in Witten Close. The Ballybay River also spills out of bank at the 1%AEP (Q100) flood event further upstream above the playing fields and at the junction of Obins Street and Charles Street, at locations marked B on Figure 5.8.4.3 in the Rose Cottages area and Corcrain Mews area.

Ballynagowan River

Downstream of Portadown the Upper Bann River has extensive floodplains which are protected to a low standard in places by agricultural defences. However, all these defences are overtopped during the 1% AEP (Q100) flood event which is illustrated in Figure 5.8.4.4.

The flood model shows that at the relatively high frequency 10% AEP (Q10) flood event, floodwater is predicted to spill from the watercourse known as Ballynagowan River within the Wood Grove and Ash Grove Manor Developments. The resulting flood water ponds to depths of up to 300mm. It is estimated that **20** residential properties could be flooded at this event causing damages in excess of **£200,000**.

At the more extreme 1% AEP (Q100) flood event the predicted flooding is generally confined to the same locations although the flood inundation areas are more extensive and deeper (up to 1m deep) particularly in

the vicinity of the Wood Grove Development. Flooding from the 1% AEP (Q100) flood event is estimated to affect **36** residential properties at this location causing damages in excess of **£360,000**. Table 5.8.4.2 summarises the number of properties at risk during each of the modelled return periods.

Annagh River

The Annagh River discharges to the Upper Bann River on the upstream side of Portadown, to the south of the Meadows Shopping Centre. It has a predominantly rural catchment flowing through the Annagh and Mahon areas of Portadown. The total length of the modelled river is 3km which included 37 topographical survey cross-sections. There are 3 structures along this length that affect the hydrodynamic characteristics of the river and have been included in the model.

The flood model shows that at the relatively high frequency 10% AEP (Q10) flood event, floodwater is predicted to spill from the Annagh River within Annagh Hill Industrial Estate. The resulting flood water ponds to a depth of up to 300mm in places. It is estimated that **15** non residential properties could be flooded at this event causing damages in excess of **£180,000**.

At the more extreme 1% AEP (Q100) flood event the predicted flooding is generally confined to the same locations plus the Annagh Hill, Bann Street, Mourenview Street, Kingsway Drive, Armagh Road, The Old Golf Links and the Annagh Meadows areas, although the flood inundation areas are more extensive and deeper (up to 1m deep) particularly in the vicinity Annagh Industrial Estate. Flooding from the 1% AEP (Q100) flood event is estimated to affect **65** residential and **22** non residential properties at this location causing damages in excess of **£980,000**. Table 5.8.4.3 summarises the number of properties at risk during each of the modelled return periods.

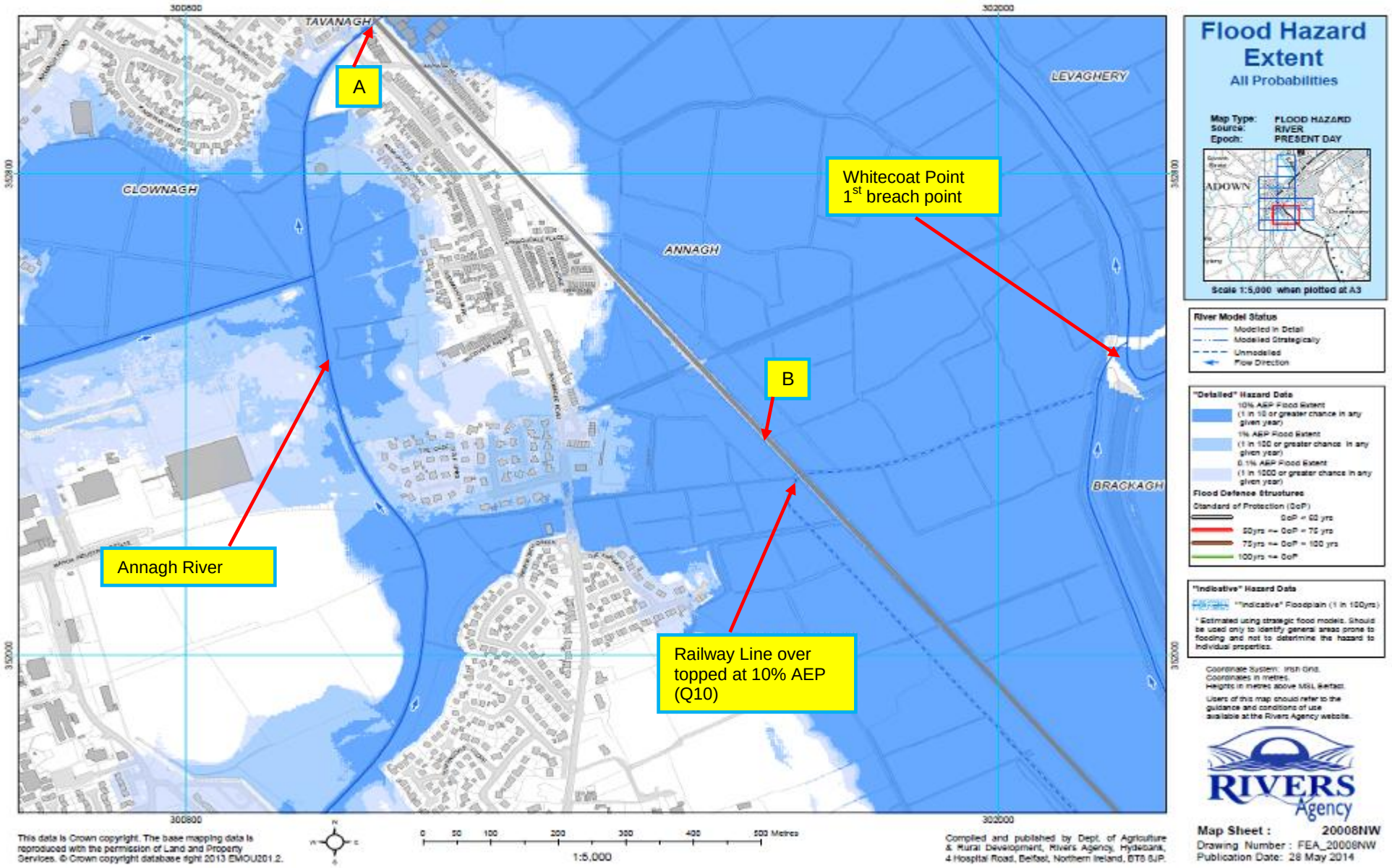


Figure 5.8.4.1 - Flood extent map for south Portadown

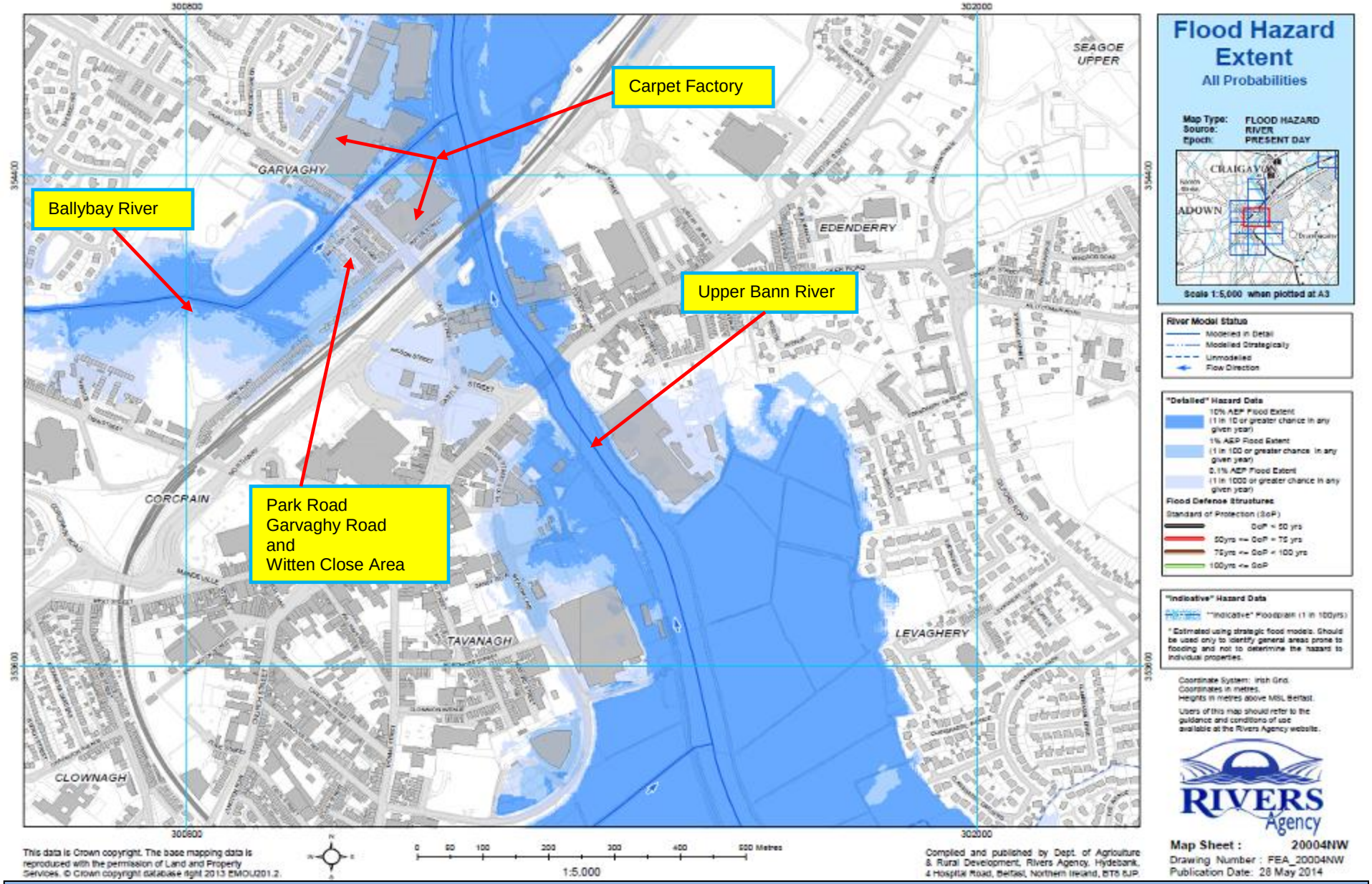


Figure 5.8.4.2 - Flood extent map for Central Portadown

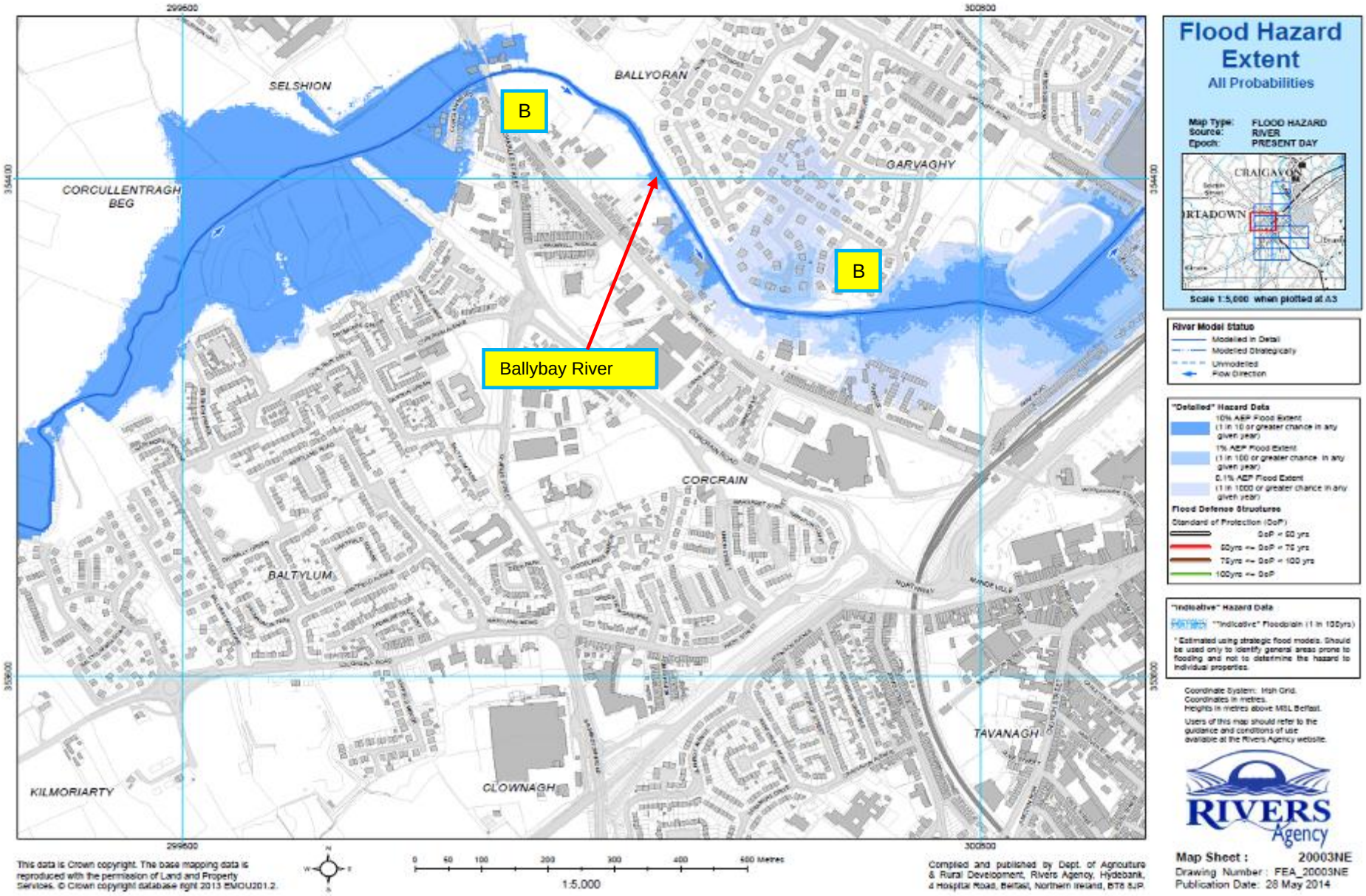


Figure 5.8.4.3 - Flood extent map for West Portadown - Ballybay River

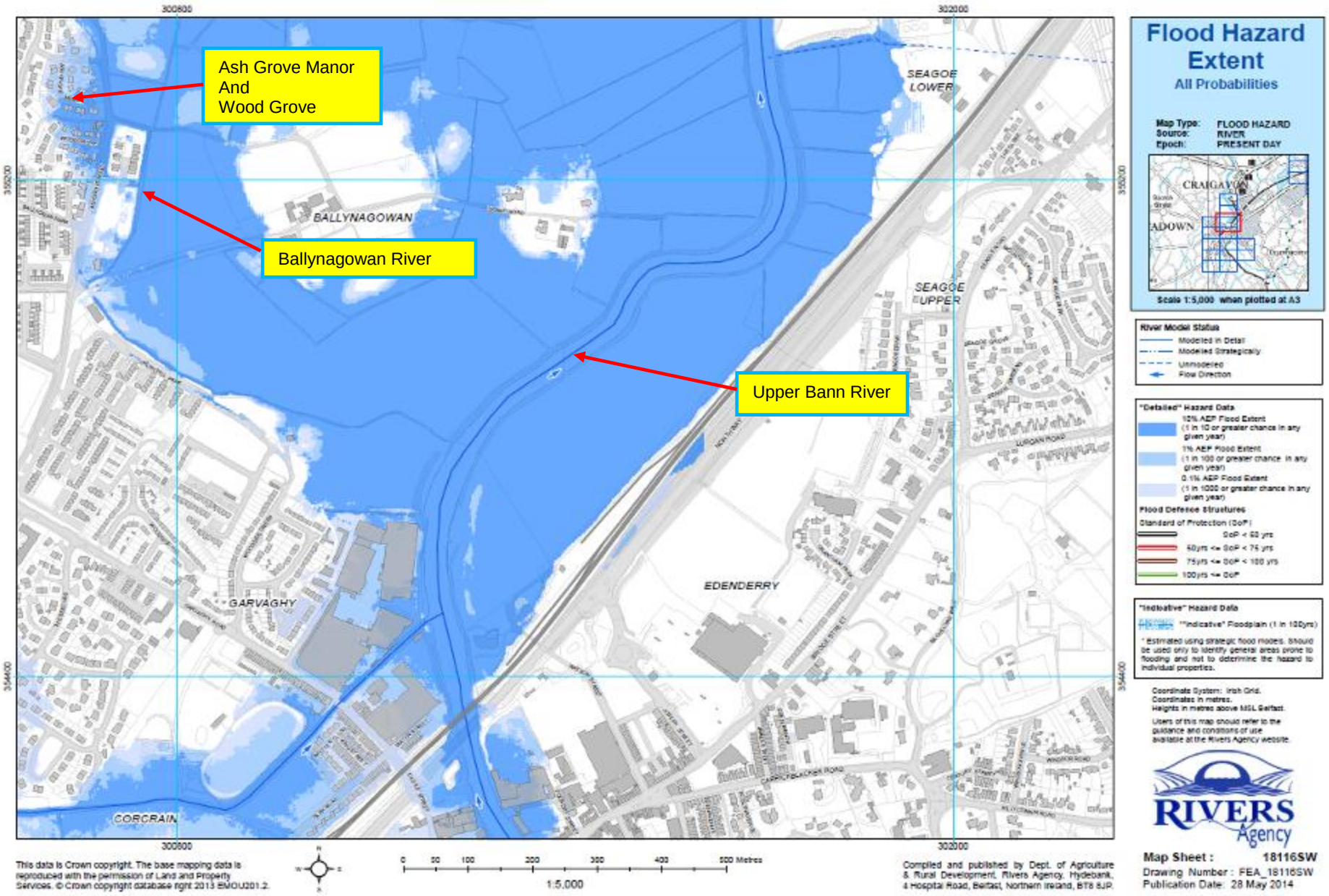


Figure 5.8.4.4 - Flood extent map for North Portadown – Ballynagowan River

Table 5.8.4.1 - Portadown SFRA – Ballybay River			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	4% AEP	1% AEP
Residential (Nr)	15	47	75
Non Residential (Nr)	4	6	10
Economic Damage (£)	£231,000	£575,000	£903,000
Annual Average Damage (£)	£86,350		
Present Value (£)	£2,590,000		

Table 5.8.4.2 - Portadown SFRA – Ballynagowan River			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	4% AEP	1% AEP
Residential (Nr)	20	28	36
Non Residential (Nr)	0	0	0
Economic Damage (£)	£200,000	£280,000	£360,000
Annual Average Damage (£)	£64,000		
Present Value (£)	£1,920,000		

Table 5.8.4.3 - Portadown SFRA – Annagh River			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	4% AEP	1% AEP
Residential (Nr)	0	22	65
Non Residential (Nr)	15	17	22
Economic Damage (£)	£180,000	£424,000	£980,000
Annual Average Damage (£)	£69,180		
Present Value (£)	£2,075,400		

One Integrated Pollution Prevention Control (IPPC) site falls within the estimated 1% AEP (Q100) flood event flood extent. This is the Ulster Carpet Mills site along the Central Corridor in Portadown. Brackagh Bog has been designated an Area of Significant Scientific Interest (ASSI) by the Northern Ireland Environment Agency. The area is a wetlands bog and natural pondage area for the Upper Bann and Cusher Rivers, as such it is unlikely to be detrimentally affected by infrequent major flooding.

The Upper Bann floodplain on the downstream side of the M1 motorway is a RAMSAR site (Convention of Wetlands). Similarly to Brackagh Bog this area is unlikely to be detrimentally affected by infrequent major flooding.

5.8.5 Proposed Fluvial Flood Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Portadown it is important that the flood risk is not increased by new development in areas of known flood risk. Planning Policy Statement, PPS 15, "Planning and Flood Risk", adopts a precautionary approach to development with the primary aim "to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere".

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the "Exception" rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to "Greenfield" built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new Development Plans for Portadown, Rivers Agency will advise against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 100 year fluvial floodplain or is susceptible elsewhere to surface water flooding.

Rivers Agency will also review the existing Development Plan for Portadown (Craigavon Area Plan) with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

The main (undeveloped) flooded areas within the Portadown area are:

- To the south of the town along the right bank of the Anngh River and the left bank of the Upper Bann River
- The area south of Kingways Drive Drain
- The area east to Park Road along the banks of the Ballybay River
- To the north of the town along the left bank of Ballynagowan River and the left bank of the Upper Bann River.

Planning Applications

Fluvial areas at risk

Rivers Agency will advise against the development of all sites that are located within the 1 in 100 year fluvial floodplain, irrespective of whether they are located within the current plan or as a single site application outside the plan area.

For those sites within the 1 in 100 year fluvial floodplain where the principle of development has been accepted by Planning NI as meeting the "Exception Test", Rivers Agency will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The main existing developed areas, amongst others, at flood risk within Portadown where re-development may be likely to take place are:

- Annagh Industrial Estate
- Ulster Carpet Factory

Areas at risk of surface water flooding

For those sites outside the 1 in 100 year fluvial floodplain/ that are located in an area where there is evidence of a history of surface water flooding identified by the flooding hardship payments Rivers Agency will further consider the application through the appraisal of the accompanying Drainage Assessment that will need to demonstrate suitable flood mitigation measures.

Where there is potential for surface water flooding as indicated in the purple predicted areas on the surface water maps Rivers Agency will advise that the applicant should assess the flood risk and drainage impact to the site himself and construct in the appropriate manner.

Areas at risk of flood inundation from Reservoirs

For all development proposals that are located within the potential flood inundation area of a controlled reservoir we will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures. If it is a new development proposal Rivers Agency will also need the applicant to demonstrate that the condition, management and maintenance regime of the reservoir is appropriate to provide sufficient assurance regarding reservoir safety. There are no controlled reservoirs in the Portadown SFRA.

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is, therefore, important that we continue to target investment by providing flood defence, culvert alleviation schemes and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. The **Flood Investment and Planning Group, (FIPG)**, provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a “Flood Risk Metric Tool” (FRISM) is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total “damage avoidance benefits” that the scheme will provide to the property over the scheme’s design life. If the benefit/cost ratio is greater than 1 (Net Present Value, NPV, figure is positive) then the potential scheme will be referred to Rivers Agency’s Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely Rivers Agency’s responsibility, or is the responsibility of NI Water or Transport NI such as a local drainage or road infrastructure issue, it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a benefit cost analysis identifies a viable scheme, a scheme will be placed on a prioritisation list for works with other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Within the Portadown area the following potential schemes have been identified and will be referred to the appropriate bodies for further investigation or detailed feasibility study.

List of possible schemes in Portadown SFRA:

Garvaghy area

- Fluvial flooding from the Ballybay River.
- Flood damage avoidance figure of **£2,590,000.**

Ballynagowan area

- Fluvial flooding from the Ballynagowan River.
- Flood damage avoidance figure of **£1,920,000.**

Annagh area

- Fluvial flooding from the Annagh River
- Flood damage avoidance figure of **£2,075,400.**

Preparedness

In Portadown it is not possible to prevent or protect against all flooding. Indeed even where flood defences exist it is possible in an extreme event that these could be over topped and flooding could still occur.

Having recognised this fact, considerable effort in recent years has been made by emergency planners in Government Departments, Councils and the Emergency Services working together and sharing information to ensure a coordinated response.

However, despite these improvements during significant flood events the emergency response of Government Departments and the Emergency Services can become over stretched. This means that not all calls for assistance during a flood event may be responded to in a timely manner. With this in mind it is important that households and communities, subject to a known flood risk, are prepared. The detail of preparedness actions, including flood warning and informing activities planned from a regional perspective, are provided in Annex E.

This is not Government withdrawing from any undertaking to respond in emergencies but an additional layer of support to ensure Government Departments and the public work together to reduce the overall impacts of flooding.

From the flood risk assessment there are certain areas of Portadown which are subject to flood risk and may have flooded before. Therefore, they may benefit from the flood warning and informing proposals outlined in Annex D.

A pilot project of community engagement to deliver flood warning and informing, held in 2014, identified basic assessment formulae to assess and score areas that could potentially be a focus for flood warning and

informing actions. Based on this scoring the following area could be considered suitable for being included in a programme of community engagement to deliver flood warning and informing initiatives:

- Park Road, Portadown.

Key activities that could be undertaken are:

- Explaining the potential and limitations of Community Resilience
- Briefing communities on information available, particulary from the Met Office
- The facilitation of self-help initiatives, including remote sandbag storage; and
- Reviewing and validating all elements of the Community Engagement Plan to help the community communicate effectively in an emergency and work together.

A table in Annex J shows how this community ranks in the overall context of the 20 SFRAs in this Plan. It should be noted that this is an indicative assessment which may change subject to further information on flood risk becoming available.

The rollout of this work is dependent on funding being available.

5.9 Glengormley and Mallusk - Sixmilewater

The core boundary of the Glengormley and Mallusk SFRA, which has been determined through the PFRA, is located within the Sixmilewater Local Management Area and illustrated in Figure 5.9 below.

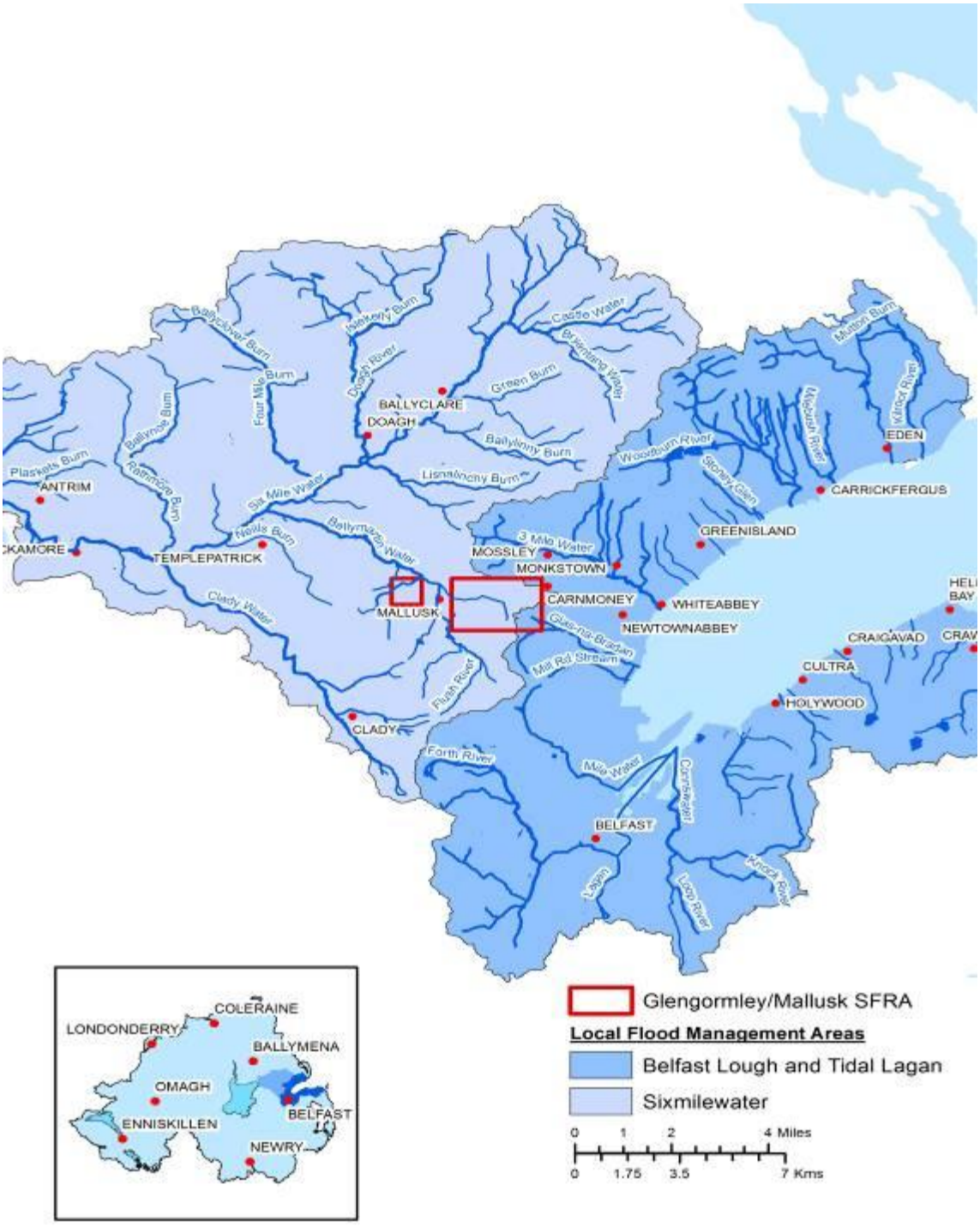


Figure 5.9 - Sixmilewater LFMA and Glengormley and Mallusk SFRA

5.9.1 Flooding history

Rivers Agency does not have any significant flooding records within the Glengormley & Mallusk Area. However, there was a significant general concern with respect to the capacity of the existing culvert network to accommodate the flood flows from the current and predicted levels of development.

It has been reported that the area around Park Road Bridge and the confluence between the Ballymartin River and Blackwater Drain is prone to out of bank flooding. No detailed records or flood data exist for the confluence but the problem has been increasing with further development of the catchment.

Records do exist however, of some localised flooding occurring on the 5th December 2001 during the development of new housing located on the left bank upstream of Park Road Bridge. Flooding was also recorded on the same day within a property in Rogan Manor.
The flood event of August 2008 caused widespread flooding across a large proportion of Northern Ireland. The most significant flooding was experienced in the North East including the overall Sixmilewater catchment. There are a number of areas within the Mallusk and Glengormley area that have flooded in the past:

- Brett Martin Factory
- 15 Roughfort Road
- 53 Lower Rogan Manor
- Localised flooding at Park Road Manor
- Commercial Property close to the Blackwater Drain at Sentry Lane

5.9.2 PFRA – Identification of Potentially Significant Flood Sources

According to the Preliminary Flood Risk Assessment (Dec 2011) the area of Glengormley and Mallusk, in terms of the potential adverse consequences of flooding, is ranked 16th of the twenty SFRA within Northern Ireland (see Figure 4.1). On the basis of this initial assessment, which was undertaken using the strategic flood maps, the predominant flood risk to the town was considered to arise from fluvial flooding.

It should be noted that the PFRA flagged up the potential for significant fluvial flooding in Glengormley and Mallusk because this national assessment is based on strategic 'undefended' flood models which ignore the presence of existing flood defence systems. Therefore, the assessment is in effect based on the worst case scenario, as it assumes there is no benefit from the defences. This precautionary approach has been taken because at the time of the assessment there was a degree of uncertainty about the level of protection that each of the existing flood defence systems provides. By adopting this approach, the urban areas that are located behind existing flood defence structures were determined to be SFRA by default and as a consequence detailed Flood Hazard/Risk Maps had to be prepared in compliance with the requirements of the EU Floods Directive. This provided the opportunity to undertake the detailed structural assessments and

flood modelling necessary to remove the uncertainty and establish the actual level of protection provided by these defences.

To facilitate a more robust assessment of the level of flood risk to Glengormley and Mallusk from fluvial flooding, Rivers Agency developed detailed predictive flood models for each of these flooding sources. It is considered that the flood hazard maps produced from these models will give a more accurate prediction of the flooded areas which may have been over or under estimated by the strategic flood maps. Details of the models and their output are described in the following sections.

5.9.3 Catchment Description

The Ballymartin River and Black Water Drain catchment is located in the general area of Glengormely and Mallusk. The Ballymartin River discharges into the Sixmilewater at Ballymartin River Bridge to the north of Templepatrick.

The overall Ballymartin River/ Blackwater Drain catchment, upstream of the Millbank Road Bridge is measured at 28.56km². The catchment area of the Ballymartin River and Flush River upstream of the Blackwater confluence is 11.31.km². The catchment area of the Ballymartin/Flush River tributary watercourse is 8.5km². This is the key sub catchment and includes the significantly developed areas of Mallusk and Glengormley.

Ballymartin River

The Ballymartin River is open channel with an isolated bridge which extends approximately 2.4km from Millbank Road Bridge to its confluence at the Blackwater Drain. The confluence is located approximately 250m downstream of Park Road Bridge.

This section of the catchment has low density urbanization with isolated developments including the Brett Martin Factory and Belfast Royal Academy (BRA) sports facilities at Roughfort Road.

Ballymartin River and Flush River

The Ballymartin River extends further upstream from the confluence with the Blackwater Drain to Hydepark Dam and upstream through the Boghill Dam. The catchment area of the Ballymartin River upstream of the Blackwater Drain confluence is 11.3 km².

Upstream of the Hydepark Dam the watercourse becomes the Flush River and extends approximately 2km to its source south west of Mallusk. The upper part of the catchment is steep rural land with only dispersed small holdings.

Development within the overall catchment area is relatively low with the land being relatively rural with dispersed small holdings. Current development levels increase significantly on the right bank of Ballymartin River from approximately 0.5km downstream of Hydepark Dam to the confluence with the Blackwater Drain.

Blackwater Drain

The Blackwater Drain commences at the confluence with the Ballymartin River and extends upstream through the extensively urbanized areas of Mullask and Glengormley. The watercourse is generally an open channel from the confluence to the Rogan Manor housing development approximately 1.2km upstream. The watercourses upstream of Rogan Manor are generally culverted with small areas of open channel mainly close to the rural open headwaters.

The catchment area upstream of Rogan Manor is steep and has a number of reaches. The section of the watercourse that extends through the urbanized area of Glengormley has two main reaches, the Inniscoole Park Stream and the Blackwater Drain Extension.

5.9.4 Fluvial Flood Risk Assessment

Flood Model

The flood model constructed for the Glengormley and Mallusk area used ISIS software. To represent the interaction of open channel, hydraulic structures and out of bank flow routes, an unsteady flood model of the Blackwater Drain and Ballymartin River was developed. ISIS performs calculations for one-dimensional steady and unsteady state flows and is capable of modelling supercritical, sub critical or mixed flow regimes.

ISIS software allows the incorporation of a range of hydraulic structures, including bridges, weirs and culverts, each of which have a number of parameters defining their shape and flow conveyance characteristics. Floodplains and out of bank flow routes can be modelled by extended sections or reservoirs storage areas.

Fluvial Flooding Mechanisms

Figures 5.9.4.1 to Figure 5.9.4.4 illustrate the predicted extents of the potential fluvial flooding in Glengormley and Mallusk and details of the impact of the flooding on property and key infrastructure is summarised in Table 5.9.4.1.

The majority of the culvert network in the Glengormley and Mallusk area is undesignated and has been built in stages over many years to facilitate the industrial development. These culvert works where undertaken following the advice of Rivers Agency.

It should be noted that when approval was given, the design standard for culverts was the 2% AEP (Q50) flood event and the majority of the culverts would have been sized on the future development proposals contained within BUAP (Belfast Urban Area Plan) 2001.

The model shows that at the relatively high frequency 10% AEP (Q10) flood event, floodwater is predicted to spill from a series of undesignated watercourses in the Richmond Grove, Richmond Way, Richmond Park East, Richmond Road and Ferndale Road areas. Also at the 10% AEP (Q10) flood event water is predicted to spill from another series of undesignated culverts in the main Mallusk Industrial Estate area. The resulting flood water ponds to a depth of up to 300mm in most of these places. It is estimated that **123** residential and **55** non residential properties could be flooded at this event causing damages in excess of **£2.2 million**.

At the more extreme 1% AEP (Q100) event the predicted flooding is generally confined to the same locations plus the Carolhill Park area. Although the flood inundation areas are more extensive the flood water still ponds to depth of 300mm. Flooding from the 1% AEP (Q100) event is estimated to affect **245** residential and **94** non residential properties at these locations causing damages in excess of **£3.8 million**.

The present value of the total property damages from potential future floods is calculated to be in excess of **£13.4 million**.

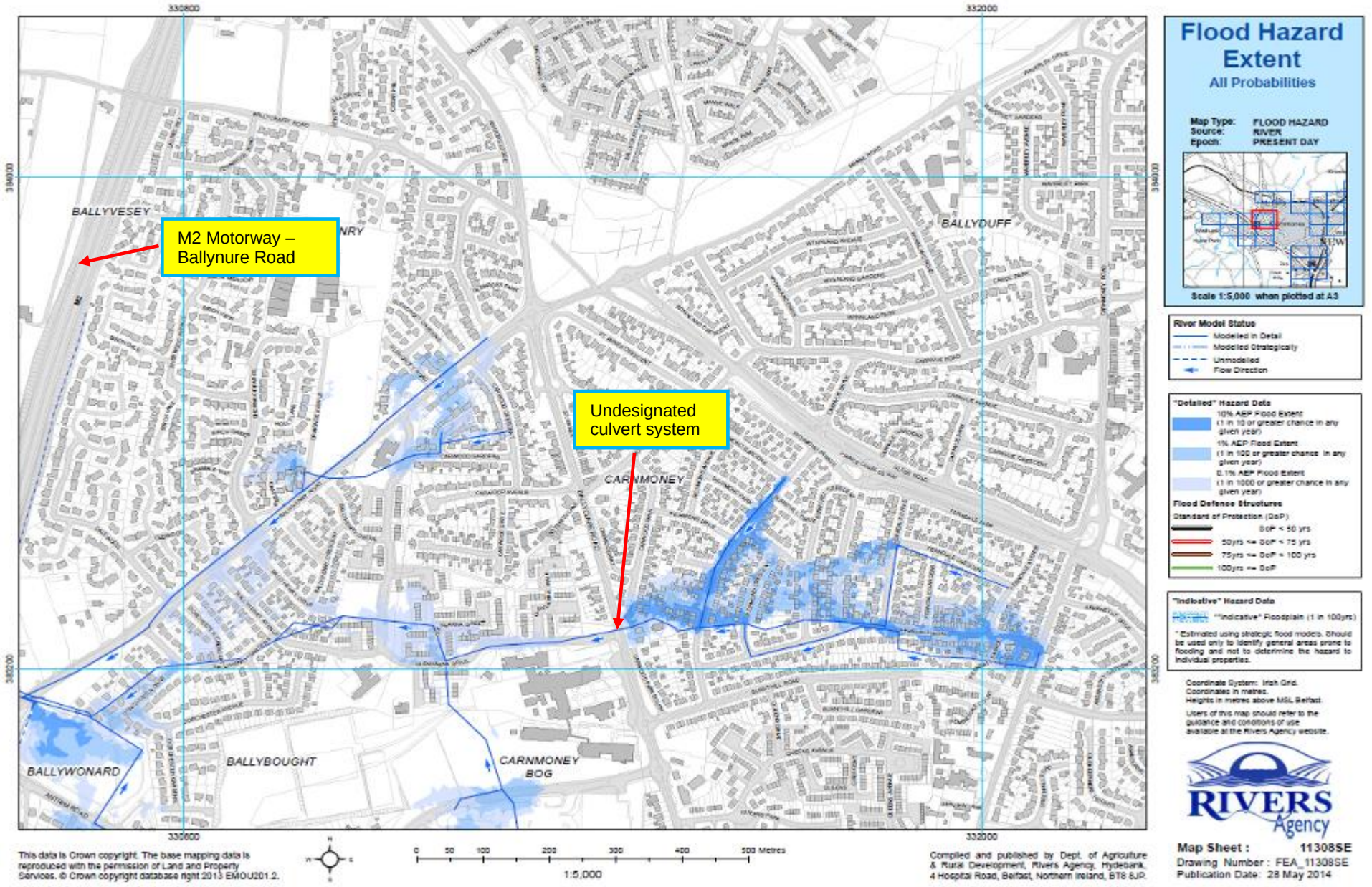


Figure 5.9.4.1 - Flood Extent map for north east Glengormley & Mallusk area

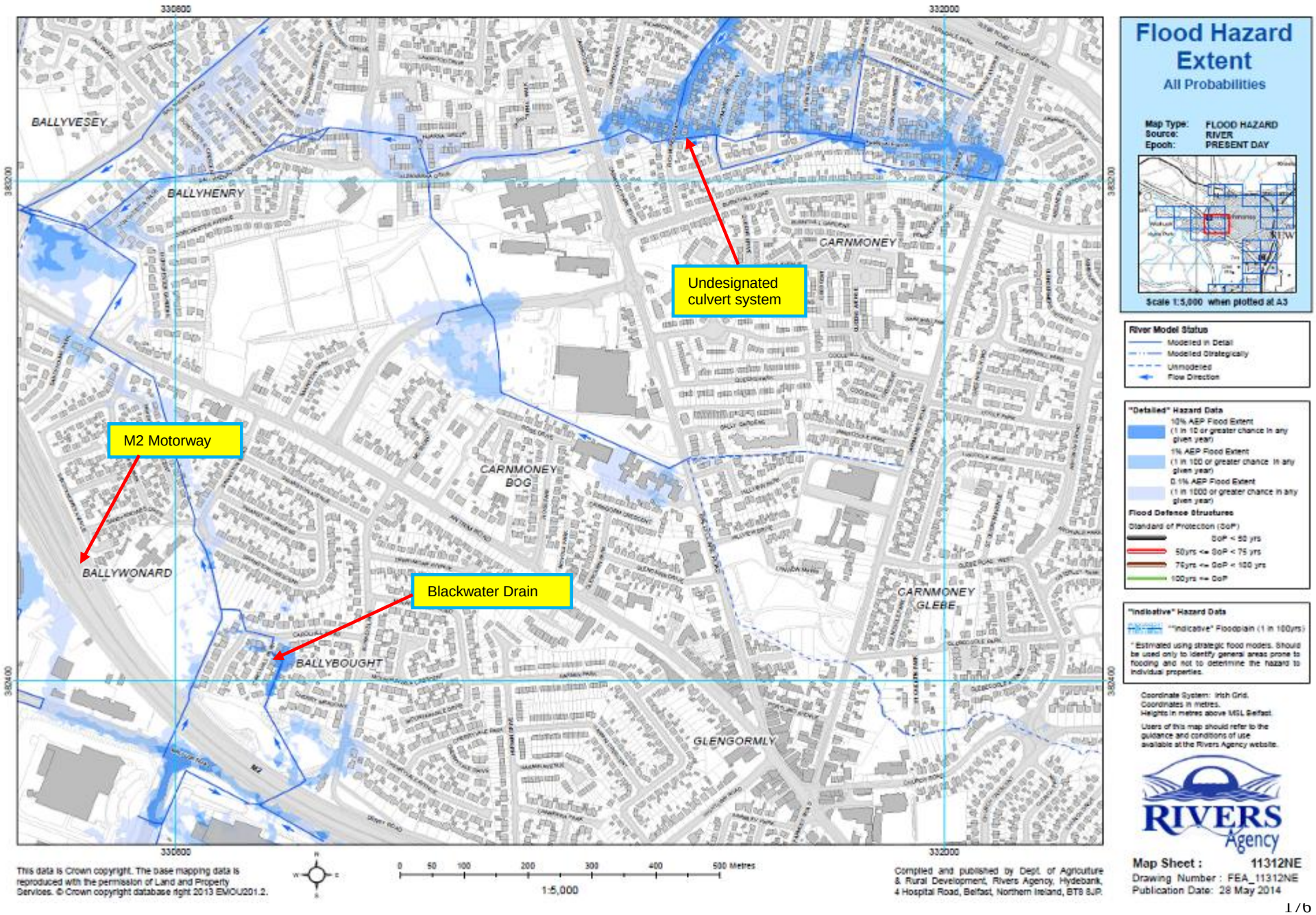


Figure 5.9.4.2 - Flood Extent map for south east Glengormley & Mallusk area

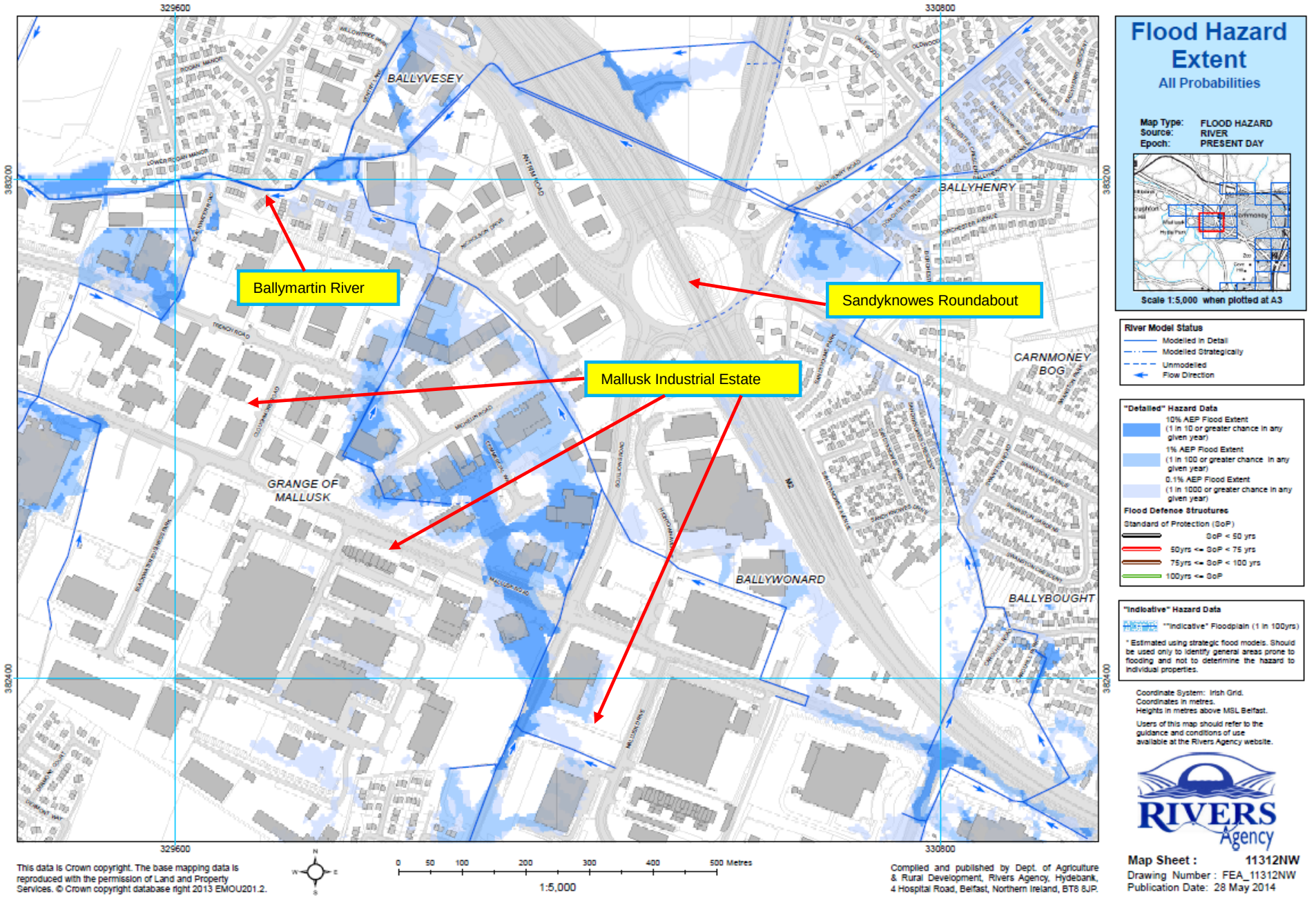


Figure 5.9.4.3 - Flood Extent map for south west Glengormley & Mallusk area

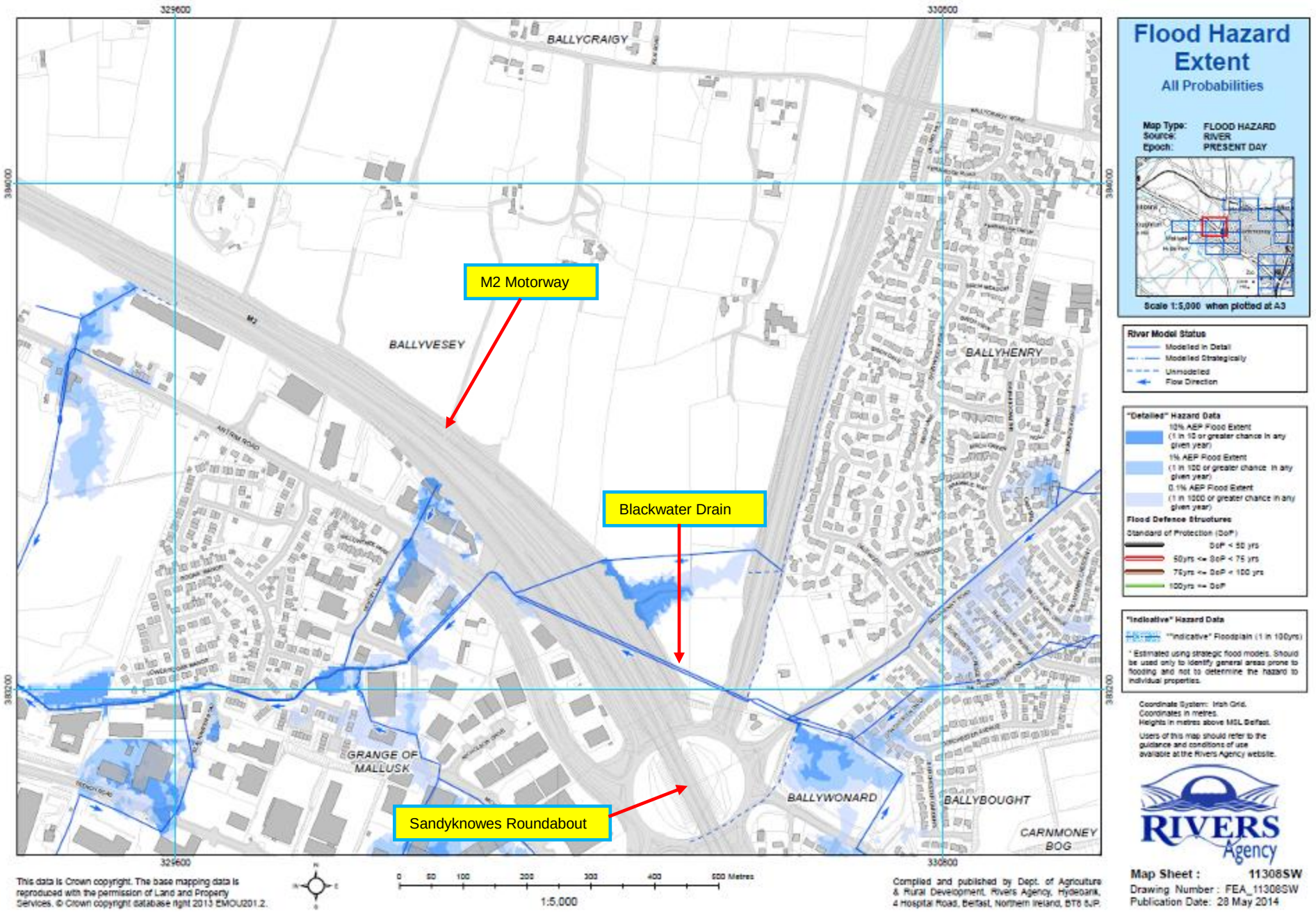


Figure 5.9.4.4 - Flood Extent map for north west Glengormley & Mallusk area

Table 5.9.4.1 - Glengormley & Mallusk SFRA			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	123	184	245
Non Residential (Nr)	55	64	94
Economic Damage (£)	£2,026,000	£2,848,000	£3,880,000
Annual Average Damage (£)	£447,140		
Present Value (£)	£13,414,200		
IPPC sites (Nr)	2	2	2
Community Assets (Nr)			
Care Homes	0	0	0
GP Surgery's	0	0	0
Fire stations	0	0	0
Hospitals	0	0	0
Police Stations	0	0	0
Schools	0	0	0
Key Infrastructure (Nr)			
NIW Wastewater Treatment Works	0	0	0
NIW Sewage Pumping Stations	0	0	0
NIW Water Treatment Work	0	0	0
NIW Treated Water Pumping Stations	0	0	0
NIE Substation 6to11kV	0	0	0
NIE Substation 33kV	0	0	0
NIE Substation 275kV	0	0	0
NIE Substation 110kV	0	0	0
Road Service - Trunk Road	0	0	0
Environmental Designated sites (Nr)			
AONB	0	0	0
ASSI	0	0	0
Environmentally Sensitive Areas	0	0	0
Maritime Nature Reserve	0	0	0
Nature Reserve	0	0	0
RAMSAR	0	0	0
SAC	0	0	0
Sites of Local Nature Conservation Importance	0	0	0
SPA	0	0	0
RSPB Reserve	0	0	0
UWT Nature Reserve	0	0	0
Built Heritage sites (Nr)			
National Trust	0	0	0
Listed Buildings	0	0	0
Sites and Monuments Records	0	0	0
Buildings of Special Architectural or Historical Interest	0	0	0
Areas of Significant Archaeological Interest	0	0	0
Historic Gardens	0	0	0

5.9.5 Proposed Fluvial Flood Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Glengormley and Mallusk it is important that the flood risk is not increased by new development in areas of known flood risk. Planning Policy Statement, PPS 15, "Planning and Flood Risk", adopts a precautionary approach to development with the primary aim "to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere".

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the "Exception" rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to "Greenfield" built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new Development Plans for Glengormley and Mallusk, Rivers Agency will advise against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 100 year fluvial floodplain or is susceptible elsewhere to surface water flooding.

We shall also review the existing Development Plan for Glengormley & Mallusk (Belfast Metropolitan Area Plan) with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

The main (undeveloped) flooded area within the Glengormley & Mallusk area is:

- The Sandyknowes Parkland area

Planning Applications

Fluvial areas at risk

Rivers Agency will advise against the development of all sites that are located within the 1 in 100 year fluvial floodplain, irrespective of whether they are located within the current plan or as a single site application outside the plan area.

For those sites within the 1 in 100 year fluvial floodplain where the principle of development has been accepted by Planning NI as meeting the "Exception Test", Rivers Agency will further consider the application

through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The main existing developed area, amongst others, at flood risk within Glengormley & Mallusk where re-development may be likely to take place is:

- Mallusk Industrial Estate

Areas at risk of surface water flooding

For those sites outside the 1 in 100 year fluvial floodplain that are located in an area where there is evidence of a history of surface water flooding identified by the flooding hardship payments Rivers Agency will further consider the application through the appraisal of the accompanying Drainage Assessment that will need to demonstrate suitable flood mitigation measures.

Where there is potential for surface water flooding as indicated in the purple predicted areas on the surface water maps, Rivers Agency will advise that the applicant should assess the flood risk and drainage impact to the site himself and construct in the appropriate manner.

Areas at risk of flood inundation from reservoirs

For all development proposals that are located within the potential flood inundation area of a controlled reservoir we will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures. If it is a new development proposal Rivers Agency will also need the applicant to demonstrate that the condition, management and maintenance regime of the reservoir is appropriate to provide sufficient assurance regarding reservoir safety.
Controlled reservoirs identified in the Glengormley & Mallusk area are as follows:

- Hydepark Dam
- Boghill Dam
- Mossley Mill

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is, therefore important, that we continue to target investment by providing flood defence, culvert alleviation schemes and infrastructure upgrade works to those communities at greatest need.
The alleviation of surface water flooding, in particular, will require input from a number of bodies. The **Flood Investment and Planning Group, (FIPG)**, provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is

represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a "Flood Risk Metric Tool" (FRISM) is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total "damage avoidance benefits" that the scheme will provide to the property over the scheme's design life. If the benefit/cost ratio is greater than 1 (Net Present Value, NPV, figure is positive) then the potential scheme will be referred to Rivers Agency's Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely Rivers Agency's responsibility, or is the responsibility of NI Water or Transport NI such as a local drainage or road infrastructure issue it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a benefit cost analysis identifies a viable scheme, a scheme will be placed on a prioritisation list for works with other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Having conducted a detailed assessment of the fluvial flood risk to Glengormley and Mallusk, Rivers Agency has determined that potential flood alleviation scheme may be justified for this area.

A feasibility study was carried out in September 2014 which identified a number of locations in the Glengormley and Mallusk area that are at risk from fluvial flooding. The feasibility study found that the source of the flooding was a number of designated and un-designated watercourses. The study produced a number of recommendations to alleviate the flooding within the study area.

The recommendations regarding designated watercourses will be submitted to Rivers Agency's Capital Procurement Unit and the recommendations regarding un-designated watercourses will be presented to the Flood Investment and Planning Group, (FIPG). The findings of this will be taken into consideration in the final version of the FRMP (December 2015).

Preparedness

In Glengormley and Mallusk it is not possible to prevent or protect against all flooding. Indeed even where flood defences exist it is possible in an extreme event that these could be over topped and flooding could still occur.

Having recognised this fact, considerable effort in recent years has been made by emergency planners in Government Departments, Councils and the Emergency Services working together and sharing information to ensure a coordinated response.

However, despite these improvements during significant flood events the emergency response of Government Departments and the Emergency Services can become over stretched. This means that not all calls for assistance during a flood event may be responded to in a timely manner. With this in mind it is important that households and communities, subject to a known flood risk, are prepared. The detail of preparedness actions, including flood warning and informing activities planned from a regional perspective, are provided in Annex E.

This is not Government withdrawing from any undertaking to respond in emergencies but an additional layer of support to ensure Government Departments and the public work together to reduce the overall impacts of flooding.

From the flood risk assessment there are certain areas of Glengormley and Mallusk which are subject to flood risk and may have flooded before. Therefore, they may benefit from the flood warning and informing proposals outlined in Annex D.

A pilot project of community engagement to deliver flood warning and informing, held in 2014, identified basic assessment formulae to assess and score areas that could potentially be a focus for flood warning and informing actions. Based on this scoring the following area could be considered suitable for being included in a programme of community engagement to deliver flood warning and informing initiatives:

- Sandholme Park / Sandyknowes Park.

Key activities that could be undertaken are:

- Explaining the potential and limitations of Community Resilience
- Briefing communities on information available, particulary from the Met Office
- The facilitation of self-help initiatives, including remote sandbag storage; and
- Reviewing and validating all elements of the Community Engagement Plan to help the community communicate effectively in an emergency and work together.

A table in Annex J shows how this community ranks in the overall context of the 20 SFRAs in this Plan. It should be noted that this is an indicative assessment which may change subject to further information on flood risk becoming available.

The rollout of this work is dependent on funding being available.

5.10 Warrenpoint – Newry & Mourne

The core boundary of the Warrenpoint SFRA, which has been determined through the PFRA, is located within the Newry & Mourne Local Management Area and illustrated in Figure 5.10 below.

Figure 5.10 - Newry and Mourne LFMA and Warrenpoint SFRA

5.10.1 Flooding history

Information not available for the draft Flood Risk Management Plan but will be included in the final Flood Risk Management Plan.

5.10.2 PFRA – Identification of Potentially Significant Flood Sources

According to the Preliminary Flood Risk Assessment (Dec 2011) the town of Warrenpoint, in terms of the potential adverse consequences of flooding, is ranked 11th of the twenty SFRA within Northern Ireland (see Figure 4.1). On the basis of this initial assessment, which was undertaken using the strategic flood maps, the flood risk to the town is considered to arise from fluvial flooding and coastal flooding.

It should be noted that the PFRA flagged up the potential for significant fluvial flooding and coastal flooding at Warrenpoint because this national assessment was based on strategic 'undefended' flood models which ignore the presence of existing flood defence systems. Therefore, the assessment is in effect based on the worst case scenario, as it assumes there is no benefit from the defences. This precautionary approach has been taken because at the time of the assessment there was a degree of uncertainty about the level of protection that each of the existing flood defence systems provides. By adopting this approach, the urban areas that are located behind existing flood defence structures were determined to be SFRA by default and as a consequence detailed Flood Hazard/Risk Maps had to be prepared in compliance with the requirements of the EU Floods Directive. This provided the opportunity to undertake the detailed structural assessments and flood modelling necessary to remove the uncertainty and establish the actual level of protection provided by these defences.

To facilitate a more robust assessment of the level of flood risk to Warrenpoint from fluvial and coastal flooding, Rivers Agency developed detailed predictive flood models for each of these sources of flooding. It is considered that the flood hazard maps produced from these models will give a more accurate prediction of the flooded areas which may have been over or under estimated by the strategic flood maps. Details of the models and their output are described in the following sections.

5.10.3 Catchment Description

Information not available for the draft Flood Risk Management Plan but will be included in the final Flood Risk Management Plan.

5.10.4 Coastal Flood Risk Assessment

Model

The tidal simulations for Warrenpoint were undertaken using a detailed MIKE 21 HD model which is a sub-model driven by the Irish Surge and Tidal Model that is used to determine extreme sea levels around the non-estuarine coastline of Ireland.

Coastal Flooding Mechanisms

The 0.5% AEP (Q200) flood level for Warrenpoint was obtained from the Irish Surge and Tidal Model that is used to determine extreme sea levels around the non-estuarine coastline of Ireland. Rivers Agency new detailed coastal hazard map indicates that Warrenpoint is at risk from coastal flooding.

Figures 5.10.4.1 and 5.10.4.2 illustrates the predicted extents of the coastal flooding to Warrenpoint and details of the impact of the flooding on property and key infrastructure is summarised in Table 5.10.4.1.

The model shows that at the relatively high frequency 10% AEP (Q10) flood event, floodwater is predicted to inundate the Harbour Industrial Estate, Charlotte Street and Newry Street. The flood water will pond to depths of up to 300mm in the low lying areas, most notably in the Charlotte Street area. It is estimated that **24** residential and **10** non residential properties could be flooded at this event causing damages in excess of **£390,000**.

At the more extreme 0.5% AEP (Q200) event the predicted flooding is generally confined to the same locations plus Meeting Street and the Clermont Gardens area, although the flood inundation areas are more extensive at the 0.5% AEP flood event. Flooding from the 0.5% AEP (Q200) coastal flood event is estimated to affect **59** residential and **27** non residential properties causing damages in excess of **£995,000**.

The present value of the total property damages from potential future coastal floods is calculated to be in excess of **£3.3million.** (See Table 5.10.4.1)

Photo 5.10.4.1 - Rostrevor Road in Warrenpoint flooded in Jan 2014

Table 5.10.4.1 - Warrenpoint SFRA			
Potential Adverse Consequences – Coastal Flooding			
	Flood Event % AEP		
	10% AEP	4% AEP	0.5% AEP
Residential (Nr)	24	34	59
Non Residential (Nr)	10	16	27
Economic Damage (£)	£390,000	£480,000	£995,000
Annual Average Damage (£)	£111,912		
Present Value (£)	£3,357,360		

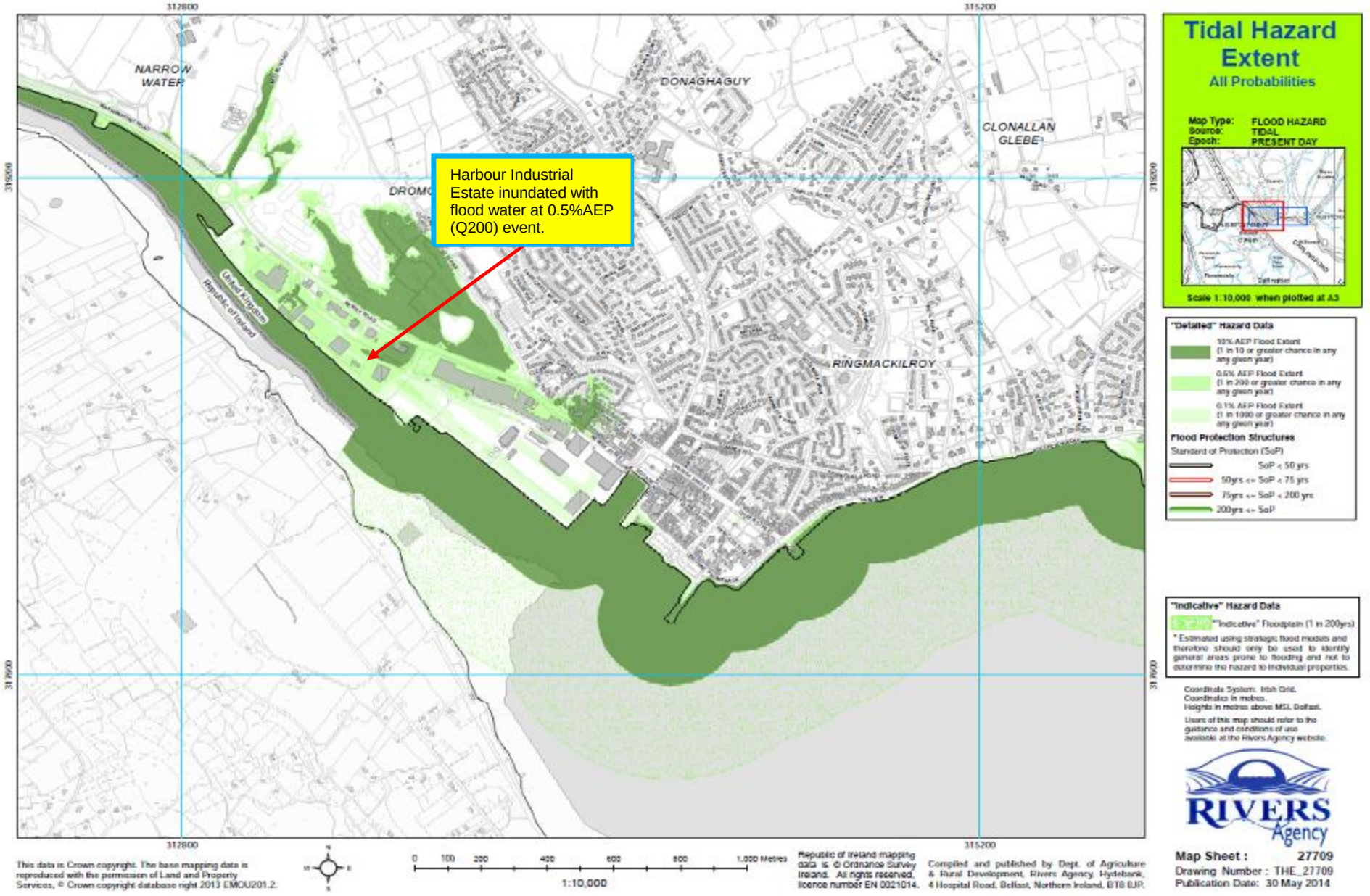


Figure 5.10.4.1 - Warrenpoint coastal hazard extent map

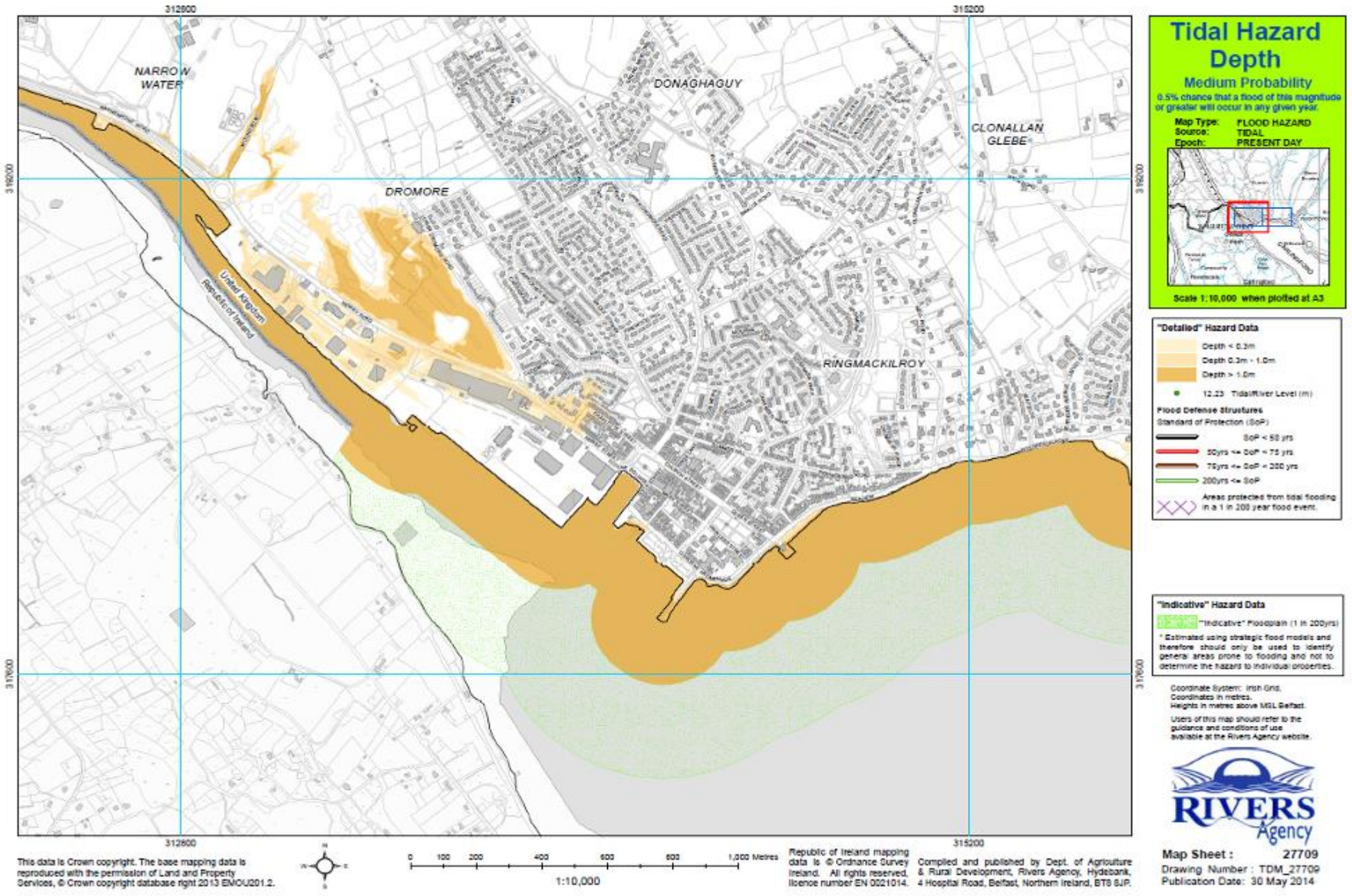


Figure 5.10.4.2 - Warrenpoint coastal hazard depth map

5.10.5 Proposed Coastal Flood Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Warrenpoint it is important that the flood risk is not increased by new development in areas of known flood risk. Planning Policy Statement, PPS 15, "Planning and Flood Risk", adopts a precautionary approach to development with the primary aim "to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere".

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the "Exception" rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to "Greenfield" built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new Development Plans for Warrenpoint, Rivers Agency will advise against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 200 year fluvial floodplain.

Rivers Agency will also review the existing Development Plan for Warrenpoint (Banbridge, Newry and Mourne Area Plan) with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

Planning Applications

Coastal areas at risk

Rivers Agency will advise against the development of all sites that are located within the 1 in 200 year coastal floodplain, irrespective of whether they are located within a current development plan or as a single site application outside the plan area.

For those sites within the 1 in 200 year coastal floodplain where the principle of development has been accepted by Planning NI as meeting the "Exception Test", Rivers Agency will further consider the application through the appraisal of an accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The main existing developed area, at coastal flood risk within Warrenpoint SFRA where re-development may be likely to take place is:-

- Harbour Industrial Estate

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is, therefore, important that we continue to target investment by providing flood defence, culvert alleviation schemes and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. The **Flood Investment and Planning Group, (FIPG**) provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a “Flood Risk Metric Tool” (FRISM) is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total “damage avoidance benefits” that the scheme will provide to the property over the scheme’s design life. If the benefit/cost ratio is greater than 1 (Net Present Value, NPV, figure is positive) then the potential scheme will be referred to Rivers Agency’s Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely Rivers Agency’s responsibility, or is the responsibility of NI Water or Transport NI such as a local drainage or road infrastructure issue, it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a benefit cost analysis identifies a viable scheme, a scheme will be placed on a prioritisation list for works with other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Preparedness

Coastal flooding has the potential to have a significant impact in terms of risk to life. This is mainly due to the rate of inundation from the sea at the height of the tidal cycle. In light of this the emergency response to significant coastal flooding with a risk to life will be led by PSNI and evacuation of potentially affected areas will be a real consideration.

To ensure a coordinated approach local, tactical Coastal Flooding Emergency Response Plans are being developed for Warrenpoint. This will link to a strategic Coastal Flooding Emergency Response Plan.

The Coastal Flood Response Plan aims to provide a pre-planned response to a warning of coastal flooding and outline the graduated incident and coordinated inter-agency response to a potential or actual coastal flooding event.

The objectives of the plan are to:-

- Identify activation triggers for responding to a coastal flood warning or incident.
- Document the actions to be taken on receipt of a coastal flood warning.
- Set out the process for a coordinated response including the graduated incident management of a potential or actual coastal flooding event.
- Ensure a common understanding of the potential impacts of a coastal flooding event in each area and act as a reference document for all the agencies involved to provide a pre-planned response at various levels of coastal flood risk.

5.10.6 Fluvial Flood Risk Assessment

Flood Model

The consultant used InfoWorks ICM 1D/ 2D (Version 3.5) modelling software for the Warrenpoint flood model. InfoWorks ICM (Integrated Catchment Modelling) is an integrated modelling platform which incorporates both urban and river catchments. It provides the ability to model the complete drainage systems both natural and engineered above and below-ground drainage system including sewers, surface water, river and floodplains.

Hydrodynamic models were established in Infoworks ICM for each watercourse listed below:

Milltown Stream

The modelled reach of Milltown Stream starts at Ballydesland Road, flows through Milltown Industrial Estate and along the side of Warrenpoint Golf Course, before discharging to the Newry River. The total length of the

modelled river is 3.27km and includes 62 topographical survey cross-sections. There are a number of culverted sections along this river.

Warrenpoint Golf Club Stream

The modelled reach of Warrenpoint Golf Club Stream flows through Warrenpoint Golf Course before discharging to the Newry River. The total length of the modelled river is 410m and includes 11 topographical survey cross-sections and 4 culverted reaches.

Clonallan Stream

The modelled reach of Clonallan Stream starts in the vicinity of St Marks High School on Upper Dromore Road, flows through the urban area of Warrenpoint and discharges to Carlingford Lough close to the junction of Springfield and Rostrevor Roads. The total length of the modelled river is 2.1km and includes 44 topographical survey cross-sections. There are 2 bridges along this length that affect the hydrodynamic characteristics of the river and are therefore included in the model.

St Leonards Stream

The modelled reach of St Leonards Stream flows for a short distance through Seafields, and discharges to Carlingford Lough. The total length of the modelled river is 500m and includes 9 topographical survey cross-sections.

Moygannon River

The modelled reach of the Moygannon River extends from upstream of the Rath Road and
flows adjacent to the Moygannon Road to its discharge point to Carlingford Lough at Dobbin's Point. The total length of the modelled river is 850m and includes 17 topographical survey cross-sections. There are 2 bridge structures along this length that affect the hydrodynamic characteristics of the river and are therefore included in the model.

Fluvial Flooding Mechanisms

This section provides an overview of the main flooding mechanisms throughout the Warrenpoint SFRA.

Moygannon River

Figure 5.10.6.1 illustrates the predicted flooding along the Moygannon River. Flooding initially begins upstream of Moygannon Bridge at location A in Figure 5.10.6.1, flooding spreads across the fields eventually over topping the Rostrevor Road. Flooding is also predicted to originate from upstream of the Rath Road at location B on Figure 5.10.6.1. Flood water overtops the Rath Road and flows through the fields towards the Rostrevor Road. At the more extreme 1% AEP (Q100) flood event the predicted flooding is generally

confined to the same locations although the flood inundation areas are more extensive. Flooding from the 1% AEP (Q100) flood event is estimated to affect no properties.

Clonallan Stream

Figure 5.10.6.2 illustrates that at the 1%AEP (Q100) flood event, floodwater is predicted to spill from the watercourse know as Clonallan Stream within Springfield Road, Sea View Road, Smalls Road and Spring Meadows area. The flood water ponds to depths of 300mm in the low lying areas, most notably in the downstream reach in the Sea View Road area. This may be due to a capacity issue with the culvert under the Springfield Road. The existing culvert is 1050mm in diameter which can vent a flow of 1.6 m^3/sec. The model shows a Q100 discharge flow of 2.8 m^3/sec which would require a 1350mm diameter culvert. At the 1%AEP (Q100) it is also predicted that flood water spills from the Clonallan Stream in the upstream reach around the Forth Road area. It is estimated that **23** residential and **2** non residential properties could be flooded at this event causing damages in excess of **£165,000**.

The present value of the total property damages from potential future floods is calculated to be in excess of **£315,000.** The impact of the flooding on property and key infrastructure from the Clonallan Stream is summarised in Table 5.10.6.1.

Milltown Stream

Figure 5.10.6.3 illustrates the predicted flooding from the Milltown Stream. Flooding is initially predicted at location A on Figure 5.10.6.2, from here it spreads south towards the Donaghaguy Reservoir. Flooding is also predicted to originate at location B, the inlet to the culverted reach under the Milltown Industrial Estate.

The model shows that at the relatively high frequency 10% AEP (Q10) flood event, floodwater is predicted to spill from Milltown stream in the Milltown Industrial Estate and Milltown Street areas. The flood water ponds to depths of up to 300mm in this area. It is estimated that **3** residential and **2** non residential properties could be flooded at this event causing damages in excess of **£35,500**.

At the more extreme 1% AEP (Q100) flood event the predicted flooding is generally confined to the same locations although the flood inundation areas are more extensive. Flooding from the 1% AEP (Q100) flood event is estimated to affect **3** residential and **9** non residential properties causing damages in excess of **£91,500**.

The present value of the total property damages from potential future floods is calculated to be in excess of **£150,000.** The impact of the flooding on property and key infrastructure from the Milltown Stream is summarised in Table 5.10.6.2.

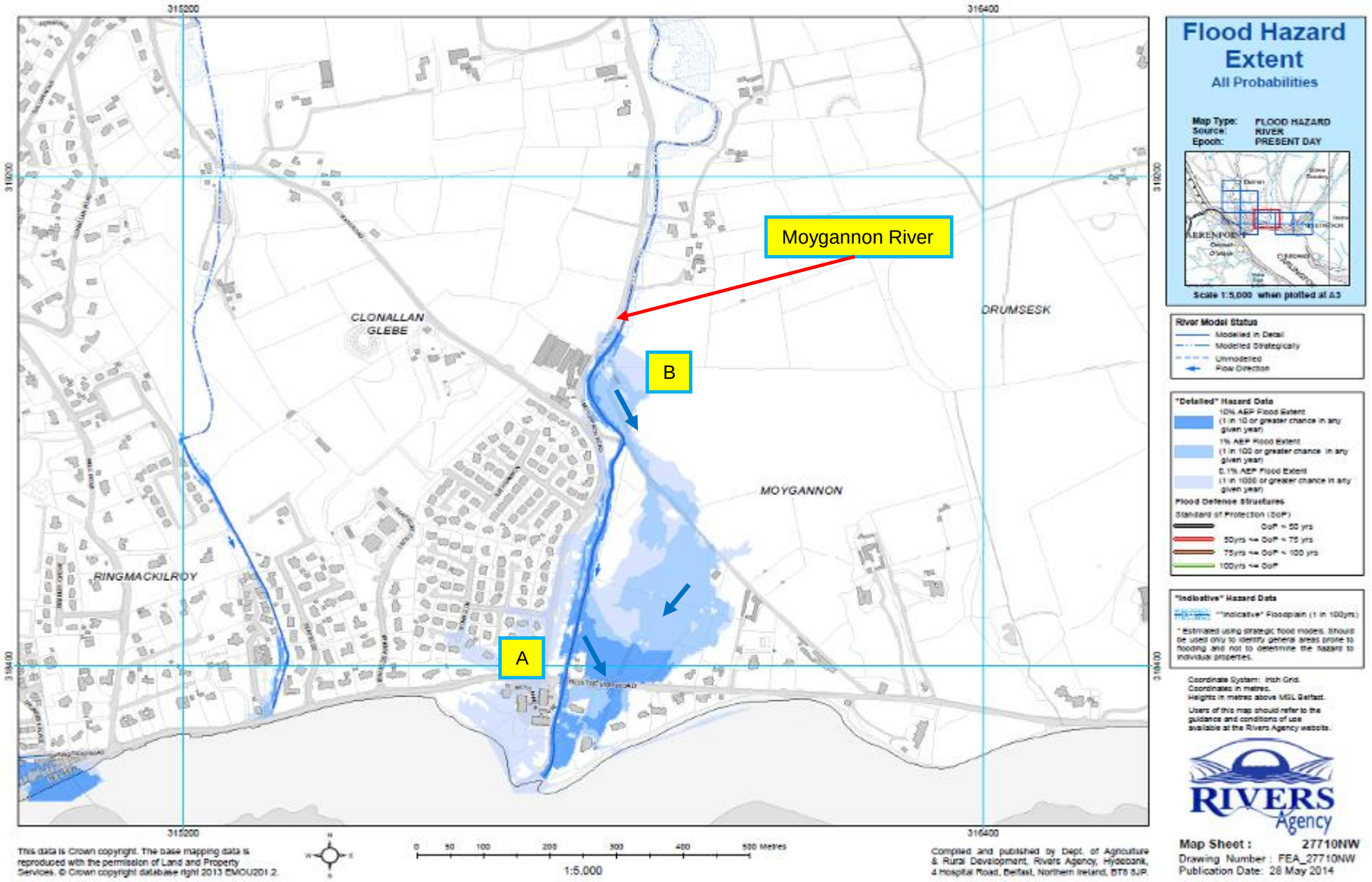


Figure 5.10.6.1 - Moygannon River Flood Hazard Extent map

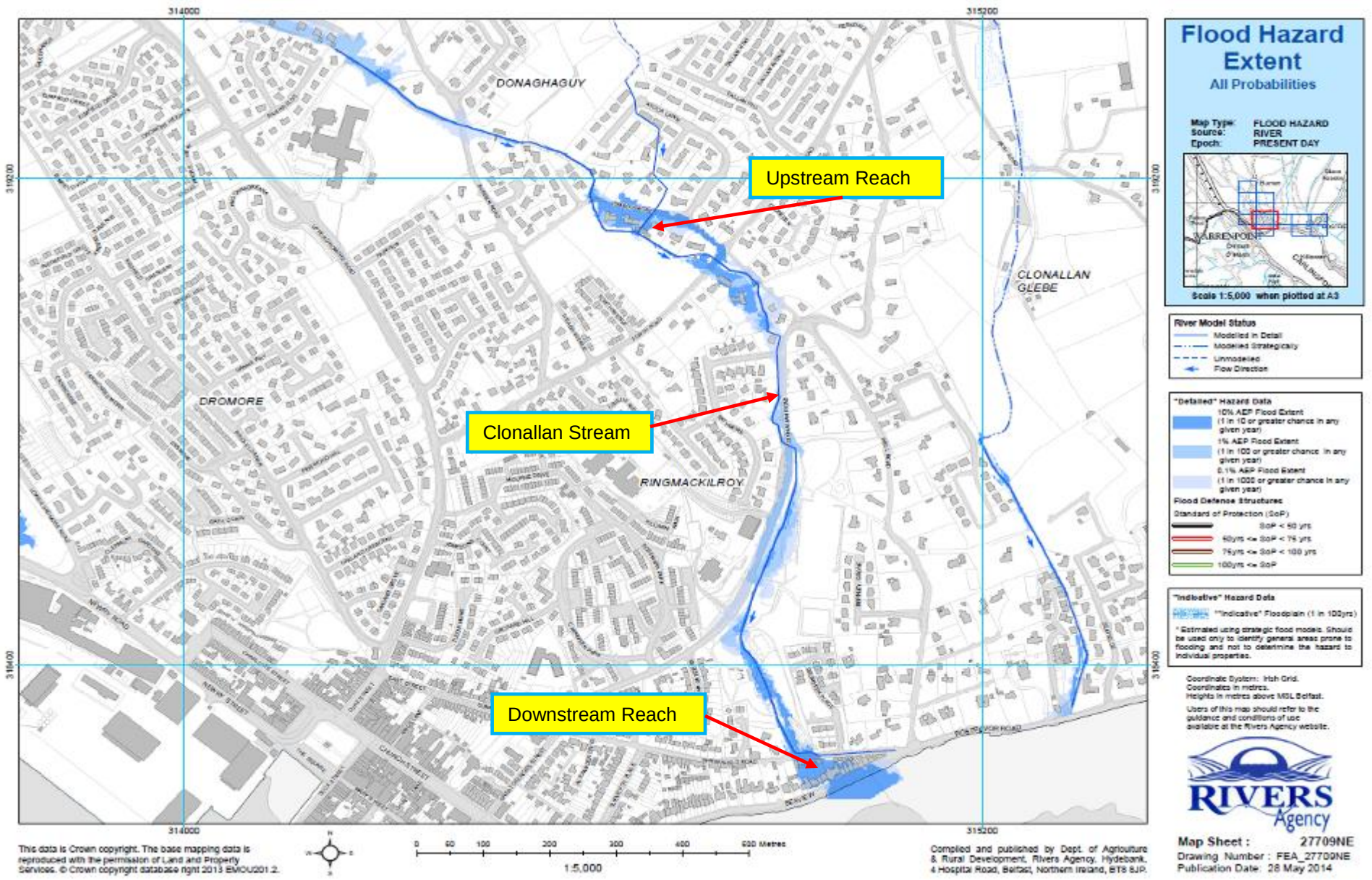


Figure 5.10.6.2 - Clonallan Stream Flood Hazard Extent map

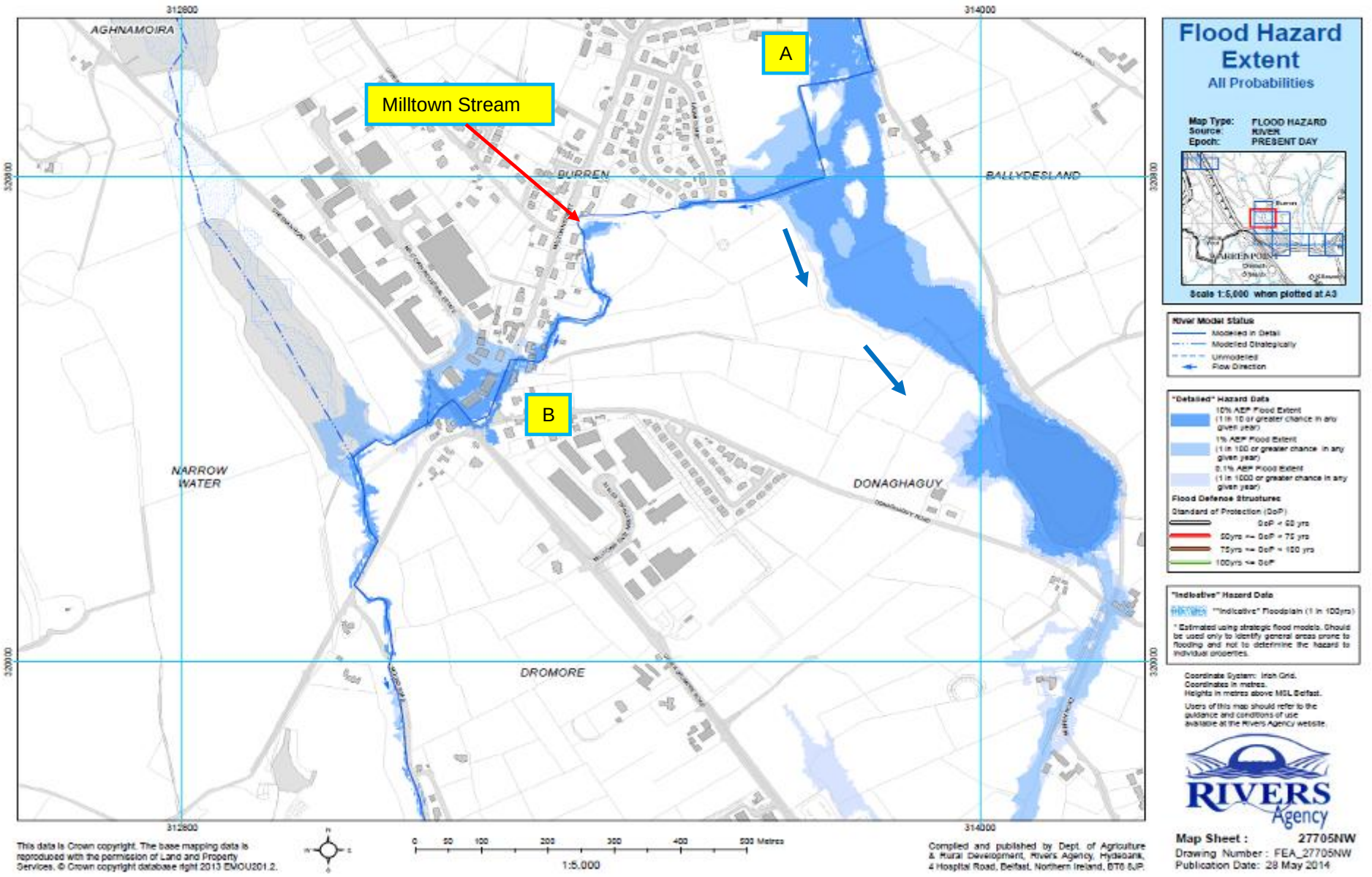


Figure 5.10.6.3 - Milltown Stream Flood Hazard Extent map

Table 5.10.6.1 - Warrenpoint SFRA – Clonallan Stream			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	**23**	**23**	**23**
Non Residential (Nr)	**2**	**2**	**2**
Economic Damage (£)	**£165,500**	**£165,500**	**£165,500**
Annual Average Damage (£)	**£10,500**		
Present Value (£)	**£315,000**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)			
Care Homes	**0**	**0**	**0**
GP Surgery's	**0**	**0**	**0**
Fire stations	**0**	**0**	**0**
Hospitals	**0**	**0**	**0**
Police Stations	**0**	**0**	**0**
Schools	**0**	**0**	**0**
Key Infrastructure (Nr)			
NIW Wastewater Treatment Works	**0**	**0**	**0**
NIW Sewage Pumping Stations	**0**	**0**	**0**
NIW Water Treatment Work	**0**	**0**	**0**
NIW Treated Water Pumping Stations	**0**	**0**	**0**
NIE Substation 6to11kV	**0**	**0**	**0**
NIE Substation 33kV	**0**	**0**	**0**
NIE Substation 275kV	**0**	**0**	**0**
NIE Substation 110kV	**0**	**0**	**0**
Road Service - Trunk Road	**0**	**0**	**0**
Environmental Designated sites (Nr)			
AONB	**0**	**0**	**0**
ASSI	**0**	**0**	**0**
Environmentally Sensitive Areas	**0**	**0**	**0**
Maritime Nature Reserve	**0**	**0**	**0**
Nature Reserve	**0**	**0**	**0**
RAMSAR	**0**	**0**	**0**
SAC	**0**	**0**	**0**
Sites of Local Nature Conservation Importance	**0**	**0**	**0**
SPA	**0**	**0**	**0**
RSPB Reserve	**0**	**0**	**0**
UWT Nature Reserve	**0**	**0**	**0**
Built Heritage sites (Nr)			
National Trust	**0**	**0**	**0**
Listed Buildings	**0**	**0**	**0**
Sites and Monuments Records	**0**	**0**	**0**
Buildings of Special Architectural or Historical Interest	**0**	**0**	**0**
Areas of Significant Archaeological Interest	**0**	**0**	**0**
Historic Gardens	**0**	**0**	**0**

Table 5.10.6.2 - Warrenpoint SFRA – Milltown Stream			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	**3**	**3**	**3**
Non Residential (Nr)	**2**	**5**	**9**
Economic Damage (£)	**£35,500**	**£59500**	**£91,500**
Annual Average Damage (£)	**£5000**		
Present Value (£)	**£150,000**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)			
Care Homes	**0**	**0**	**0**
GP Surgery's	**0**	**0**	**0**
Fire stations	**0**	**0**	**0**
Hospitals	**0**	**0**	**0**
Police Stations	**0**	**0**	**0**
Schools	**0**	**0**	**0**
Key Infrastructure (Nr)			
NIW Wastewater Treatment Works	**0**	**0**	**0**
NIW Sewage Pumping Stations	**0**	**0**	**0**
NIW Water Treatment Work	**0**	**0**	**0**
NIW Treated Water Pumping Stations	**0**	**0**	**0**
NIE Substation 6to11kV	**0**	**0**	**0**
NIE Substation 33kV	**0**	**0**	**0**
NIE Substation 275kV	**0**	**0**	**0**
NIE Substation 110kV	**0**	**0**	**0**
Road Service - Trunk Road	**0**	**0**	**0**
Environmental Designated sites (Nr)			
AONB	**0**	**0**	**0**
ASSI	**0**	**0**	**0**
Environmentally Sensitive Areas	**0**	**0**	**0**
Maritime Nature Reserve	**0**	**0**	**0**
Nature Reserve	**0**	**0**	**0**
RAMSAR	**0**	**0**	**0**
SAC	**0**	**0**	**0**
Sites of Local Nature Conservation Importance	**0**	**0**	**0**
SPA	**0**	**0**	**0**
RSPB Reserve	**0**	**0**	**0**
UWT Nature Reserve	**0**	**0**	**0**
Built Heritage sites (Nr)			
National Trust	**0**	**0**	**0**
Listed Buildings	**0**	**0**	**0**
Sites and Monuments Records	**0**	**0**	**0**
Buildings of Special Architectural or Historical Interest	**0**	**0**	**0**
Areas of Significant Archaeological Interest	**0**	**0**	**0**
Historic Gardens	**0**	**0**	**0**

5.10.7 Proposed Fluvial Flood Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Warrenpoint it is important that the flood risk is not increased by new development in areas of known flood risk. Planning Policy Statement, PPS 15, "Planning and Flood Risk", adopts a precautionary approach to development with the primary aim "to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere".

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the "Exception" rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to "Greenfield" built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new Development Plans for Warrenpoint, Rivers Agency will advise against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 100 year fluvial floodplain or is susceptible elsewhere to surface water flooding.

Rivers Agency will also review the existing Development Plan for Warrenpoint (Banbridge, Newry & Mourne Area Plan 2015) with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

The main (undeveloped) flooded areas within the Warrenpoint area are:

- To the north west of the Upper Dromore Road, (upper reach of the Clonallan Stream)
- The Warrenpoint Golf Course

Planning Applications

Fluvial areas at risk

Rivers Agency will advise against the development of all sites that are located within the 1 in 100 year fluvial floodplain, irrespective of whether they are located within the current plan or as a single site application outside the plan area.

For those sites within the 1 in 100 year fluvial floodplain where the principle of development has been accepted by Planning NI as meeting the "Exception Test", Rivers Agency will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The main existing developed area, at flood risk within Warrenpoint where re-development may be likely to take place is:

- Milltown Industrial Estate

Areas at risk of surface water flooding

For those sites outside the 1 in 100 year fluvial floodplain that are located in an area where there is evidence of a history of surface water flooding Rivers Agency will further consider the application through the appraisal of the accompanying Drainage Assessment that will need to demonstrate suitable flood mitigation measures.

Where there is potential for surface water flooding as indicated in the purple predicted areas on the surface water maps, Rivers Agency will advise that the applicant should assess the flood risk and drainage impact to the site himself and construct in the appropriate manner.

Areas at risk of flood inundation from reservoirs

For all development proposals that are located within the potential flood inundation area of a controlled reservoir we will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures. If it is a new development proposal Rivers Agency will also need the applicant to demonstrate that the condition, management and maintenance regime of the reservoir is appropriate to provide sufficient assurance regarding reservoir safety.

Controlled reservoirs identified in the Warrenpoint area are as follows:

- Donaghaguy Reservoir
- Mill Pond Donaghaguy

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is, therefore, important that we continue to target investment by providing flood defence, culvert alleviation schemes and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. The **Flood Investment and Planning Group, (FIPG)**, provides a coordinated approach across Government in relation

to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a "Flood Risk Metric Tool", (FRISM) is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total "damage avoidance benefits" that the scheme will provide to the property over the scheme's design life. If the benefit/cost ratio is greater than 1 (Net Present Value, NPV, figure is positive) then the potential scheme will be referred to Rivers Agency's Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely Rivers Agency's responsibility, or is the responsibility of NI Water or Transport NI such as a local drainage or road infrastructure issue, it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a benefit cost analysis identifies a viable scheme, a scheme will be placed on a prioritisation list for works with other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Within the Warrenpoint area the following potential schemes have been identified and will be referred to the appropriate bodies for further investigation or detailed feasibility study.

List of possible schemes in Warrenpoint SFRA:

Milltown Area

- Fluvial flooding from the Milltown Stream
- Flood damage avoidance figure of £150k

Springfield Road, Seaview Road and Forth Road areas

- Fluvial flooding from the Clonallan Stream
- Flood damage avoidance figure of £315k

Preparedness

In Warrenpoint it is not possible to prevent or protect against all flooding. Indeed even where flood defences exist it is possible in an extreme event that these could be over topped and flooding could still occur.

Having recognised this fact, considerable effort in recent years has been made by emergency planners in Government Departments, Councils and the Emergency Services working together and sharing information to ensure a coordinated response.

However, despite these improvements during significant flood events the emergency response of Government Departments and the Emergency Services can become over stretched. This means that not all calls for assistance during a flood event may be responded to in a timely manner. With this in mind it is important that households and communities, subject to a known flood risk, are prepared. The detail of preparedness actions, including flood warning and informing activities planned from a regional perspective, are provided in Annex E.

This is not Government withdrawing from any undertaking to respond in emergencies but an additional layer of support to ensure Government Departments and the public work together to reduce the overall impacts of flooding.

From the flood risk assessment there are certain areas of Warrenpoint which are subject to flood risk and may have flooded before. Therefore, they may benefit from the flood warning and informing proposals outlined in Annex D.

A pilot project of community engagement to deliver flood warning and informing, held in 2014, identified basic assessment formulae to assess and score areas that could potentially be a focus for flood warning and informing actions. Based on this scoring these areas did not score high enough to be placed within the top 20 communities to be offered a programme of community engagement during the period of this plan. However, if communities want to become more resilient, the Department is committed to providing assistance were possible to develop the consistent approach to resilience. The NI Direct website www.nidirect.gov.uk/ will host further information and advice on what to do in advance of flooding, what to do during flooding and how to recover after flooding. The website will also contain templates for communities wishing to develop their own plan.

5.11 Coleraine SFRA – Lower Bann

The core boundary of the Coleraine SFRA, which has been determined through the PFRA, is located within the Lower Bann Local Management Area and illustrated in Figure 5.11 below.

Figure 5.11 – Lower Bann Local Management Area and Coleraine SFRA

5.11.1 Flooding History

Coleraine has been identified as being an area at risk from flooding as a result of the preliminary flood risk assessments carried out by Rivers Agency.

Coleraine has no registered flooding hotspots nor has it any record of any flood relief payments made by the Coleraine Council in the last 7 years. There are also no records of flooding on the current NI Water DG5 register.

There have been a number of occasions in the past where flooding has occurred in the Lodge Burn area through Coleraine, particularly in Anderson Park and downstream of Millburn Road area of Coleraine. Anderson Park previously had a pond located at its centre which the Lodge Burn River flowed through. (See photo 5.11.1.1 below.)

Photo 5.11.1.1 – Anderson Park pre Flood Alleviation Scheme

The Anderson Park pond had a very visible siltation problem which, in turn, led to some local flooding issues in the surrounding areas. However, the siltation problem was incorporated into the Lodge Burn flood alleviation scheme, which was carried out by Rivers Agency in 2012. (See photo 5.11.1.2.)

Photo 5.11.1.2 – Anderson Park post Flood Alleviation Scheme

Lodge Burn Flood Alleviation scheme

The Lodge Burn Flood Alleviation scheme is a complex urban flood defence scheme that required the construction of flood walls within close proximity to existing buildings, structures and street slopes. The geotechnics were complex with an artesian water table below the near surface clay layer. This prompted a bored piled secant wall solution with reinforced concrete up-stand walls. (See photo 5.11.1.3.)

Photo 5.11.1.3 – New secant piled reinforced concrete flood wall with toe protection.

5.11.2 PFRA – Identification of Potentially Significant Flood Sources

According to the Preliminary Flood Risk Assessment (Dec 2011) Coleraine, in terms of the potential adverse consequences of flooding, is ranked 14th of the twenty SFRA within Northern Ireland (see Figure 4.1). On the basis of this initial assessment, which was undertaken using the strategic flood maps, the predominant flood risk to the town was considered to arise from fluvial flooding. However the strategic flood map for Coleraine indicates a minor risk from coastal flooding, in particular to the area west of Millburn Road. This is not a significant risk as there is a lack of coastal flood history for the Coleraine area.

It should be noted that the PFRA flagged up the potential for significant fluvial flooding at Coleraine because the assessment is based on the strategic 'undefended' flood models, which ignore the presence of existing flood defence systems such as the Lodge Burn Flood Walls. Therefore, the assessment is in effect based on the worst case scenario, as it assumes there is no benefit from the defences (See Figure 5.11.2.1). This precautionary approach was taken because at the time of the assessment there was a degree of uncertainty about the level of protection that each of the existing flood defence systems provides. By adopting this approach, the urban areas that are located behind existing flood defence structures were determined to be SFRA's by default and as a consequence detailed Flood Hazard/Risk Maps had to be prepared in compliance with the requirements of the EU Floods Directive (See Figure 5.11.2.2). This provided the opportunity to undertake the detailed structural assessments and flood modelling necessary to remove the uncertainty and establish the actual level of protection offered by these defences.

To facilitate a more robust assessment of the level of flood risk to Coleraine fluvial flooding, Rivers Agency developed detailed predictive flood models for each of these sources. It is considered that the flood hazard maps produced from these models will give a more accurate prediction of the flooded areas which may have been over or under estimated by the strategic flood maps. Details of the models and their output are described in the following sections.

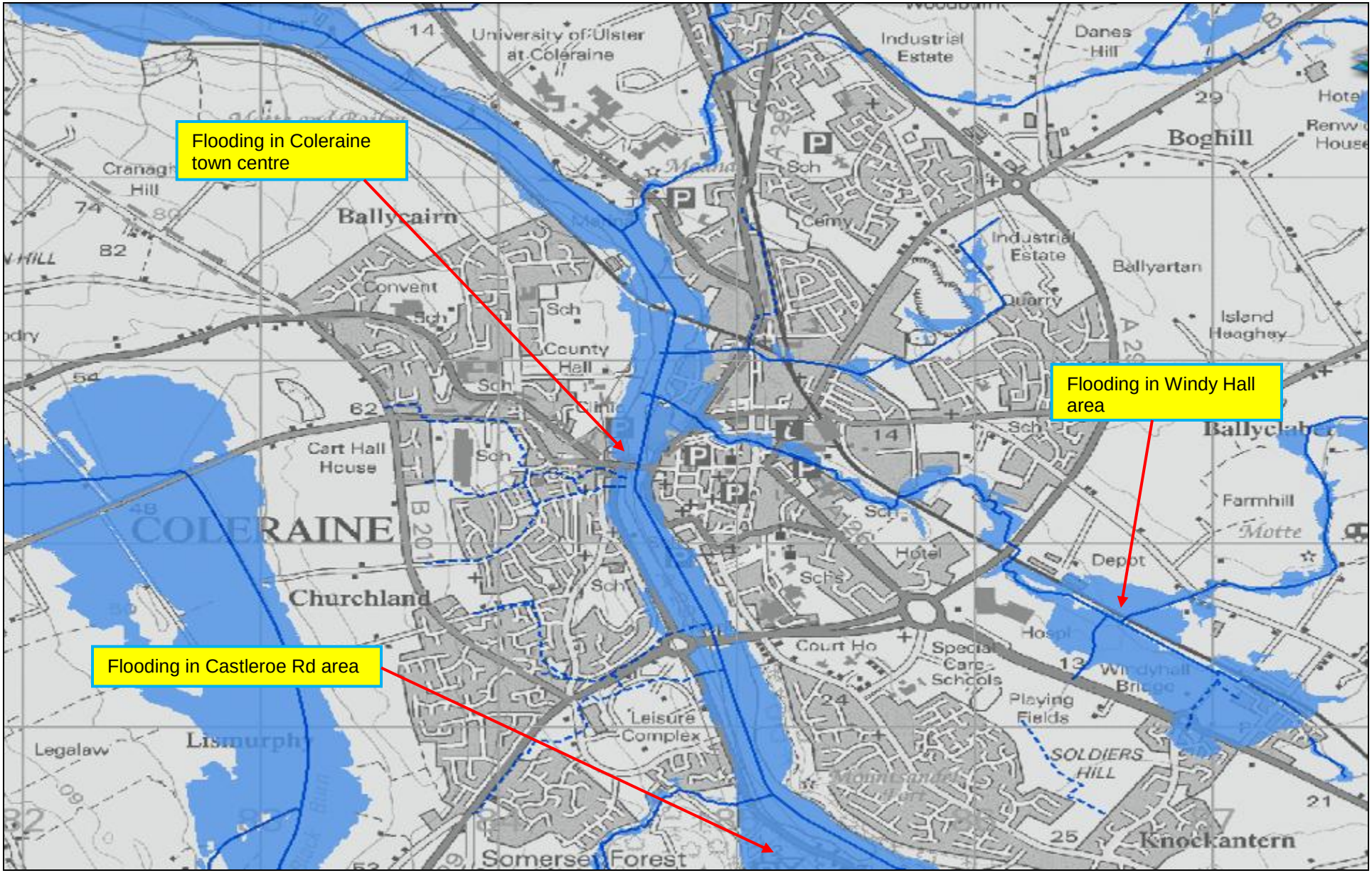


*Figure 5.11.2.1 - Map indicating the **strategic** flood outline for Coleraine SFRA.*

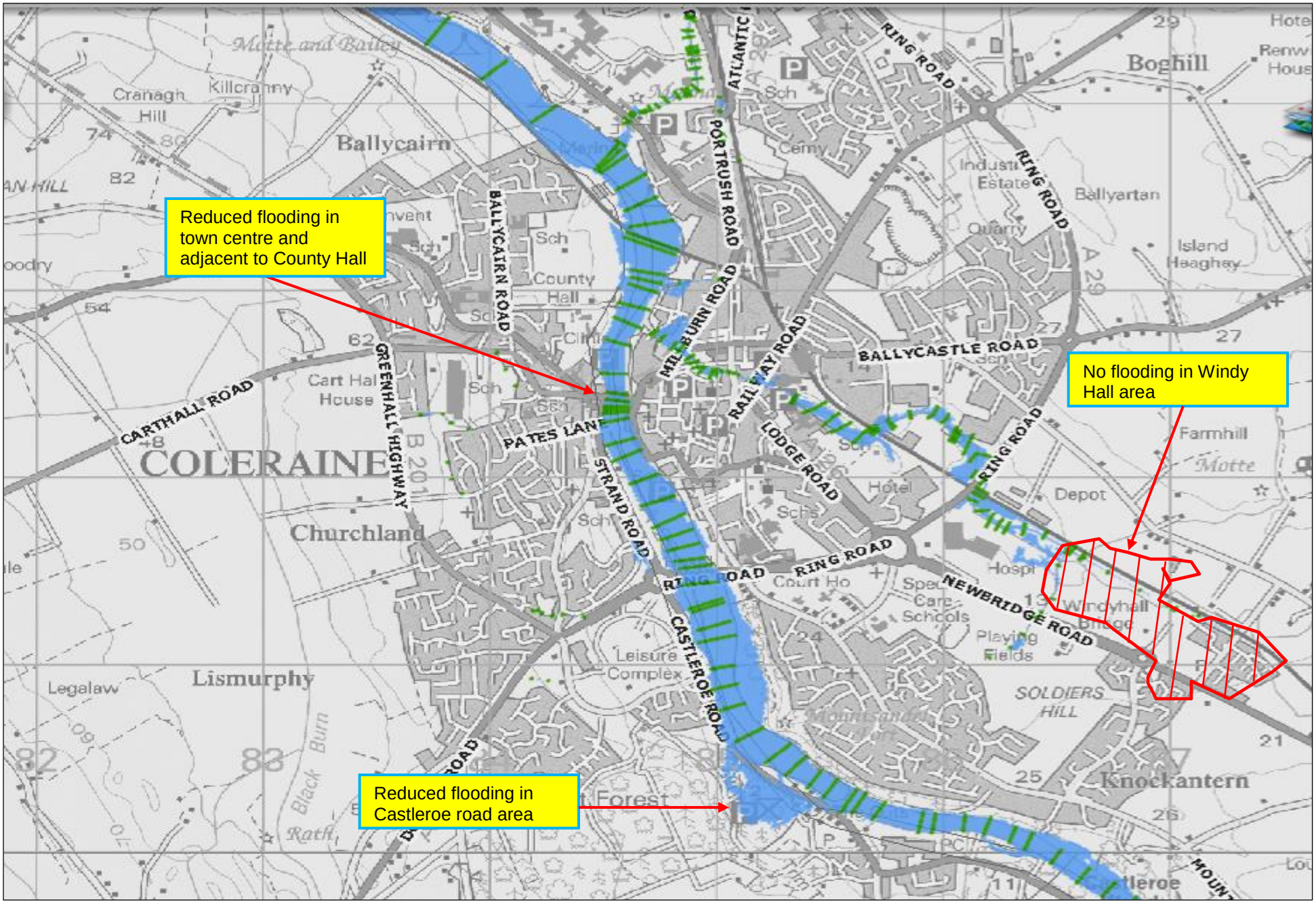


*Figure 5.11.2.2 - Map indicating the **new detailed** flood outline for Coleraine SFRA.*

5.11.3 Catchment Description

The River Bann catchment is the largest catchment in Northern Ireland (5,697km²) to the downstream limit and drains 43% of the Northern Ireland catchment (See Figure 5.11.3.1). The lower reaches of the Bann cover County Antrim and Londonderry and the upper reaches covers Lough Neagh, County Down, Armagh and Tyrone.

The main tributaries of the River Bann include the Rivers Moyola, Clady, Macosquin, Aghadowey, Agivey and Ballymoney. The catchment is largely rural, however, the drainage network at Coleraine is very heavily urbanised. The River Bann catchment is also characterised by Lough Neagh mid-way along its reach (upstream of the model limits). This presents significant attenuation of flow within the catchment.

Rainfall in Northern Ireland varies widely, with the wettest places being in the Sperrin, Antrim and Mourne Mountains. The highest areas have average annual totals of about 1600 mm, which is about half that of the English Lake District or the western Highlands of Scotland. The standard average annual rainfall for the Coleraine area is approximately 1000mm to 1200mm.

Coleraine town centre is a very heavily urbanised area with a lot of hard standing areas with some large green areas such as Andersons Park. Approximately 90% of Coleraine is urbanised.

Figure 5.11.3.1 – Lower Bann Catchment

5.11.4 Fluvial Flood Risk Assessment

Flood Model

A hydrodynamic Infoworks-ICM model has been developed for the purposes of this SFRA. This model incorporated several existing models into a new model. The existing models were converted into Infoworks-ICM format and combined with the newly modelled watercourses. All of the modelled watercourses have been incorporated into the same model and share the same 2D domain. This allows for interaction between the watercourses.

A sensitivity analysis has also been undertaken on the model. This involved testing the effects of hydraulic roughness, flow and bank coefficients on maximum water levels along the study reach.

The model included both open channels and culverted urban watercourses in Coleraine. Figure 5.11.4.1 shows the watercourses modelled in the Coleraine Flood Model.

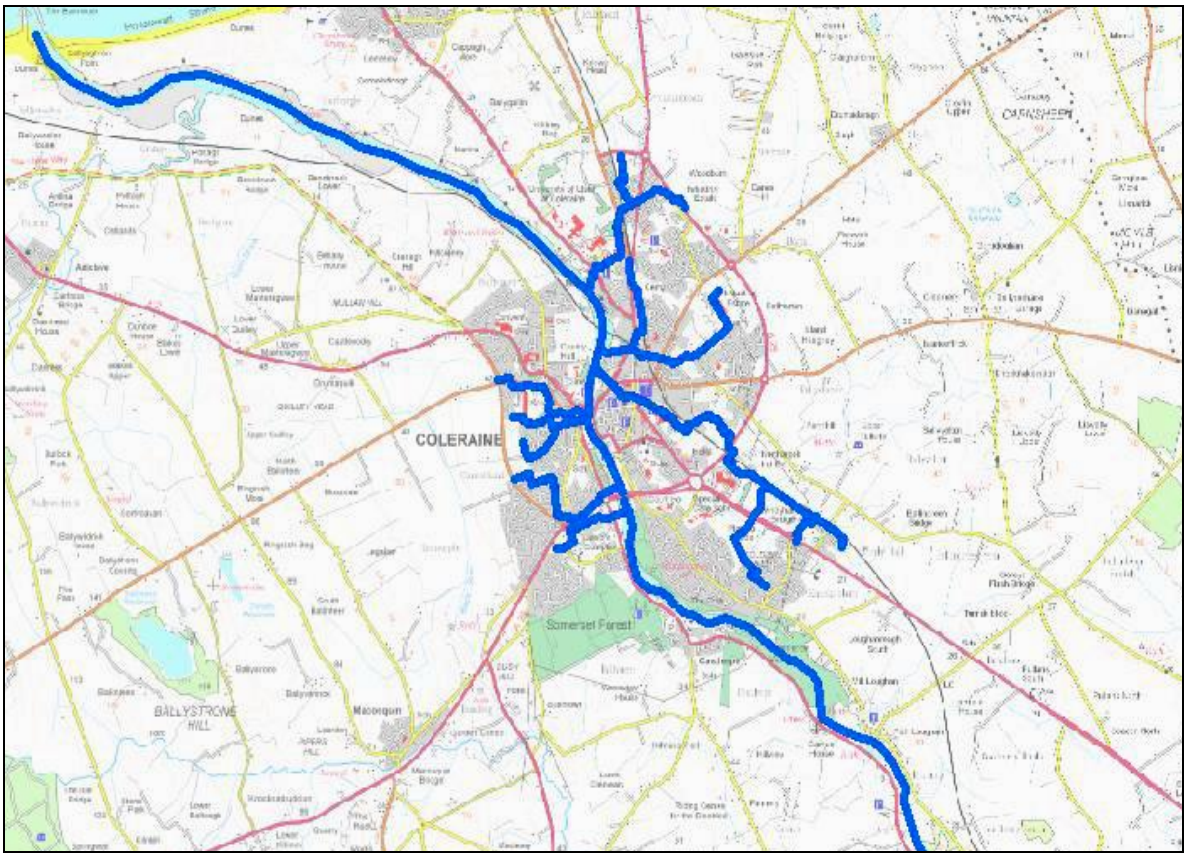


Figure 5.11.4.1 - Map showing the watercourses included in the Coleraine model.

Fluvial Flooding Mechanisms

The source of flooding in Coleraine occurs from fluvial flooding from the Lower Bann River and from two tributaries known as the Lodge Burn and Jubilee Terrace River. The PRFA indicated flooding in and around the town centre along with the Windy Hall area of Coleraine. The new detailed flood hazard map shows a reduced flood outline in both of these areas (See Figures 5.11.2.1 and 5.11.2.2)

Flood water exceeding bank full levels and spilling onto the floodplain causes some flood risk in the Coleraine SFRA. Additionally, when the capacity of culverted watercourses is exceeded flood water can either build up behind the culvert and spill out over banks or escape out of manholes onto the floodplain.

The two main areas that indicate flooding in the Coleraine SFRA according to Rivers Agency new flood hazard maps are:

- Castleroe Road,
- Millburn Road, Riversdale Trade Effluent storage facility

The main source of flooding in Coleraine SFRA is from the River Bann and the Lodge Burn which joins the River Bann from the east of Coleraine. The majority of flood water flows along the River Bann remain in bank apart from a few localised locations as highlighted on the next page.

Figures 5.11.4.2 and 5.11.4.3 on the next pages illustrates the predicted extents of the potential fluvial flooding from the Lower Bann River in Coleraine and details of the impact of the flooding on property and key infrastructure to the Millburn Road and Castleroe areas is summarised in Tables 5.11.4.1 and 5.11.4.2.

The model shows that at the relatively high frequency 10% AEP flood event, floodwater is predicted to spill from the downstream limit of the Lodge Burn watercourse and the resulting flood water ponds to shallow depths up to 300mm in the low lying areas most notably at the tennis courts off Millburn Road, Coleraine. It is estimated **1** non residential property could be flooded at this event causing damages in excess of £ **£22,844**

At the more extreme 1% AEP (Q100) event the predicted flooding is generally confined to the same locations plus the Castleroe Road area where the rivers agency depot is located. The flood inundation areas are more extensive and tend to be slightly deeper (up to 1m deep). Flooding from the 1% AEP (Q100) event is estimated to affect **3** residential and **11** non residential properties at a cost of around **£119,997**. The present value of the total property damages from potential future floods is calculated to be in excess of **£577,000.**

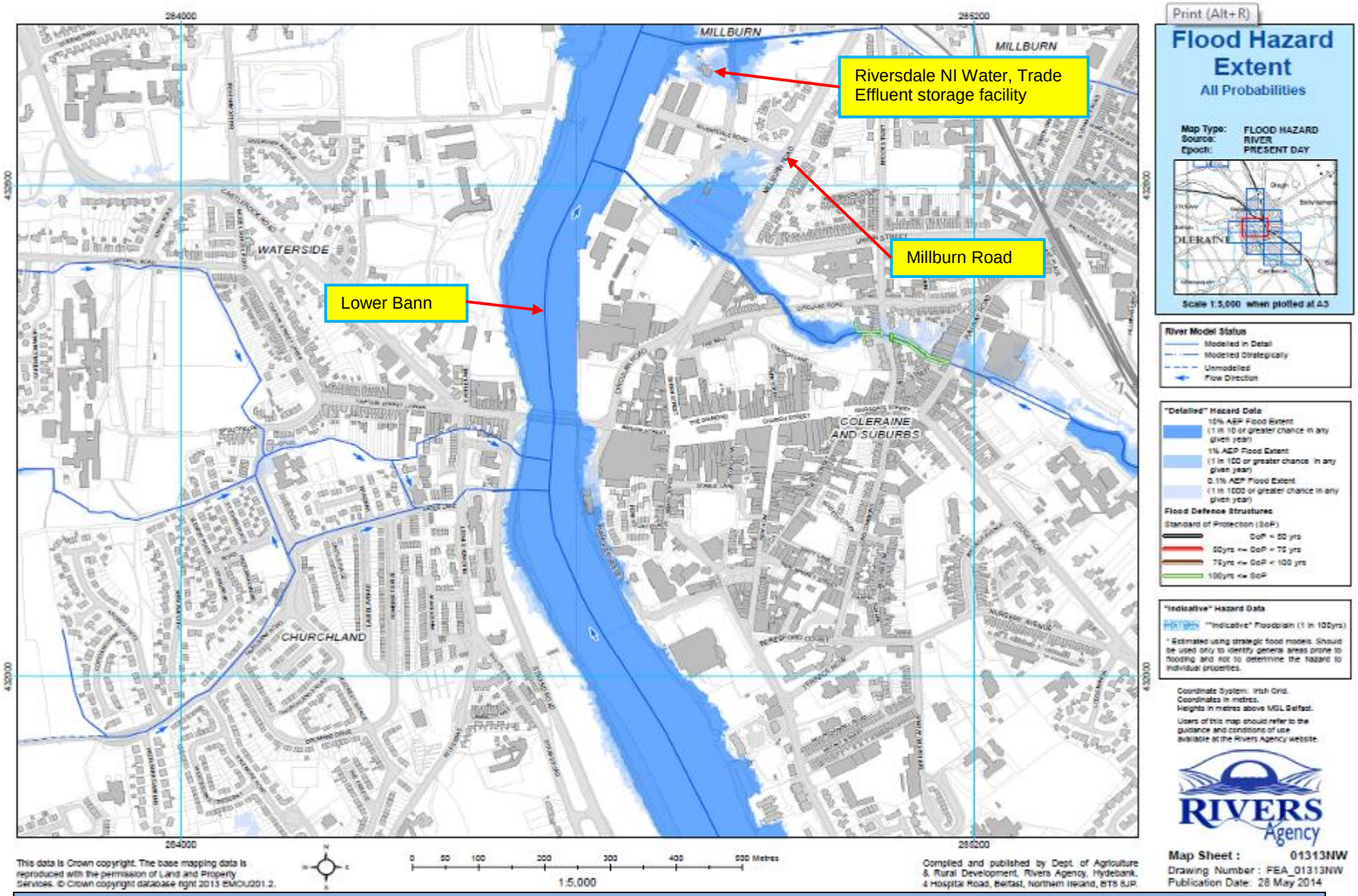


Figure 5.11.4.2 - Map indicating the 1%AEP (Q100) flood outline around NI Water storage facility, Millburn Road Coleraine

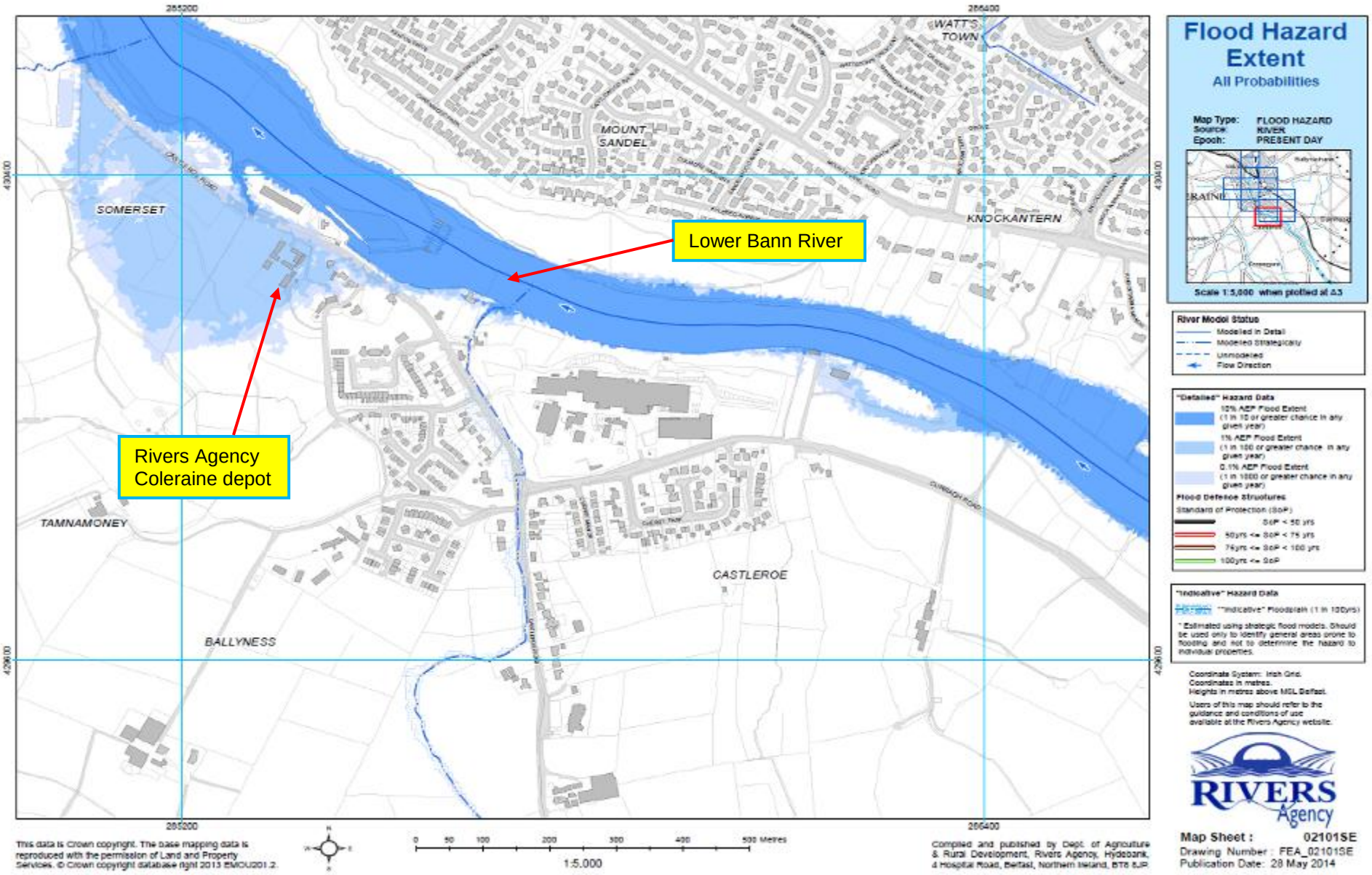


Figure 5.11.4.3 - Map indicating the 1%AEP (Q100) flood outline around the Rivers Agency depot

Table 5.11.4.1 - Coleraine SFRA – Castleroe Road area			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	**1**	**1**	**3**
Non Residential (Nr)	**0**	**1**	**8**
Economic Damage (£)	**£6,555**	**£16,661**	**£66,739**
Annual Average Damage (£)	**£4,740**		
Present Value (£)	**£142,200**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)			
Care Homes	**0**	**0**	**0**
GP Surgery's	**0**	**0**	**0**
Fire stations	**0**	**0**	**0**
Hospitals	**0**	**0**	**0**
Police Stations	**0**	**0**	**0**
Schools	**0**	**0**	**0**
Key Infrastructure (Nr)			
NIW Wastewater Treatment Works	**0**	**0**	**0**
NIW Sewage Pumping Stations	**0**	**0**	**1**
NIW Water Treatment Work	**0**	**0**	**0**
NIW Treated Water Pumping Stations	**0**	**0**	**0**
NIE Substation 6to11kV	**0**	**0**	**0**
NIE Substation 33kV	**0**	**0**	**0**
NIE Substation 275kV	**0**	**0**	**0**
NIE Substation 110kV	**0**	**0**	**0**
Road Service - Trunk Road	**0**	**0**	**0**
Environmental Designated sites (Nr)			
AONB	**0**	**0**	**0**
ASSI	**0**	**0**	**0**
Environmentally Sensitive Areas	**0**	**0**	**0**
Maritime Nature Reserve	**0**	**0**	**0**
Nature Reserve	**0**	**0**	**0**
RAMSAR	**0**	**0**	**0**
SAC	**0**	**0**	**0**
Sites of Local Nature Conservation Importance	**1**	**1**	**1**
SPA	**0**	**0**	**0**
RSPB Reserve	**0**	**0**	**0**
UWT Nature Reserve	**0**	**0**	**0**
Built Heritage sites (Nr)			
National Trust	**0**	**0**	**0**
Listed Buildings	**2**	**2**	**2**
Sites and Monuments Records	**0**	**0**	**0**
Buildings of Special Architectural or Historical Interest	**0**	**0**	**0**
Areas of Significant Archaeological Interest	**0**	**0**	**0**
Historic Gardens	**0**	**0**	**0**

Table 5.11.4.2 - Coleraine SFRA – Millburn Road			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	**0**	**0**	**0**
Non Residential (Nr)	**1**	**2**	**3**
Economic Damage (£)	**£22,844**	**£26,508**	**£55,258**
Annual Average Damage (£)	**£14,500**		
Present Value (£)	**£435,000**		
IPPC sites (Nr)	**1**	**1**	**1**
Community Assets (Nr)			
Care Homes	**0**	**0**	**0**
GP Surgery's	**0**	**0**	**0**
Fire stations	**0**	**0**	**0**
Hospitals	**0**	**0**	**0**
Police Stations	**0**	**0**	**0**
Schools	**0**	**0**	**0**
Key Infrastructure (Nr)			
NIW Wastewater Treatment Works	**0**	**0**	**0**
NIW Sewage Pumping Stations	**0**	**0**	**0**
NIW Water Treatment Work	**0**	**0**	**0**
NIW Treated Water Pumping Stations	**0**	**0**	**0**
NIE Substation 6to11kV	**0**	**5**	**5**
NIE Substation 33kV	**0**	**0**	**0**
NIE Substation 275kV	**0**	**0**	**0**
NIE Substation 110kV	**0**	**0**	**0**
Road Service - Trunk Road	**0**	**0**	**0**
Environmental Designated sites (Nr)			
AONB	**0**	**0**	**0**
ASSI	**0**	**0**	**0**
Environmentally Sensitive Areas	**0**	**0**	**0**
Maritime Nature Reserve	**0**	**0**	**0**
Nature Reserve	**0**	**0**	**0**
RAMSAR	**0**	**0**	**0**
SAC	**0**	**0**	**0**
Sites of Local Nature Conservation Importance	**0**	**0**	**0**
SPA	**0**	**0**	**0**
RSPB Reserve	**0**	**0**	**0**
UWT Nature Reserve	**0**	**0**	**0**
Built Heritage sites (Nr)			
National Trust	**0**	**0**	**0**
Listed Buildings	**0**	**6**	**6**
Site and Monuments and Records	**0**	**0**	**0**
Buildings of Special Architectural or Historical Interest	**0**	**0**	**0**
Areas of Significant Archaeological Interest	**0**	**0**	**0**
Historic Gardens	**0**	**0**	**0**

5.11.5 Proposed Fluvial Flood Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Coleraine it is important that the flood risk is not increased by new development in areas of known flood risk. Planning Policy Statement, PPS 15, "Planning and Flood Risk", adopts a precautionary approach to development with the primary aim "to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere".

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the "Exception" rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to "Greenfield" built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new Development Plans for Coleraine, Rivers Agency will advise against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 100 year fluvial floodplain or is susceptible elsewhere to surface water flooding.

Rivers Agency shall also review the existing Development Plan for Coleraine (Northern Area Plan) with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

The main (undeveloped) flooded areas within the Coleraine SFRA are:

- In the Anderson Park area in the town centre
- To the west of the Coleraine Ring Road in the Bellasses area
- The area to the north west of the Rivers Agency depot along the Castleroe Road

Planning Applications

Fluvial areas at risk

Rivers Agency will advise against the development of all sites that are located within the 1 in 100 year fluvial floodplain irrespective of whether they are located within the current plan or as a single site application outside the plan area.

For those sites within the 1 in 100 year fluvial floodplain where the principle of development has been accepted by Planning NI as meeting the "Exception Test", Rivers Agency will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The main existing developed areas, amongst others, at flood risk within Coleraine where re-development may be likely to take place are:

- Castleroe Road
- Millburn Road

Areas at risk of surface water flooding

For those sites outside the 1 in 100 year fluvial floodplain that are located in an area where there is evidence of a history of surface water flooding identified by the flooding hardship payments Rivers Agency will further consider the application through the appraisal of the accompanying Drainage Assessment that will need to demonstrate suitable flood mitigation measures.

Where there is potential for surface water flooding as indicated in the purple predicted areas on the surface water maps, Rivers Agency will advise that the applicant should assess the flood risk and drainage impact to the site himself and construct in the appropriate manner.

Areas at risk of flood inundation from reservoirs

For all development proposals that are located within the potential flood inundation area of a controlled reservoir we will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures. If it is a new development proposal Rivers Agency will also need the applicant to demonstrate that the condition, management and maintenance regime of the reservoir is appropriate to provide sufficient assurance regarding reservoir safety.

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is, therefore, important that we continue to target investment by providing flood defence, culvert alleviation schemes and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. The **Flood Investment and Planning Group, (FIPG)**, provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is

represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a “Flood Risk Metric Tool” (FRISM) is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total “damage avoidance benefits” that the scheme will provide to the property over the scheme’s design life. If the benefit/cost ratio is greater than 1 (Net Present Value, NPV, figure is positive) then the potential scheme will be referred to Rivers Agency’s Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely Rivers Agency’s responsibility, or is the responsibility of NI Water or Transport NI such as a local drainage or road infrastructure issue, it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a benefit cost analysis identifies a viable scheme, a scheme will be placed on a prioritisation list for works with other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Determination on the need for an engineering solution

Having conducted a detailed assessment of the flood risk to Coleraine from the Lower Bann River and its tributaries, Rivers Agency has determined that a broad scale engineering solution is not justified at this time. Although the model predicts that there is a low risk to property from a section of the main Lower Bann in the vicinity of Castleroe Road and Millburn Road, there are no records of historical flooding to property at these locations to support this conclusion. As there is a degree of uncertainty with all of the predictive flood models, there is always a possibility that the model is overestimating the likelihood of flooding from these watercourses. Therefore, Rivers Agency will engage with the affected parties with regard to informing them that they lie within the flood plain and may consider site specific arrangements such as water level recorders, text alerts or voice announcer/online access to live water levels.

Preparedness

In Coleraine it is not possible to prevent or protect against all flooding. Indeed even where flood defences exist it is possible in an extreme event that these could be over topped and flooding could still occur.

Having recognised this fact, considerable effort in recent years has been made by emergency planners in Government Departments, Councils and the Emergency Services working together and sharing information to ensure a coordinated response.

However, despite these improvements during significant flood events the emergency response of Government Departments and the Emergency Services can become over stretched. This means that not all calls for assistance during a flood event may be responded to in a timely manner. With this in mind it is important that households and communities, subject to a known flood risk, are prepared. The detail of preparedness actions, including flood warning and informing activities planned from a regional perspective, are provided in Annex E.

This is not Government withdrawing from any undertaking to respond in emergencies but an additional layer of support to ensure Government Departments and the public work together to reduce the overall impacts of flooding.

From the flood risk assessment there are certain areas of Coleraine which are subject to flood risk and may have flooded before. Therefore, they may benefit from the flood warning and informing proposals outlined in Annex D.

A pilot project of community engagement to deliver flood warning and informing, held in 2014, identified basic assessment formulae to assess and score areas that could potentially be a focus for flood warning and informing actions. Based on this scoring these areas did not score high enough to be placed within the top 20 communities to be offered a programme of community engagement during the period of this plan. However, if communities want to become more resilient, the Department is committed to providing assistance were possible to develop the consistent approach to resilience. The NI Direct website www.nidirect.gov.uk/ will host further information and advice on what to do in advance of flooding, what to do during flooding and how to recover after flooding. The website will also contain templates for communities wishing to develop their own plan.

Section 6

North West River Basin District

Identified Flood Risk

6.1 River Basin Overview

This Flood Risk Management Plan is based on the ***North West River Basin District*** (see Figure 6.1.1 below). The North West River Basin District covers an area of around 4900 km². It takes in large parts of County Fermanagh, County Londonderry and County Tyrone. The area is very mountainous, with the Sperrins in the east, and this topography contributes to the low average population density in the District. Most of the urban areas are located beside rivers. In rural areas, many people live in small villages or single dwellings.

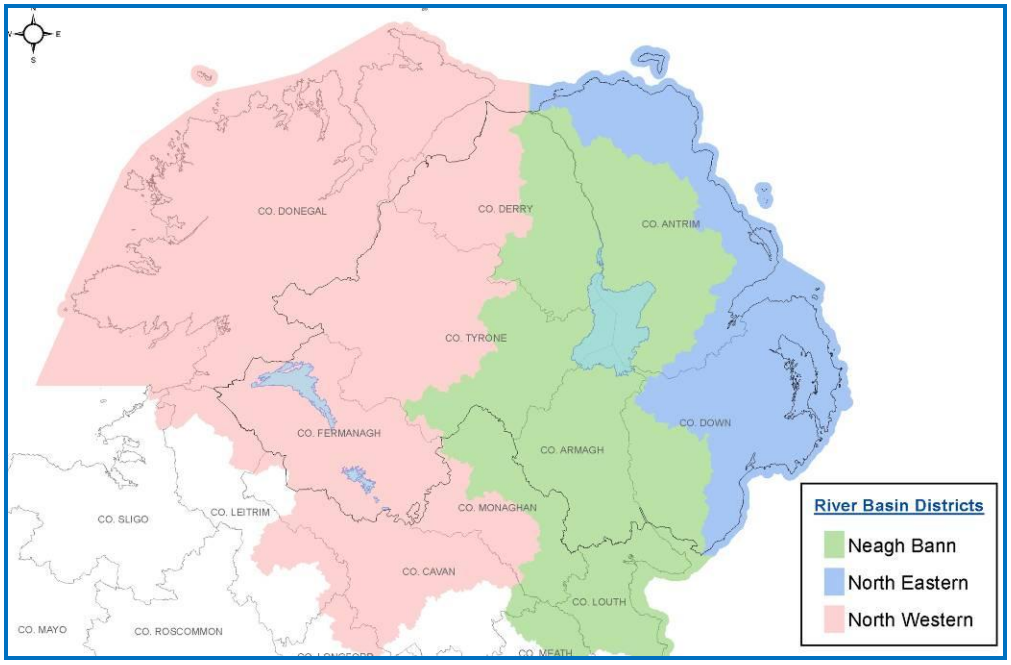


Figure 6.1.1 – North West River Basin District (N.I. Portion Pink)

6.2 Areas of Significant Flood Risk

Following the Preliminary Flood Risk Assessment (PFRA) in 2009, twenty areas of potential significant flood risk were identified within Northern Ireland. Three of the Significant Flood Risk Areas (SFRAs) are located in the North West River Basin District and named as follows:-

- Omagh
- Strabane
- Londonderry.

6.3 Omagh Significant Flood Risk Area – Strule LMA

The core boundary of the Omagh SFRA, which has been determined through the PFRA, is located within the Strule Local Management Area (LMA) and illustrated in Figure 6.3.1 below.

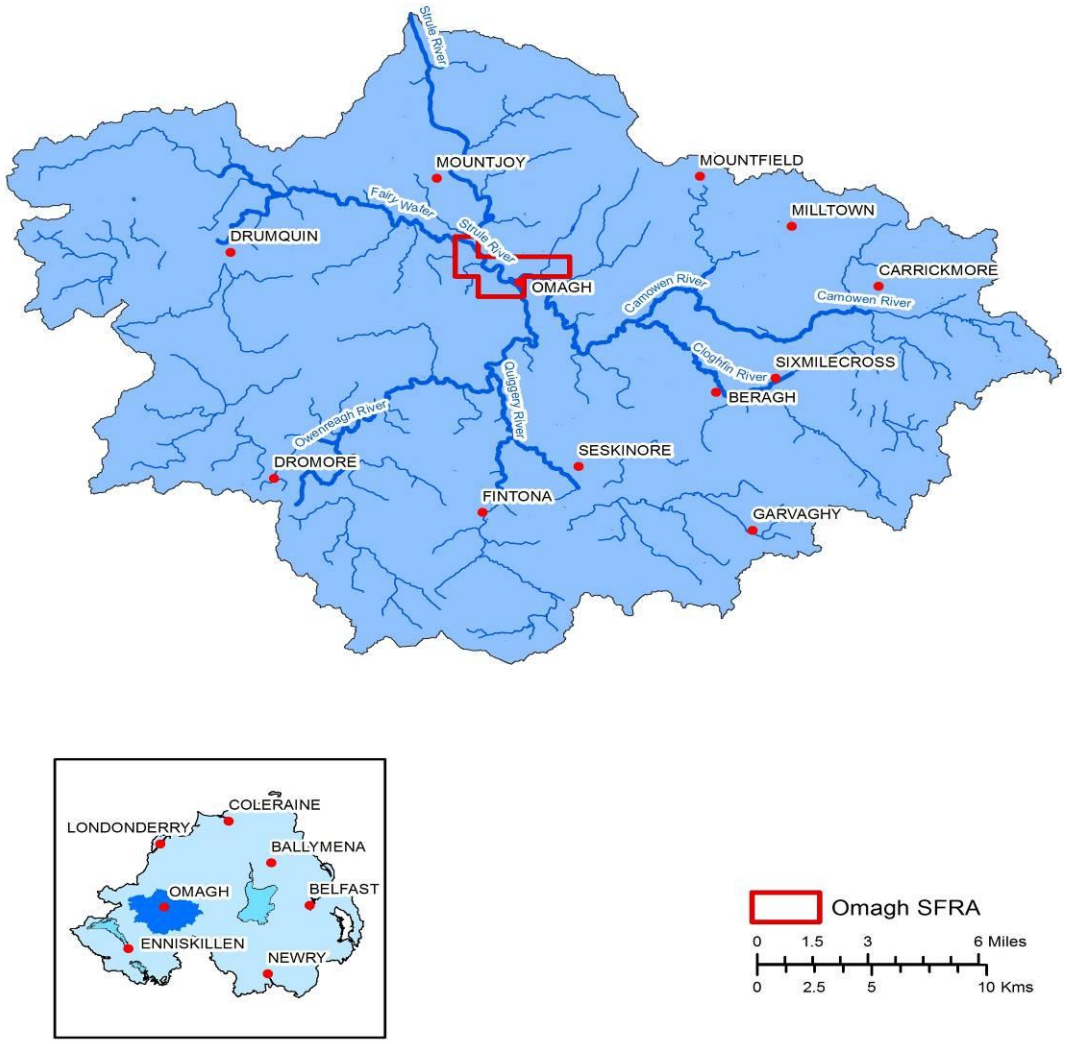


Figure 6.3.1 – Omagh SFRA and Strule LMA

6.3.1 Flooding History

Photograph 6.3.1 – Upstream of Campsie Bridge on the Drumragh River

Omagh Town has flooded 6-8 times in the last century. This problem is caused by the urban development right at the confluence of two main watercourses, the Drumragh River and the Camowen River. The most recent flood event was October 2011 where the flood walls in Omagh Town came within 200-300mm of over topping. Omagh Town is also susceptible to surface water flooding as the surface water cannot enter the watercourse in flood conditions and, therefore, it is pumped over the flood defences by NI Water pumping stations. Omagh Town currently has 3 NI Water storm pumping stations; all of which have a main pump, assist pump, and a duty standby pump. Many of recent flood reports relate to areas of the town near the confluence of the Drumragh and Camowen Rivers and the reach of the River Strule just downstream of the confluence.

12 June 2007

Intense storms developed across central parts of Northern Ireland from late morning on 12 June 2007. The storms were typically intense and slow moving summer rainfall events. In the Omagh area 95mm of rain fell

in the day and much occurred during a three hour period in the afternoon. This is the highest daily rainfall total recorded in that area since records began in 1872.

17 October 2011

Although there was no major flooding in Omagh on 17 October 2011 the water level in the River Strule was extremely close to the top of the existing floodwalls.

Description of some major flood events

The town of Omagh is situated at the confluence of the Drumragh and Camowen rivers which join to form the River Strule. The town has a long history of fluvial flooding and has suffered major flood events in 1909, 1929, 1954, 1956, 1969 and 1987. Many of these flood events have resulted in the inundation of hundreds of properties and it is reported that there was a loss of life due to a drowning as a consequence of the flood in 1929. Flood protection works, which included channel improvements, flood banks, and concrete flood walls, were commenced in the mid 1950s. When completed in 1961 it is estimated that the scheme provided protection to floods with a 50 year return period (2% AEP). These defences failed to protect the town from an estimated 1% AEP flood event which occurred in 1969 and as a consequence further works to improve the defences were undertaken in the 1970s. In 1987 the defences were breached yet again by the largest flood event on record which was estimated at the time to be a 170 year flood. Subsequent to this event a major scheme to upgrade the defences was undertaken in the early 1990s and since that time the defences have not been overtopped by the rivers although there has been some, albeit much reduced, flooding due to surface water drainage problems behind the defences, most notably in 1999 and 2007. In October 2011 there was an extreme flood event in the rivers running through the town that is estimated to have a return period of around 120 years and the defence systems performed very effectively.

6.3.2 PFRA – Identification of Potentially Significant Flood Sources

According to the Preliminary Flood Risk Assessment (Dec 2011) the town of Omagh, in terms of the potential adverse consequences of flooding, is ranked 10th of the twenty SFRA within Northern Ireland (see Figure 4.1). On the basis of this initial assessment, which was undertaken using the strategic flood maps, the predominant flood risk to the town was considered to arise from fluvial flooding.

It should be noted that the PFRA flagged up the potential for significant fluvial flooding at Omagh because this national assessment is based on strategic 'undefended' flood models which ignore the presence of existing flood defence systems such as the Omagh Flood Walls. Therefore, the assessment is in effect based on the worst case scenario, as it assumes there is no benefit from the defences. This precautionary approach has been taken because at the time of the assessment there was a degree of uncertainty about the level of protection that each of the existing flood defence systems provides. By adopting this approach, the urban areas that are located behind existing flood defence structures were determined to be SFRA by default

and as a consequence detailed Flood Hazard/Risk Maps had to be prepared in compliance with the requirements of the EU Directive. This provided the opportunity to undertake the detailed structural assessments and flood modelling necessary to remove the uncertainty and establish the actual level of protection offered by these defences. The detailed flood maps will, therefore, give a more accurate prediction of the flooded areas that may have been over estimated/under estimated or missed by the strategic flood maps.

6.3.3 Catchment Description

The Strule River catchment is mainly rural with Omagh the largest urban area. The main tributaries, the Drumragh River and the Camowen River, rise in the hills to the east of Omagh and flow in a north westerly direction to Omagh to join the River Strule.

To facilitate a more robust assessment of the level of flood risk to Omagh from rivers, Rivers Agency developed detailed predictive flood models. Details of the models and their output are described in the following sections.

6.3.4 Fluvial Flood Risk Assessment

Flood Model

The model used to assess the fluvial risk to Omagh settlement is an Infoworks ICM 2D model, developed by a Rivers Agency Consultant.

Fluvial Flooding Mechanism

Main Rivers

Figures 6.3.4.2 and 6.3.4.3 illustrate the predicted extents of the potential flooding from the River Strule, River Camowen and Drumragh River and details of the impact of the flooding on property and key infrastructure is summarised in Table 6.3.4.1. The main flood risk along these rivers is a result of flood water conveying around the back of the lock keepers cottage at King James Bridge and the overtopping of flood defences. The medium risk 1% AEP (1 in 100 year) flood hazard map indicates fairly extensive flooding to residential and non residential property at the confluence of the Drumragh River and Camowen River with the Strule River. The areas affected include:-

- High Street
- Market Street
- Drumragh Avenue
- Campsie Road
- Mountjoy Road
- Sedan Avenue
- Dublin Road

- Irishtown Road
- Bridge Street.

From the modelling, Standards of Protection (SoP) for Rivers Agency's flood defences have been determined. The Strule has a SoP varying from 1 in 75 year to 1 in 100 year. The section of flood wall between Lisanelly Avenue to Strule Bridge has a SoP of 1 in 75 year. The right hand bank of the Camowen upstream of the Strule Bridge also has this SoP. However, the left hand bank of the Camowen at the same location has only a SoP of 1 in 50 year. The Drumragh also has a SoP of 1 in 50 year upstream of Strule Bridge. The 1% AEP (1 in 100 year) event flood hazard map indicates extensive flooding to residential and non residential property near the confluence of the Drumragh River, Camowen River and Strule River. It should be noted that there are other structures that act as flood defences. From Table 6.3.4.1 flooding from the 1% AEP event is estimated to affect 185 residential and 338 non-residential properties with a damage cost of around £35,824,800.

Watercourses

Figures 6.3.4.4 and 6.3.4.5 illustrate the predicted extents of the potential flooding from the Mullaghmore Burn and details of the impact of the flooding on property and key infrastructure is summarised in Table 6.3.4.2. The fluvial modelling predicts that the culverts at Circular Road and Meadowvale Park overflow at the 50% AEP (1 in 2 year) event – a frequent flood event. Areas upstream and downstream of Circular Road and Meadowvale Park would be flooded with about 21 houses affected at the1% AEP (1 in 100 year) event. The depths of flooding would be greater than 1m for this event in places. The flooding would appear to be caused by inadequate channel/inlet/culvert capacity. However, there are no recorded flooding complaints. At the 2% AEP (1 in 50 year) event water overflows from a manhole near Castleview Crescent with a depth of up to 1m at the1% AEP (1 in 100 year) event and a number of houses affected (approximately 5). This would indicate inadequate culvert capacity. At Old Mountfield Road the channel overflows upstream of the culvert at the 2% AEP (1 in 50 year) event. However, no houses are affected. At Oakland Avenue the channel overflows just upstream of a culverted section at the 50% AEP (I in 2 year) event. At the1% AEP (1in 100 year) event flooding would spread to the Knocknamoe Road area with depths of up to 1m and a number of houses (13) affected. Flooding at the Knocknamoe Road would be compounded due to the Killyclogher Burn also overflowing at the1% AEP (1 in 100 year) event.

Figure 6.3.4.4 illustrates the predicted extents of the potential flooding from the Killyclogher Burn Branch B and details of the impact of the flooding on property and key infrastructure is summarised in Table 6.3.4.2. The fluvial modelling predicts that upstream of Old Montfield Road the watercourse would overflow at the 2% AEP (1 in 50 year) event. At the1% AEP (1 in100 year) event the depth of flooding would be up to 1m and about 3 houses would be affected. Upstream of Knocknamoe Road the watercourse would overflow at the 20% AEP (1 in 5 year) event and 3 properties would be affected with the depth of flooding less than 300mm

at the 1% AEP (1 in 100 year) event. A section of 450 diameter concrete culvert is Grade 5 downstream of Knocknamoe Road.

Figures 6.3.4.5 illustrate the predicted extents of the potential flooding from the Killyclogher Burn Branch C and details of the impact of the flooding on property and key infrastructure is summarised in Table 6.3.4.2. The fluvial modelling predicts that a manhole near Burn View overflows at the 2% AEP event with 1 property affected – there has been a flood report from this property. At the1% AEP event the depth of flooding would be up to 1m.

Figures 6.3.4.5 and 6.3.4.6 illustrate the predicted extents of the potential flooding from the Killyclogher Burn and details of the impact of the flooding on property and key infrastructure is summarised in Table 6.3.4.2. The fluvial modelling predicts that upstream of Killyclogher Bridge (Old Mountfield Road) the channel would start to overflow at the 50% AEP (1 in 2 year) event. At the1.33% AEP (1 in 75 year) event at least 2 houses would be affected and depths would be greater than 1m in places at the 1% AEP (1 in 100 year) event. The location of the flooding would suggest that the flow capacity at Killyclogher Bridge is inadequate. Upstream of the Knocknamoe Road there is inadequate channel capacity and one building starts to be affected at the1.33% AEP (1 in 75 year) event. The depth of flooding would be less than 300mm at the 1% AEP (1 in 100 year) event. At the 20% AEP (1 in 5 year) event the channel overflows just upstream of two culverts at Retreat Avenue and at the 10% AEP (1 in 10 year) event water levels further upstream are affected beyond the entrance to the culvert at Killyclogher Road. Also, at the 2% AEP (1 in 50 year) event overland flow from the Mullaghmore Burn complicates the situation. Water levels in the Camowen River further complicate the situation in this reach of the Killyclogher Drain. Upstream of the Killyclogher Road about 6 houses would be affected along Knocknamoe Road by flooding and depths would be less than 1m near buildings at the1% AEP (1 in 100 year) event.

In order to calculate the potential fluvial damages the Killyclogher Burn and its tributaries, including the Mullaghmore Burn, were considered together. From Table 6.3.4.2, flooding from the 1% AEP event is estimated to affect 55 residential and 3 non-residential properties with a damage cost of around £2,126,100.
Figure 6.3.4.2 illustrates the predicted extents of the potential flooding from the Dromore Road Stream and Dromore Road Drain Diversion. Details of the impact of the flooding on property and key infrastructure is summarised in Table 6.3.4.3. The fluvial modelling predicts flooding in the vicinity of a grille at Tamlaght Road at the1.33% AEP (1 in 75 year) event. There may be an inlet/culvert capacity problem. There has been historical flooding at this location. The surface water modelling also predicts flooding at this location - so it is a low lying area. From Table 6.3.4.3, flooding from the 1% AEP event is estimated to affect 5 residential and 1 non-residential properties with a damage cost of around £50,370.
Figure 6.3.4.7 illustrates the predicted extents of the potential flooding from the Fairy Water/River Strule and details of the impact of the flooding on property and key infrastructure is summarised in Table 6.3.4.4. The

fluvial modelling predicts that flooding affects houses on the Beltany Road from the 20% AEP (1 in 5 year) event. In the1% AEP (1 in 100 year) event the depths of flooding would be up to 1m. From Table 6.3.4.4, flooding from the 1% AEP event is estimated to affect 8 residential and 3 non-residential properties with a damage cost of around £499,020.

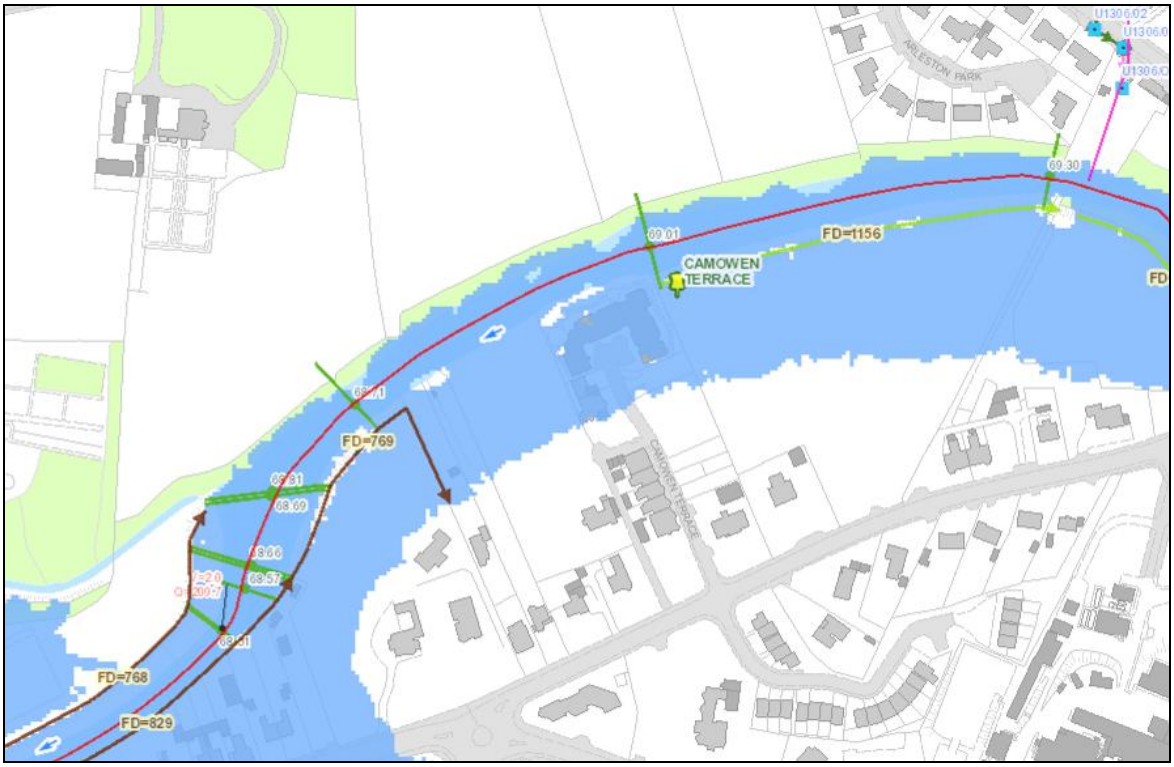


Figure 6.3.4.1 – Nursing home on Camowen Terrace, Omagh, at 1% AEP

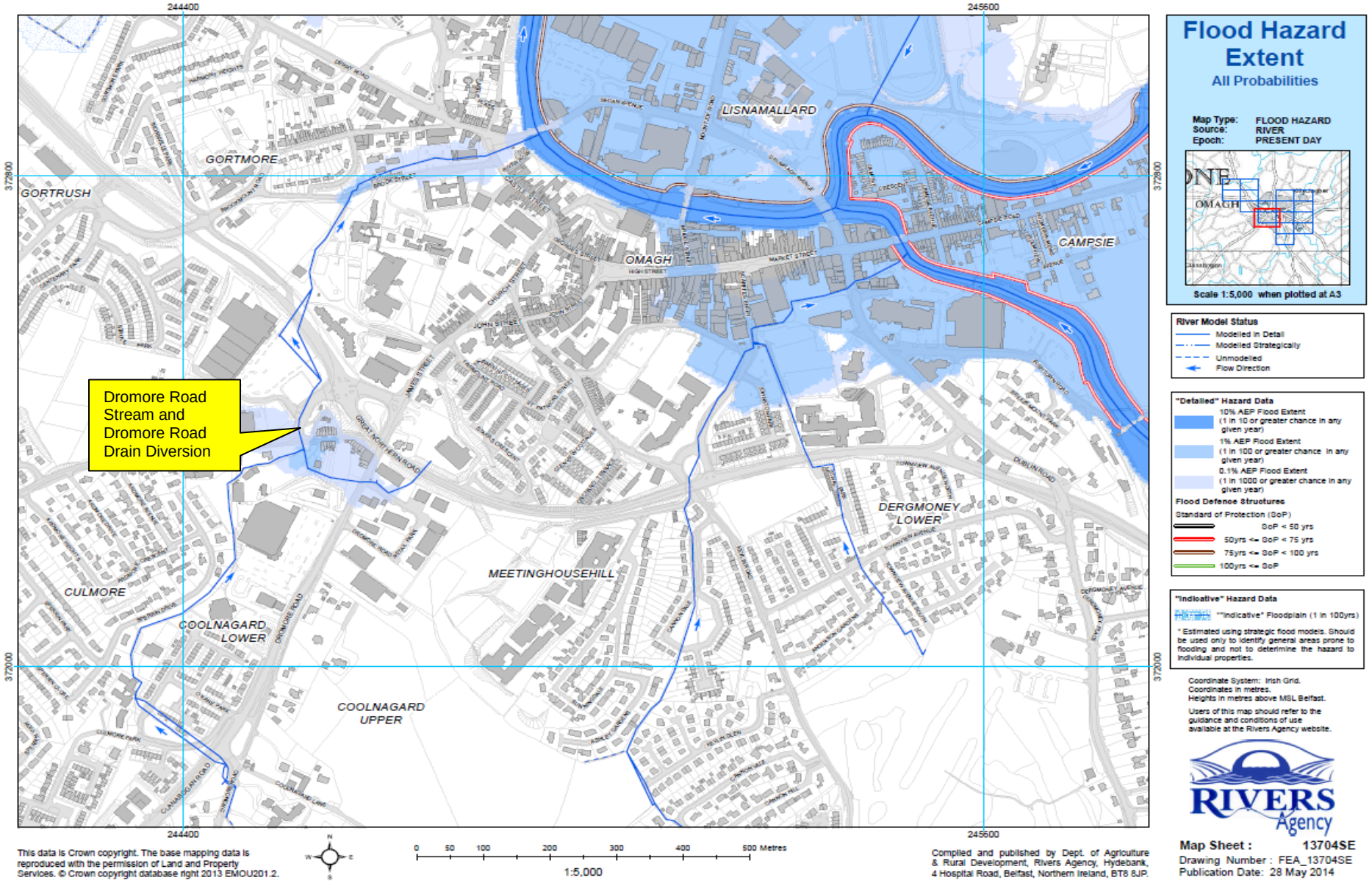


Figure 6.3.4.2 - Flood Hazard Extent Map for Omagh Town Centre - South

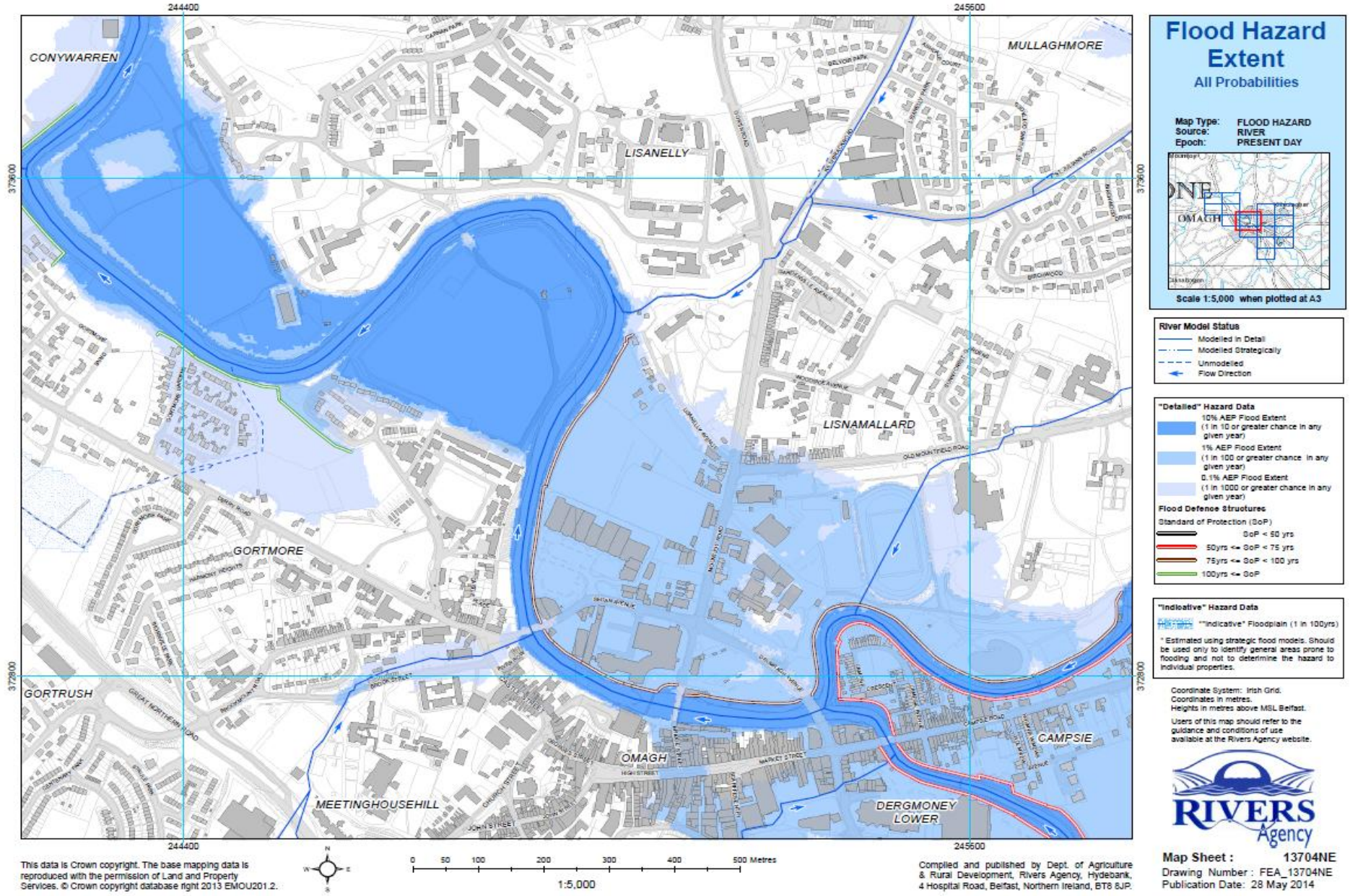


Figure 6.3.4.3 - Flood Hazard Extent Map for Omagh Town Centre - North

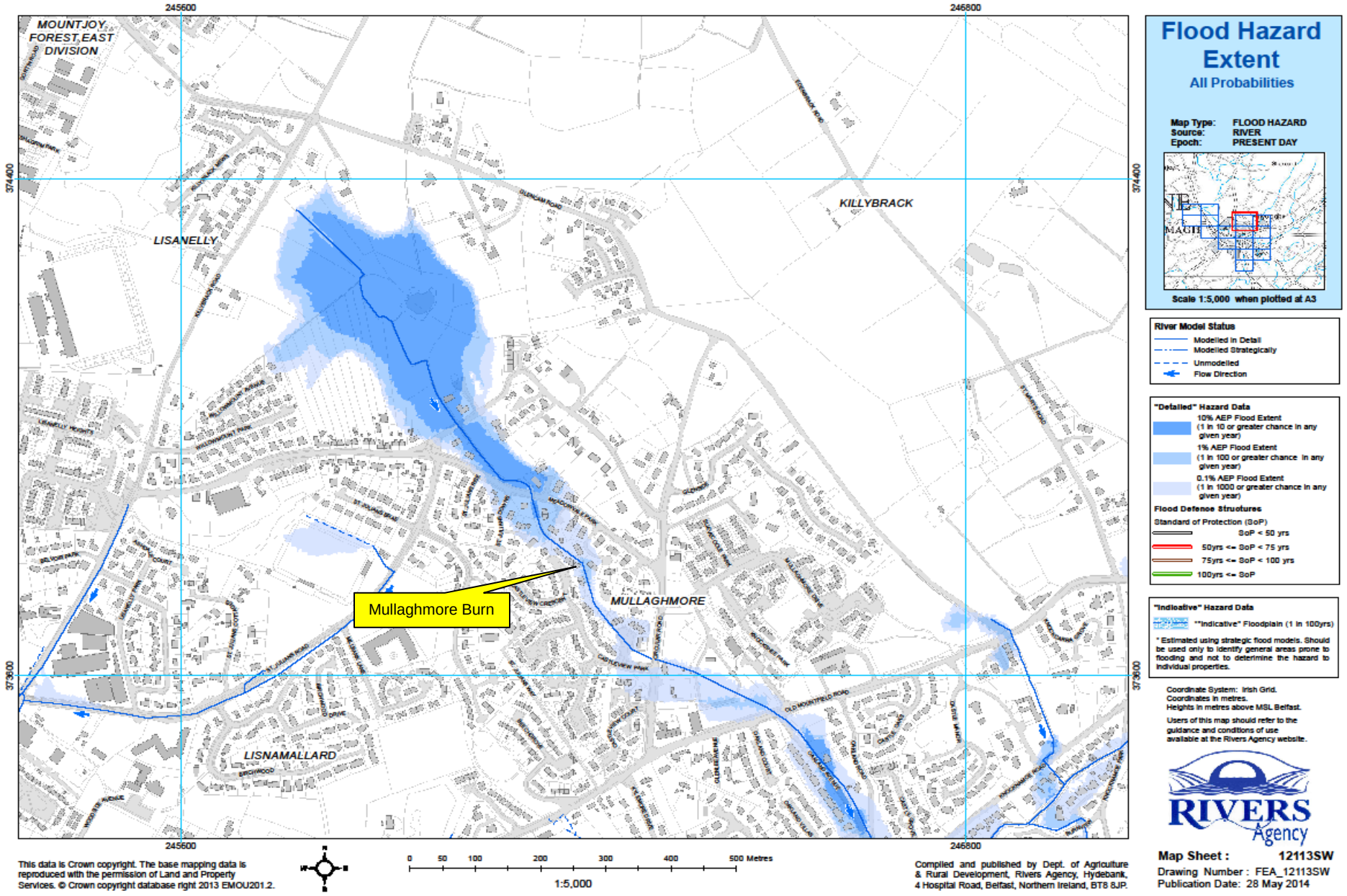


Figure 6.3.4.4 - Flood Hazard Extent Map for Mullaghmore Burn, Omagh

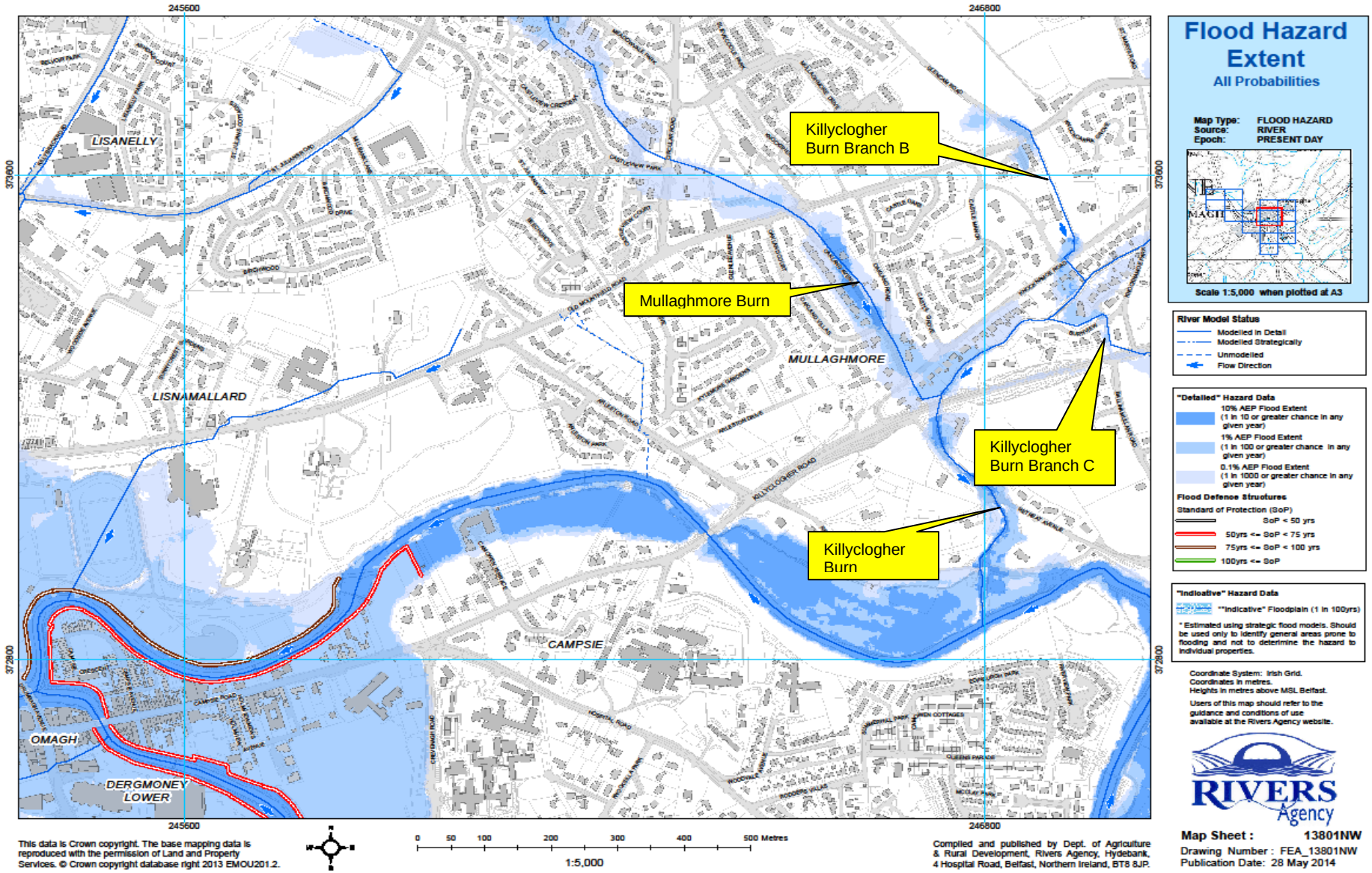


Figure 6.3.4.5 - Flood Hazard Extent Map for Mullaghmore Burn & Killyclogher Drain, Omagh

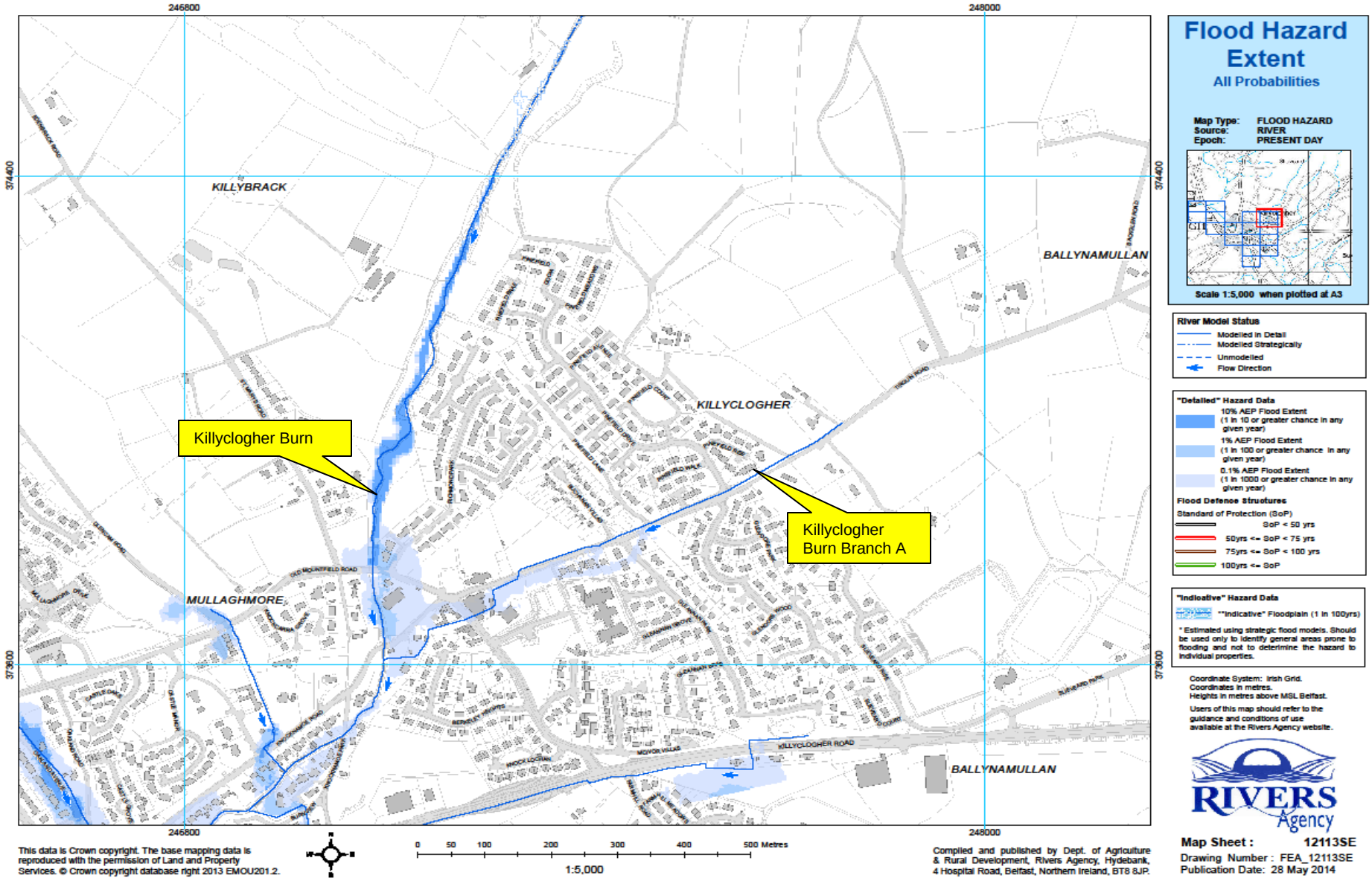


Figure 6.3.4.6 - Flood Hazard Extent Map for Killyclogher Burn, Omagh

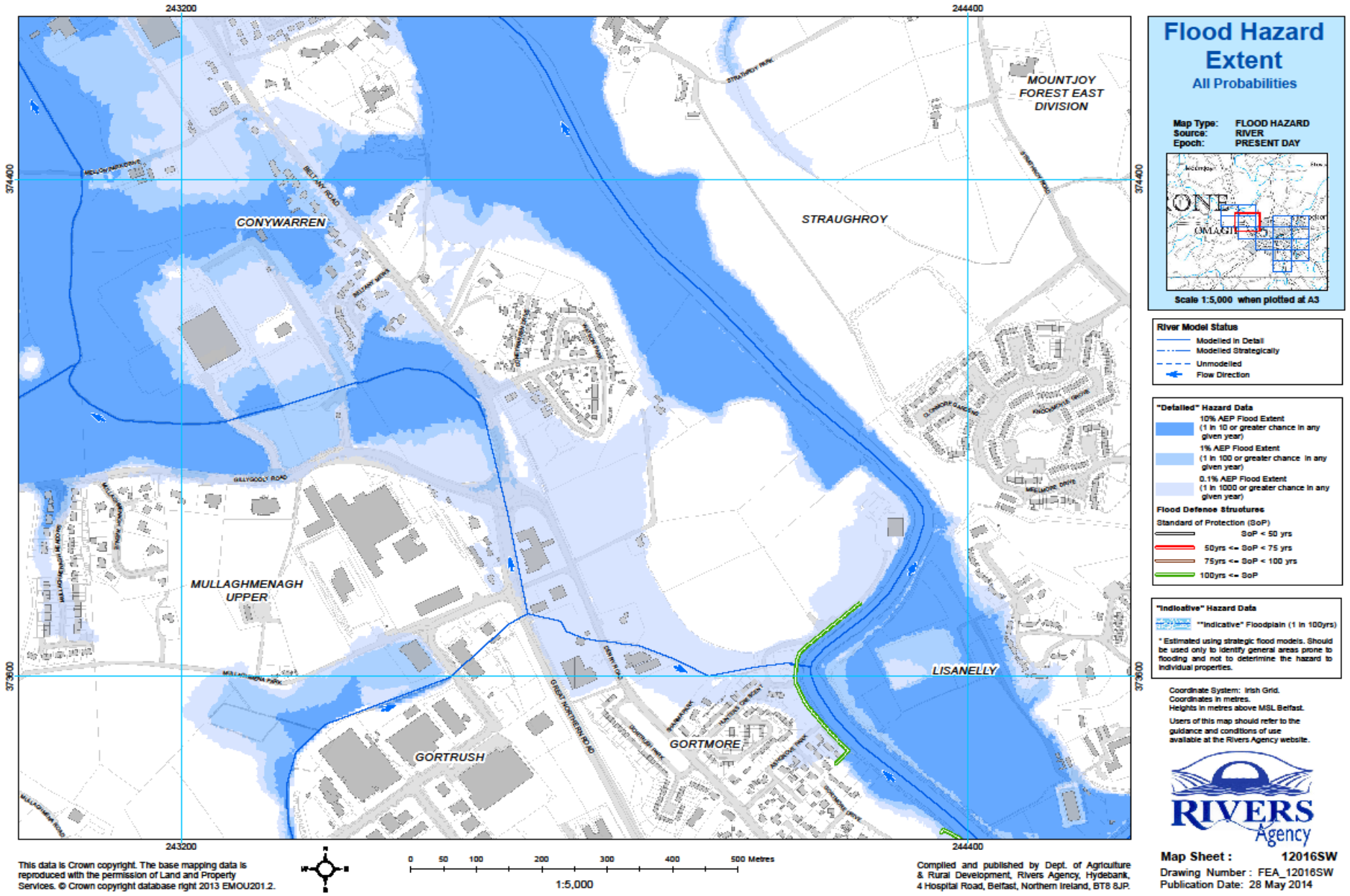


Figure 6.3.4.7 - Flood Hazard Extent Map for Beltany Road - Fairy Water and River Strule, Omagh

Table 6.3.4.1 - Omagh SFRA- Town Centre			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	2	9	185
Non Residential (Nr)	18	80	338
Economic Damage (£)	£47,399	£2,713,104	£47,876,804
Annual Average Damage (£)	£1,194,160		
Present Value (£)	**£35,824,800**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)	**0**	0	6
Care Homes			
GP Surgery's			**4**
Fire stations			**1**
Hospitals			
Police Stations			
Schools			**1**
Key Infrastructure (Nr)	**1**	**7**	**18**
NIW Wastewater Treatment Works			
NIW Sewage Pumping Stations		**1**	**3**
NIW Water Treatment Work			
NIW Treated Water Pumping Stations			
NIE Substation 6to11kV	**1**	**6**	**15**
NIE Substation 33kV			
NIE Substation 275kV			
NIE Substation 110kV			
Road Service - Trunk Road			
Environmental Designated sites (Nr)	**0**	**0**	**0**
AONB			
ASSI			
Environmentally Sensitive Areas			
Maritime Nature Reserve			
Nature Reserve			
RAMSAR			
SAC			
Sites of Local Nature Conservation Importance			
SPA			
RSPB Reserve			
UWT Nature Reserve			
Built Heritage sites (Nr)	**1**	**2**	**2**
National Trust			
Listed Buildings	**1**	**1**	**1**
Sites and Monuments Records		**1**	**1**
Buildings of Special Architectural or Historical Interest			
Areas of Significant Archaeological Interest			
Historic Gardens			

Table 6.3.4.2 - Omagh SFRA - Killyclogher Burn + Branches B & C and Mullaghmore Burn			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	10	21	55
Non Residential (Nr)	1	2	3
Economic Damage (£)	£108,035	£353,535	£1,088,647
Annual Average Damage (£)	£70,870		
Present Value (£)	**£2,126,100**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)	**0**	0	0
Care Homes GP Surgery's Fire stations Hospitals Police Stations Schools			
Key Infrastructure (Nr)	**3**	**3**	**3**
NIW Wastewater Treatment Works NIW Sewage Pumping Stations NIW Water Treatment Work NIW Treated Water Pumping Stations NIE Substation 6to11kV NIE Substation 33kV NIE Substation 275kV NIE Substation 110kV Road Service - Trunk Road	**2** **1**	**2** **1**	**2** **1**
Environmental Designated sites (Nr)	**0**	**0**	**0**
AONB ASSI Environmentally Sensitive Areas Maritime Nature Reserve Nature Reserve RAMSAR SAC Sites of Local Nature Conservation Importance SPA RSPB Reserve UWT Nature Reserve			
Built Heritage sites (Nr)	**0**	**0**	**0**
National Trust Listed Buildings Sites and Monuments Records Buildings of Special Architectural or Historical Interest Areas of Significant Archaeological Interest Historic Gardens			

Table 6.3.4.3 - Omagh SFRA – Dromore Road Stream & Dromore Road Drain Diversion			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	0	0	5
Non Residential (Nr)	0	0	1
Economic Damage (£)	0	0	£4,417
Annual Average Damage (£)	£1,679		
Present Value (£)	**£50,370**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)	**0**	0	0
Care Homes GP Surgery's Fire stations Hospitals Police Stations Schools			
Key Infrastructure (Nr)	**0**	**0**	**0**
NIW Wastewater Treatment Works NIW Sewage Pumping Stations NIW Water Treatment Work NIW Treated Water Pumping Stations NIE Substation 6to11kV NIE Substation 33kV NIE Substation 275kV NIE Substation 110kV Road Service - Trunk Road			
Environmental Designated sites (Nr)	**0**	**0**	**0**
AONB ASSI Environmentally Sensitive Areas Maritime Nature Reserve Nature Reserve RAMSAR SAC Sites of Local Nature Conservation Importance SPA RSPB Reserve UWT Nature Reserve			
Built Heritage sites (Nr)	**0**	**0**	**0**
National Trust Listed Buildings Sites and Monuments Records Buildings of Special Architectural or Historical Interest Areas of Significant Archaeological Interest Historic Gardens			

Table 6.3.4.4 - Omagh SFRA – Beltany Road			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	2	6	8
Non Residential (Nr)	1	2	3
Economic Damage (£)	£18,695	£42,311	£395,291
Annual Average Damage (£)	£16,634		
Present Value (£)	**£499,020**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)	**0**	0	0
Care Homes GP Surgery's Fire stations Hospitals Police Stations Schools			
Key Infrastructure (Nr)	**0**	**0**	**0**
NIW Wastewater Treatment Works NIW Sewage Pumping Stations NIW Water Treatment Work NIW Treated Water Pumping Stations NIE Substation 6to11kV NIE Substation 33kV NIE Substation 275kV NIE Substation 110kV Road Service - Trunk Road			
Environmental Designated sites (Nr)	**0**	**0**	**0**
AONB ASSI Environmentally Sensitive Areas Maritime Nature Reserve Nature Reserve RAMSAR SAC Sites of Local Nature Conservation Importance SPA RSPB Reserve UWT Nature Reserve			
Built Heritage sites (Nr)	**0**	**0**	**0**
National Trust Listed Buildings Sites and Monuments Records Buildings of Special Architectural or Historical Interest Areas of Significant Archaeological Interest Historic Gardens			

6.3.5 Proposed Fluvial Flood Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Omagh it is important that the flood risk is not increased by new development in areas of known flood risk. Planning Policy Statement, PPS 15, "Planning and Flood Risk", adopts a precautionary approach to development with the primary aim "to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere".

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the "Exception" rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to "Greenfield" built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new Development Plans for Omagh, Rivers Agency advise against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 100 year fluvial floodplain/reservoir inundation area or is susceptible elsewhere to surface water flooding.

Rivers Agency shall also review the existing Development Plan for Omagh with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

The main (undeveloped) flooded areas, amongst others, within the Omagh Significant Flood Risk Area are:-

- In the flood plains of the Strule, Camowen and Drumragh Rivers – for example, Conywarren, Lisanelly, Lisnamallard and Campsie areas.

Planning Applications

Fluvial Area at Risk

Rivers Agency shall advise against the development of all sites that are located within the1 in 100 year fluvial floodplain, irrespective of whether they are located within a current development plan or as a single site application outside the plan area.

For those sites within the1in 100 year fluvial floodplain where the principle of development has been accepted by Planning NI as meeting the "Exception Test", Rivers Agency will further consider the application through the appraisal of an accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The main existing developed areas, amongst others, at flood risk within Omagh where re-development may be likely to take place are:-

- Areas in and around the Town Centre – for example, High Street, Market Street, Drumragh Ave, Campsie Road, Mountjoy Road, Sedan Ave, Dublin Road, Irishtown Road and Bridge Street near the confluence of the Drumragh River and Camowen River with the Strule River.

Areas at Risk of Surface Water Flooding

For those sites outside the 1 in 100 year fluvial floodplain that are located in an area where there is evidence of a history of surface water flooding (identified by flood hardship payments), Rivers Agency will further consider the application through the appraisal of the accompanying Drainage Assessment that will need to demonstrate suitable flood mitigation measures.

Where there is potential for surface water flooding as indicated in the 'purple' predicted areas on the Surface Water Maps, Rivers Agency will advise that the applicant should assess the flood risk and drainage impact to the site and construct in an appropriate manner.

The main areas identified in Omagh as being at surface water flood risk are:-

- Tamlaght Road/Dromore Road
- Dergmoney Lower
- Behind the flood defences

Areas at Risk of Flood Inundation from Reservoirs

For all development proposals that are located within the potential flood inundation area of a controlled reservoir Rivers Agency will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures. If it is a new development proposal Rivers Agency will also need the applicant to demonstrate that the condition, management and maintenance regime of the reservoir is appropriate to provide sufficient assurance regarding reservoir safety.

The controlled reservoir identified in the Omagh area is Glencordial.

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is, therefore, important that we continue to target investment by providing flood defence, culvert alleviation schemes, and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. The Flood Investment and Planning Group, FIPG, provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a "Flood Risk Metric Tool" (FRISM) is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total "damage avoidance benefits" that the scheme will provide to the property over the scheme's design life. If the benefit/cost ratio is greater than 1 (Net Present Value, NPV, figure is positive) the potential scheme will be referred to Rivers Agency's Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely Rivers Agency's responsibility, or is the responsibility of NI Water or Transport NI such as a local drainage or road infrastructure issue, it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a benefit cost analysis identifies a viable scheme, a scheme will be placed on a prioritisation list for works with other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take anything from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Within the Omagh area the following potential schemes have been identified and will be referred to the appropriate bodies for further investigation or detailed feasibility study.

Possible Schemes in Omagh SFRA

Flood Defences

Rivers Agency designs new flood defences for a Standard of Protection (SoP) of 1 in 100 year. SoP of 1 in 75 and 1 in 50 are causes of concern as walls with this SoP would be the first to be over topped in high flow conditions. The affects of bridges, in general, and the weir in the Strule downstream of Bell's Bridge would need to be investigated with a view to improving the flow characteristics of the rivers thus removing the threat of flood walls being over topped too soon (i.e. before those with a SoP of 1 in 100 year). Also, drainage behind the flood walls would need to be taken into consideration.

NI Water has indicated that they have solved the flooding problem that occurred in Rodgers Villas in Omagh by carrying out works to its infrastructure. Roads Service is to assess and review the upgrade of Abbey Bridge, Bells Bridge and Campsie Bridge in Omagh.

An inter Agency study of Omagh Town has been suggested by Rivers Agency, NI Water and Road Service. In this study each of the organisations would assesses their own infrastructure in Omagh Town. The study should consider different options, such as removing bridges, rising bridge decks, removing centre piers of bridges, and also consider the removal of the weir on the River Strule. This proposed study should be referred to the Flood Investment Policy Group in view of its cross cutting nature.

River Agency's flood defences in Omagh have been assessed and given Condition Grades. All of the flood defences in the urban areas have Condition Grades of 2 or 3 (Good or Fair respectively), except that for Hunters Crescent which is Condition Grade 5 (Very Poor). Thus this section of flood defence will be prioritised for the Works Study Programme.

Given the fluvial damages calculated it is proposed that the following rivers are considered for Flood Alleviation Schemes and prioritised for the Works Study Programme:-

- Camowen;
- Drumragh;
- Fairy Water (Beltany Road); and
- Strule

Watercourses

Rivers Agency has carried out recent works on the Hunters Crescent to alleviate flooding. Rivers Agency also plans to carry out works in 2014-2015 to Johnston Park Stream to address flooding in Scarffes Entry and the Kelvin Avenue link road between two car parks.

Given the fluvial damages calculated it is proposed that the following watercourses are considered for Flood Alleviation Schemes and prioritised for the Works Study Programme:-

- Killyclogher Burn;
- Killyclogher Burn Branch B;
- Killyclogher Burn Branch C; and

- Mullaghmore Burn.

As the fluvial damages for the following watercourse are not considered high enough it will not be progressed to the Works Study Programme:-

- Dromore Road Stream and Dromore Road Drain Diversion

However, they will continue to be subject to routine maintenance by Rivers Agency.
The Rivers Agency culvert network in Omagh town is in very good condition. 46% of the network is Structural Grade 1, 20% Structural Grade 2, 8% Structural Grade 3, 8.6% Structural Grade 4, 5% Structural Grade 5, and 12% has not yet been surveyed.

Preparedness

In Omagh it is not possible to prevent or protect against all flooding. Indeed, even where flood defences exist it is possible in an extreme event that these could be over topped and flooding could still occur.
Having recognised this fact, considerable effort in recent years has been made by emergency planners in Government Departments, Councils and the Emergency Services working together and sharing information to ensure a coordinated response.

However, despite these improvements during significant flood events the emergency response of Government Departments and the Emergency Services can become over stretched. This means that not all calls for assistance during a flood event may be responded to in a timely manner. With this in mind it is important that households and communities, subject to a known flood risk, are prepared. The detail of preparedness actions, including flood warning and informing activities planned from a regional perspective, are provided in Annex E.

This is not Government withdrawing from any undertaking to respond in emergencies but an additional layer of support to ensure Government Departments and the public work together to reduce the overall impacts of flooding.

From the flood risk assessment there are 4 areas of Omagh which are subject to flood risk and may have flooded before. Therefore, they may benefit from the flood warning and informing proposals outlined in Annex D.

A pilot project of community engagement to deliver flood warning and informing, held in 2014, identified basic assessment formulae to assess and score areas that could potentially be a focus for flood warning and informing actions. Based on this scoring the following area could be considered suitable for being included in a programme of community engagement to deliver flood warning and informing initiatives:-

- Omagh Town centre.

Key activities that could be undertaken are:-

- Explaining the potential and limitations of Community Resilience;
- Briefing communities on information available, particularly from the Met Office;
- The facilitation of self-help initiatives, including remote sandbag storage; and
- Reviewing and validating all elements of the Community Engagement Plan to help the community communicate effectively in an emergency and work together.

A table in Annex J shows how this community ranks in the overall context of the 20 FRAs in this Plan. It should be noted that this is an indicative assessment which may change subject to further information on flood risk becoming available.

The rollout of this work is dependent on funding being available.

6.4 Strabane Significant Flood Risk Area – Finn, Deele, Burndennet and Foyle LMA

The core boundary of the Strabane SFRA, which has been determined through the PFRA, is located within the Finn, Deele, Burndennet and Foyle Local Management Areas (LMAs) and illustrated in Figure 6.4.1 below.

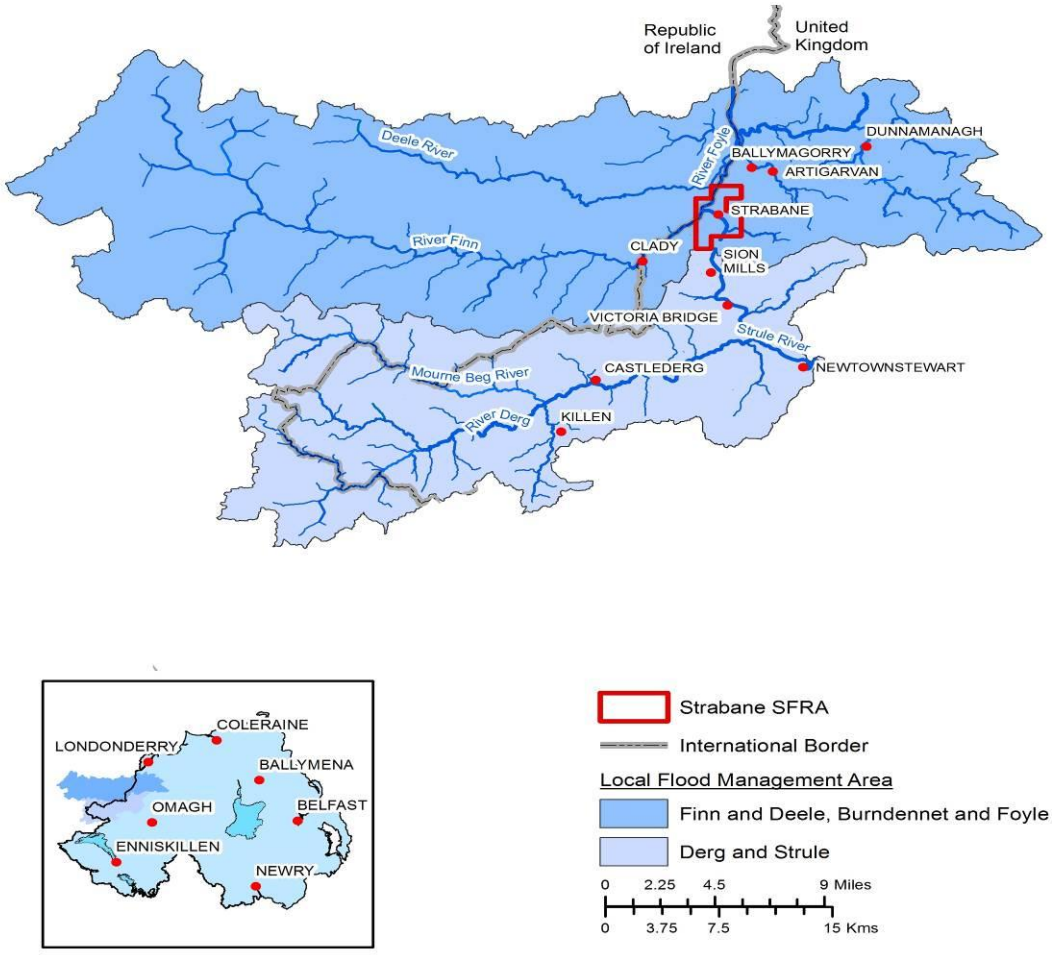


Figure 6.4.1 – Strabane SFRA and LMAs

6.4.1 Flooding History

Photograph 6.4.1 – Mourne River Downstream of Bridge Street, Strabane

After the flooding of 27 October 1987 flood walls were constructed to protect the main built up areas of Strabane. These walls have withstood all the flood flows to date. In recent years Rivers Agency has dealt with isolated drainage problems many of which relate to surface water. In order to address specific drainage issues Rivers Agency has carried out major culvert replacement works on Nancy Burn in the 1990s.

6.4.2 PFRA – Identification of Potentially Significant Flood Sources

According to the Preliminary Flood Risk Assessment (Dec 2011) the town of Strabane, in terms of the potential adverse consequences of flooding, is ranked 19th of the twenty SFRA within Northern Ireland (see Figure 4.1). On the basis of this initial assessment, which was undertaken using the strategic flood maps, the predominant flood risk to the town was considered to arise from fluvial flooding.

It should be noted that the PFRA flagged up the potential for significant fluvial flooding at Strabane because this national assessment is based on strategic 'undefended' flood models which ignore the presence of

existing flood defence systems such as the River Mourne Flood Walls. Therefore, the assessment is in effect based on the worst case scenario, as it assumes there is no benefit from the defences. This precautionary approach has been taken because at the time of the assessment there was a degree of uncertainty about the level of protection that each of the existing flood defence systems provides. By adopting this approach, the urban areas that are located behind existing flood defence structures were determined to be SFRA by default and as a consequence detailed Flood Hazard/Risk Maps had to be prepared in compliance with the requirements of the EU Directive. This provided the opportunity to undertake the detailed structural assessments and flood modelling necessary to remove the uncertainty and establish the actual level of protection offered by these defences. The detailed flood maps will, therefore, give a more accurate prediction of the flooded areas that may have been over estimated/under estimated or missed by the strategic flood maps.

6.4.3 Catchment Description

Strabane is at the confluence of the River Mourne and the River Finn. Downstream from the confluence is the River Foyle. The Burndennet River flows west and joins the River Foyle some distance downstream of the Strabane SFRA. Both the Finn River and Deele River flow east from Donegal. The Deele River joins the River Foyle downstream of the Strabane SFRA. The catchments are mainly rural with Omagh and Strabane being the only significant urban areas.

To facilitate a more robust assessment of the level of flood risk to Strabane from rivers, Rivers Agency developed detailed predictive flood models. Details of the models and their output are described in the following sections.

6.4.4 Fluvial Flood Risk Assessment

Flood Model

The model used to assess the fluvial risk to Strabane settlement is an Infoworks ICM 2D model, developed by a Rivers Agency Consultant. There has been cooperation between the Office of Public Works in the Republic of Ireland and Rivers Agency regarding the modelling in the Lifford/Strabane area.

Fluvial Flooding Mechanisms

Figure 6.4.4.1 illustrates the predicted extents of the potential flooding in the Urney Road/ Glenfinn Park area and details of the impact of the flooding on property and key infrastructure is summarised in Table 6.4.4.1. An undesignated watercourse, which was not modelled, would overflow as a result of the water level in the River Finn. Roads would be affected at the 10% AEP (1 in 10 year) event and houses would be affected by flooding at the 2% AEP (1 in 50 year) event. At the1% AEP (1 in 100 year) event depths of flooding would be up to 1m. There has been historical flooding in this area. From Table 6.4.4.1, flooding from the 1% AEP (1 in 100 year) event is estimated to affect 20 residential properties with a damage cost of around £298,680.

Figure 6.4.4.1 illustrates the predicted extents of the potential flooding from the Urney Road Drain and Urney Road Drain Extension and details of the impact of the flooding on property and key infrastructure is summarised in Table 6.4.4.2. The fluvial modelling predicts that flooding would take place upstream of the culvert at Urney Road and the culvert near Finn Park. The flooding would be directly related to the water level in the River Finn. At the 10% AEP (1 in 10 year) event depths would be generally less than 300mm near houses. However, at the 1% AEP (1 in 100 year) event the depth of flooding would be up to 1m and in certain places in excess of 1m. There has been historical flooding in this area. From Table 6.4.4.2, flooding from the 1% AEP (1 in 100 year) event is estimated to affect 13 residential properties with a damage cost of around £496,410.

Figure 6.4.4.2 illustrates the predicted extents of the potential flooding from the River Foyle and details of the impact of the flooding on property and key infrastructure are summarised in Tables 6.4.4.3 and 6.4.4.4. The fluvial modelling predicts that flooding from the River Foyle would affect large areas. However, only a limited number of properties on the Lifford Road and one property on the Barnhill Road would be affected (from the Park Road Drain). The Lifford Road would also be affected. This flooding would take place at the 2% AEP (1 in 50 year) event and at the1% AEP (1 in 100 year) event the depth of flooding would be up to 1m in places. There has been historical flooding in the area. For Lifford Road from Table 6.4.4.4 flooding from the 1% AEP (1 in 100 year) event is estimated to affect 1 residential and 4 non-residential properties with a damage cost of around £46,800 and for Park Road Drain from Table 6.4.4.3 flooding from the 1% AEP (1 in 100 year) event is estimated to affect 17 residential and 1 non-residential properties with a damage cost of around £696,960.

Figure 6.4.4.3 illustrates the predicted extents of the potential flooding from the Roundhill Drain Extension and details of the impact of the flooding on property and key infrastructure is summarised in Table 6.4.4.5. The fluvial modelling predicts that water would overflow from 3 manholes near Tullacorr Gardens. The depth of flooding at the1% AEP (1 in 100 year) event is less than 300mm. It is unlikely that any houses would flood given the falling contours of the land. In any case the storm water system would reduce the affect of the overflow from the manholes on the culvert. There are no flooding hot spots in the vicinity and no records to indicate that Rivers Agency has responded to localised flooding problems. From Table 6.4.4.5, flooding from the 1% AEP (1 in 100 year) event is estimated to affect 37 residential properties with a damage cost of around £198,420.

The main flood defences for Strabane, namely the walls along the banks of the Mourne and the embankment alongside the Barnhill Road, provide a Standard of Protection of 1 in 100 year, which is the normal Rivers Agency design standard. At the 1 in 100 year event certain low lying areas would be affected by flooding, in particular close to the Park Road Drain and Tarry Drain/Nancy Burn.

The flood embankment on the River Finn is predicted to overtop initially at the 1 in 5 year event and most of the area between this embankment, the embankment on the Mourne River, and the Great Northern Link would be flooded at the 1 in 50 year event. At the 1 in 50 year event significant flooding is predicted to affect the area between the River Foyle embankment and the embankment alongside the Barnhill Road. None of the embankments close to rivers provide adequate flood protection.

The main flood defences for Strabane have the Condition Grade of 3 (Fair). The flood embankments on the Mourne and Finn near their confluence have Condition Grades of 4 (Poor) and 3 (Fair) respectively. The flood embankment on the River Foyle, downstream of the Lifford Road Bridge, has a condition Grade of 3 (Fair). A short section of floodwall on right hand bank of the River Mourne downstream of the Bradley Way Bridge has a Condition Grade of 4 (Poor).

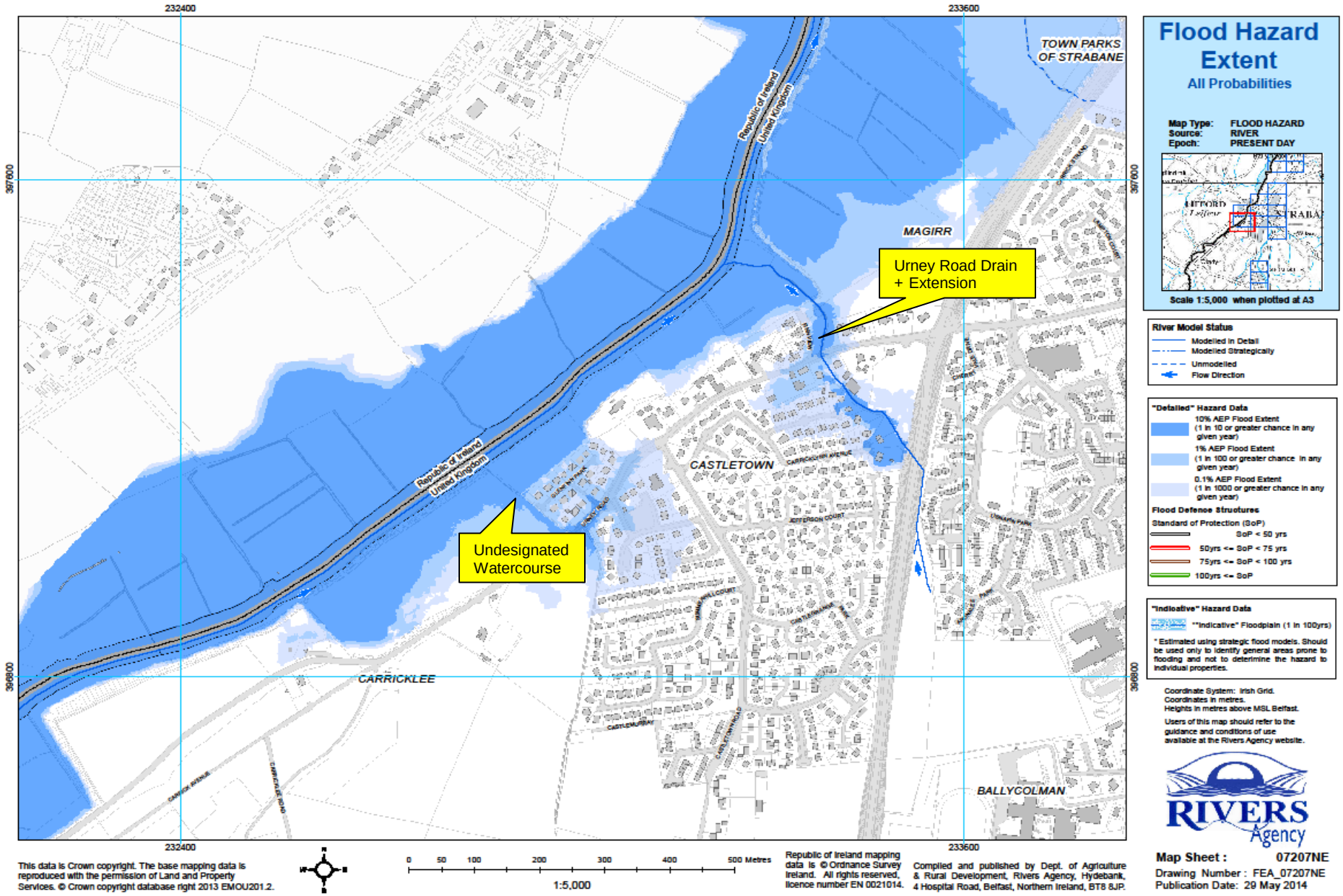


Figure 6.4.4.1 - Flood Hazard Extent Map for Urney Road Area, Strabane

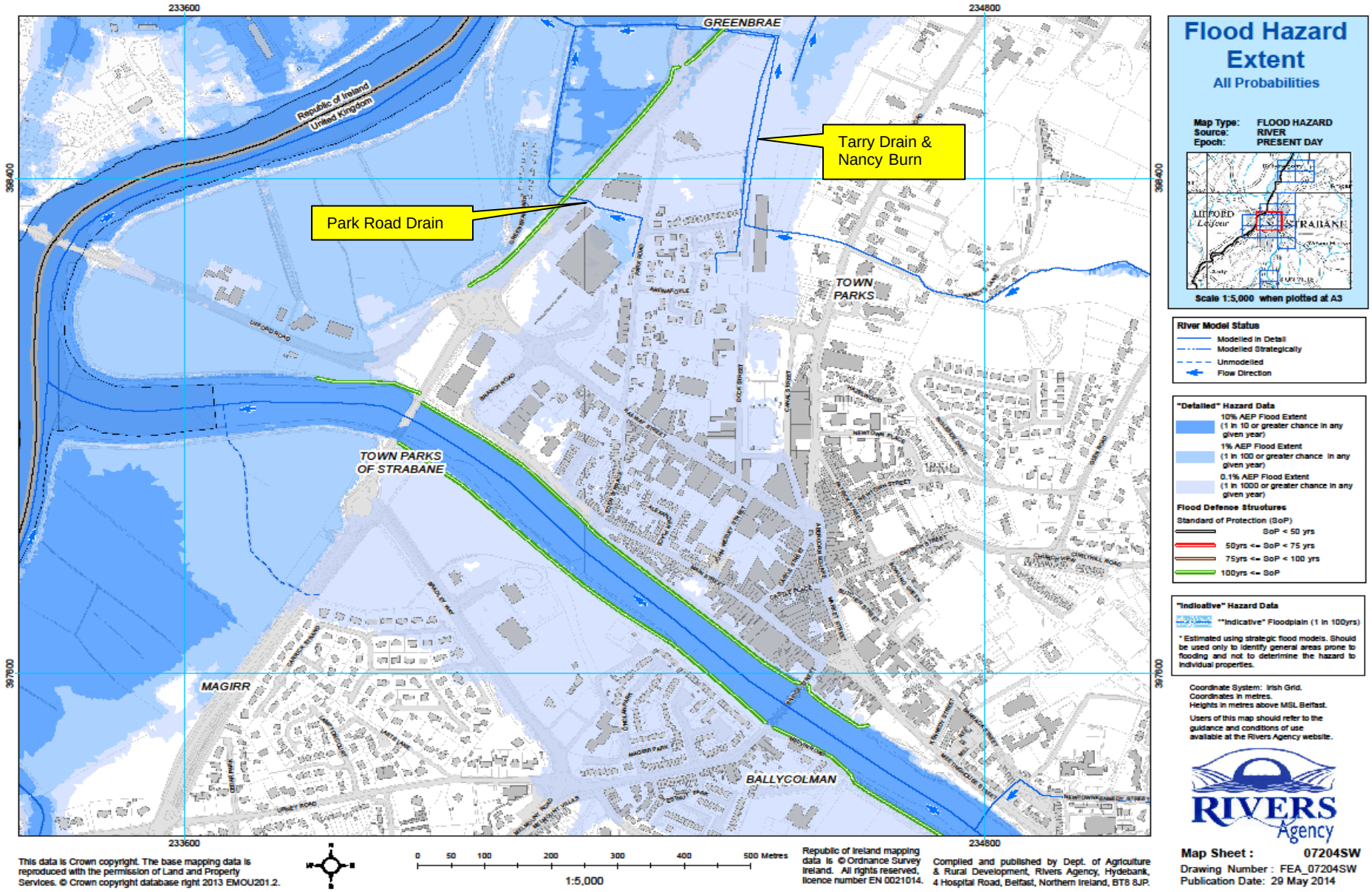


Figure 6.4.4.2 - Flood Hazard Extent Map Town Park of Strabane

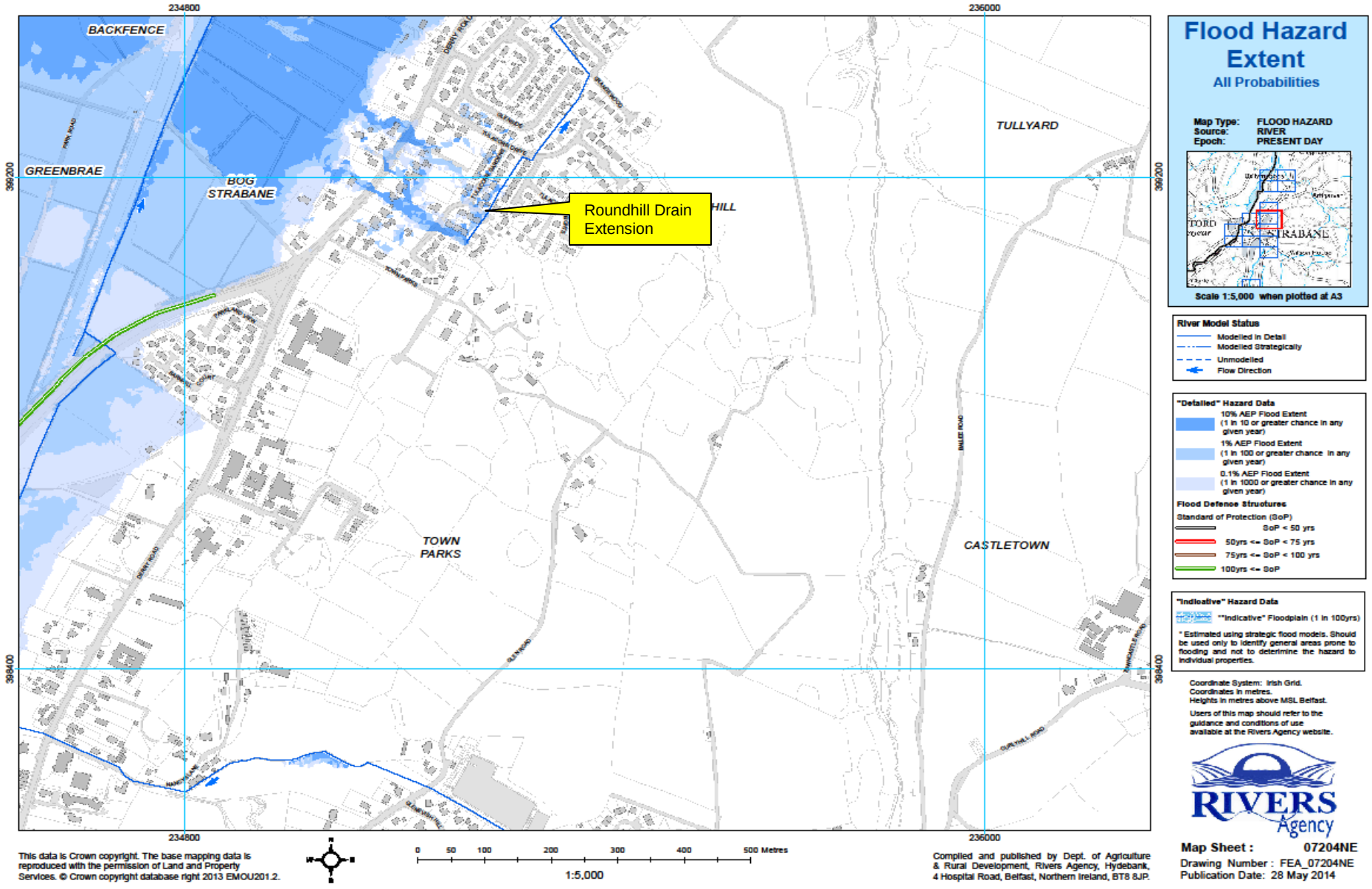


Figure 6.4.4.3 - Flood Hazard Extent Map for Roundhill Drain Extension, Strabane

Table 6.4.4.1 - Strabane SFRA			
Potential Adverse Consequences – Undesignated, Urney Road			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	0	0	20
Non Residential (Nr)	0	0	0
Economic Damage (£)	0	0	£43,810
Annual Average Damage (£)	£9,956		
Present Value (£)	**£298,680**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)	**0**	0	0
Care Homes GP Surgery's Fire stations Hospitals Police Stations Schools			
Key Infrastructure (Nr)	**1**	**1**	**1**
NIW Wastewater Treatment Works NIW Sewage Pumping Stations NIW Water Treatment Work NIW Treated Water Pumping Stations NIE Substation 6to11kV NIE Substation 33kV NIE Substation 275kV NIE Substation 110kV Road Service - Trunk Road	**1**	**1**	**1**
Environmental Designated sites (Nr)	**0**	**0**	**0**
AONB ASSI Environmentally Sensitive Areas Maritime Nature Reserve Nature Reserve RAMSAR SAC Sites of Local Nature Conservation Importance SPA RSPB Reserve UWT Nature Reserve			
Built Heritage sites (Nr)	**0**	**0**	**0**
National Trust Listed Buildings Sites and Monuments Records Buildings of Special Architectural or Historical Interest Areas of Significant Archaeological Interest Historic Gardens			

Table 6.4.4.2 - Strabane SFRA			
Potential Adverse Consequences – Urney Road Drain & Extension			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	12	13	13
Non Residential (Nr)	0	0	0
Economic Damage (£)	£28,448	£37,829	£125,383
Annual Average Damage (£)	£16,547		
Present Value (£)	**£496,410**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)	**0**	0	0
Care Homes GP Surgery's Fire stations Hospitals Police Stations Schools			
Key Infrastructure (Nr)	**0**	**0**	**1**
NIW Wastewater Treatment Works NIW Sewage Pumping Stations NIW Water Treatment Work NIW Treated Water Pumping Stations NIE Substation 6to11kV NIE Substation 33kV NIE Substation 275kV NIE Substation 110kV Road Service - Trunk Road			**1**
Environmental Designated sites (Nr)	**0**	**0**	**0**
AONB ASSI Environmentally Sensitive Areas Maritime Nature Reserve Nature Reserve RAMSAR SAC Sites of Local Nature Conservation Importance SPA RSPB Reserve UWT Nature Reserve			
Built Heritage sites (Nr)	**0**	**0**	**0**
National Trust Listed Buildings Sites and Monuments Records Buildings of Special Architectural or Historical Interest Areas of Significant Archaeological Interest Historic Gardens			

Table 6.4.4.3 - Strabane SFRA			
Potential Adverse Consequences – Park Road Drain			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	0	0	17
Non Residential (Nr)	0	1	1
Economic Damage (£)	0	0	£326,212
Annual Average Damage (£)	£23,232		
Present Value (£)	**£696,960**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)	**0**	0	0
Care Homes GP Surgery's Fire stations Hospitals Police Stations Schools			
Key Infrastructure (Nr)	**0**	**0**	**1**
NIW Wastewater Treatment Works NIW Sewage Pumping Stations NIW Water Treatment Work NIW Treated Water Pumping Stations NIE Substation 6to11kV NIE Substation 33kV NIE Substation 275kV NIE Substation 110kV Road Service - Trunk Road			**1**
Environmental Designated sites (Nr)	**0**	**0**	**0**
AONB ASSI Environmentally Sensitive Areas Maritime Nature Reserve Nature Reserve RAMSAR SAC Sites of Local Nature Conservation Importance SPA RSPB Reserve UWT Nature Reserve			
Built Heritage sites (Nr)	**0**	**0**	**0**
National Trust Listed Buildings Sites and Monuments Records Buildings of Special Architectural or Historical Interest Areas of Significant Archaeological Interest Historic Gardens			

Table 6.4.4.4 - Strabane SFRA			
Potential Adverse Consequences – Lifford Road			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	0	0	1
Non Residential (Nr)	0	0	4
Economic Damage (£)	0	0	£54,579
Annual Average Damage (£)	£1,560		
Present Value (£)	**£46,800**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)	**0**	0	0
Care Homes GP Surgery's Fire stations Hospitals Police Stations Schools			
Key Infrastructure (Nr)	**0**	**0**	**0**
NIW Wastewater Treatment Works NIW Sewage Pumping Stations NIW Water Treatment Work NIW Treated Water Pumping Stations NIE Substation 6to11kV NIE Substation 33kV NIE Substation 275kV NIE Substation 110kV Road Service - Trunk Road			
Environmental Designated sites (Nr)	**0**	**0**	**0**
AONB ASSI Environmentally Sensitive Areas Maritime Nature Reserve Nature Reserve RAMSAR SAC Sites of Local Nature Conservation Importance SPA RSPB Reserve UWT Nature Reserve			
Built Heritage sites (Nr)	**0**	**0**	**0**
National Trust Listed Buildings Sites and Monuments Records Buildings of Special Architectural or Historical Interest Areas of Significant Archaeological Interest Historic Gardens			

Table 6.4.4.5 - Strabane SFRA			
Potential Adverse Consequences – Roundhill Drain Extension			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	25	30	37
Non Residential (Nr)	0	0	0
Economic Damage (£)	£15,547	£22,487	£37,415
Annual Average Damage (£)	£6,614		
Present Value (£)	**£198,420**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)	**0**	0	0
Care Homes GP Surgery's Fire stations Hospitals Police Stations Schools			
Key Infrastructure (Nr)	**0**	**0**	**0**
NIW Wastewater Treatment Works NIW Sewage Pumping Stations NIW Water Treatment Work NIW Treated Water Pumping Stations NIE Substation 6to11kV NIE Substation 33kV NIE Substation 275kV NIE Substation 110kV Road Service - Trunk Road			
Environmental Designated sites (Nr)	**0**	**0**	**0**
AONB ASSI Environmentally Sensitive Areas Maritime Nature Reserve Nature Reserve RAMSAR SAC Sites of Local Nature Conservation Importance SPA RSPB Reserve UWT Nature Reserve			
Built Heritage sites (Nr)	**0**	**0**	**0**
National Trust Listed Buildings Sites and Monuments Records Buildings of Special Architectural or Historical Interest Areas of Significant Archaeological Interest Historic Gardens			

6.4.5 Proposed Fluvial Flood Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Strabane it is important that the flood risk is not increased by new development in areas of known flood risk. Planning Policy Statement, PPS 15, "Planning and Flood Risk", adopts a precautionary approach to development with the primary aim "to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere".

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the "Exception" rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to "Greenfield" built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new Development Plans for Strabane, Rivers Agency advises against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 100 year fluvial floodplain or is susceptible elsewhere to surface water flooding. Rivers Agency shall also review the existing Development Plan for Strabane with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

The main (undeveloped) flooded areas, amongst others, within the Strabane Significant Flood Risk Area are:-

- Areas behind river flood embankments – for example, between the River Foyle and the Barnhill Road/Derry Road and between the River Finn/Mourne River and the Great Northern Link.

Planning Applications

Fluvial Areas at Risk

Rivers Agency shall advise against the development of all sites that are located within the1% AEP fluvial floodplain, irrespective of whether they are located within a current development plan or as a single site application outside the plan area.

For those sites within the 1 in 100 year fluvial floodplain where the principle of development has been accepted by Planning NI as meeting the "Exception Test", Rivers Agency will further consider the application through the appraisal of an accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The main existing developed areas, amongst others, at flood risk within Strabane where re-development may be likely to take place are:-

- Areas in and around the town centre – for example, Bradley Way, Bridge Street, Main Street, Branch Road, Railway Street, Barnhill Road and Dock Street.

Areas at Risk of Surface Water Flooding

For those sites outside the 1 in 100 year fluvial floodplain that are located in an area where there is evidence of a history of surface water flooding (identified by flood hardship payments), Rivers Agency will further consider the application through the appraisal of the accompanying Drainage Assessment that will need to demonstrate suitable flood mitigation measures.

Where there is potential for surface water flooding as indicated in the 'purple' predicted areas on the Surface Water Maps, Rivers Agency will advise that the applicant should assess the flood risk and drainage impact to the site and construct in an appropriate manner.

The main areas identified in Strabane as being at surface water flood risk are behind the flood defences.

Areas at Risk of Flood Inundation from Reservoirs

For all development proposals that are located within the potential flood inundation area of a controlled reservoir Rivers Agency will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures. If it is a new development proposal River Agency will also need the applicant to demonstrate that the condition, management and maintenance regime of the reservoir is appropriate to provide sufficient assurance regarding reservoir safety.

The controlled reservoirs identified in the Strabane area are: - none.

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is, therefore, important that we continue to target investment by providing flood defence, culvert alleviation schemes, and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. The Flood Investment and Planning Group, FIPG, provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a "Flood Risk Metric Tool" (FRISM) is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total "damage avoidance benefits" that the scheme will provide to the property over the scheme's design life. If the benefit/cost ratio is greater than 1 (Net Present Value, NPV, figure is positive) the potential scheme will be referred to Rivers Agency's Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely Rivers Agency's responsibility, or is the responsibility of NI Water or Transport NI such as a local drainage or road infrastructure issue, it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a benefit cost analysis identifies a viable scheme, a scheme will then be placed on a prioritisation list for works with other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take anything from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Within the Strabane area the following potential schemes have been identified and will be referred to the appropriate bodies for further investigation or detailed feasibility study.

Possible Schemes in Strabane SFRA

Given the fluvial damages calculated it is proposed that the following watercourses are considered for Flood Alleviation Schemes and they are prioritised for the Works Study Programme:-

- Urney Road/Glenfinn Park (undesignated watercourse);
- Urney Road Drain and Urney Road Drain Extension;

- Park Road Drain; and
- Roundhill Drain.

As the fluvial damages for the following area are not considered high enough it will not be progressed to the Works Study Programme:-

- Lifford Road.

However, the rivers and flood banks will continue to be subject to routine maintenance by Rivers Agency.

Preparedness

In Strabane it is not possible to prevent or protect against all flooding. Indeed, even where flood defences exist it is possible in an extreme event that these could be over topped and flooding could still occur.

Having recognised this fact considerable effort in recent years has been made by emergency planners in Government Departments, Councils, and the Emergency Services working together and sharing information to ensure a coordinated response.

However, despite these improvements during significant flood events the emergency response of Government Departments and the Emergency Services can become over stretched. This means that not all calls for assistance during a flood event may be responded to in a timely manner. With this in mind it is important that households and communities, subject to a known flood risk, are prepared. The detail of preparedness actions including flood warning and informing activities planned from a regional perspective are provided in Annex E.

This is not Government withdrawing from any undertaking to respond in emergencies but an additional layer of support to ensure Government Departments and the public work together to reduce the overall impacts of flooding.

From the flood risk assessment there are 3 areas of Strabane which are subject to flood risk and may have flooded before. Therefore, they may benefit from the flood warning and informing proposals outlined in Annex D.

A pilot project of community engagement to deliver flood warning and informing, held in 2014, identified basic assessment formulae to assess and score areas that could potentially be a focus for flood warning and informing actions. Based on this scoring these areas did not score high enough to be placed within the top 20 communities to be offered a programme of community engagement during the period of this Plan. However, if communities want to become more resilient, the Department is committed to providing assistance were possible to develop the consistent approach to resilience. The NI Direct website www.nidirect.gov.uk/ will host further information and advice on what to do in advance of flooding, what to do during flooding and how to recover after flooding. The website will also contain templates for communities wishing to develop their own plan.

6.5 Londonderry Significant Flood Risk Area – River Foyle and River Faughan LMAs

The core boundary of the Londonderry SFRA, which has been determined through the PFRA, is located within River Foyle and River Faughan Local Management Areas (LMAs) and illustrated in Figure 6.5.1 below.

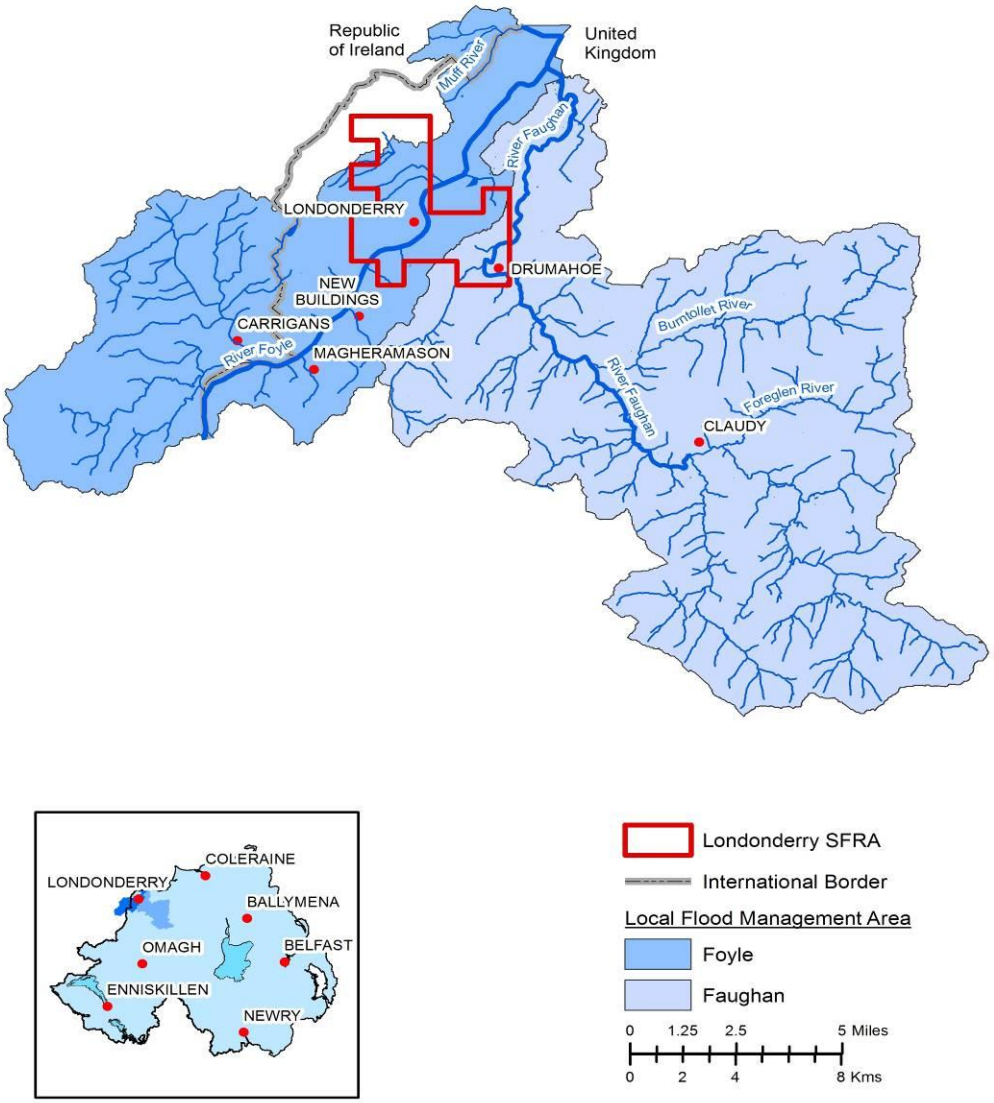


Figure 6.5.1 – Londonderry SFRA and LMAs

6.5.1 Flooding History

17 August 2004

The weather during August 2004 was unsettled with a number of heavy rainfall events affecting various parts of Northern Ireland. On the 17th a line of intense storms developed over Co. Tyrone during the day and became slow moving over the Derry City area during the late afternoon. It is estimated that 30mm of rain fell in the city centre area in less than an hour. The extreme rainfall overwhelmed drainage systems causing widespread flooding of the city centre. The floodwater inundated many commercial properties and homes, mainly in the Dunluce Road, Strand Road and Shantallow area. It also trapped a number of motorists who had to be rescued from their cars by the emergency services.

Recent Years

In recent years Rivers Agency has dealt mainly with isolated drainage problems many of which relate to surface water.

A number of major Schemes have been undertaken by Rivers Agency to address specific drainage and flood defence issues. They include culvert works at Shantallow, for the Springtown Tributary Extension and Coshquin Burn Extension, and flood defence works on the River Faughan at Drumahoe. There was also a major Scheme to divert some of the flow in the Skeoge River to the River Foyle. This Scheme enabled extensive development to take place on the west bank of the River Foyle.

6.5.2 PFRA – Identification of Potentially Significant Flood Sources

According to the Preliminary Flood Risk Assessment (Dec 2011) the City of Londonderry, in terms of the potential adverse consequences of flooding, is ranked 4th of the twenty SFRA within Northern Ireland (see Figure 4.1). On the basis of this initial assessment, which was undertaken using the strategic flood maps, the predominant flood risk to the City was considered to arise from fluvial flooding.

It should be noted that the PFRA flagged up the potential for significant fluvial flooding at Londonderry because this national assessment is based on strategic 'undefended' flood models which ignore the presence of existing flood defences. Therefore, the assessment is in effect based on the worst case scenario, as it assumes there is no benefit from the defences. This precautionary approach has been taken because at the time of the assessment there was a degree of uncertainty about the level of protection that each of the existing flood defence systems provides. By adopting this approach, the urban areas that are located behind existing flood defence structures were determined to be SFRA by default and as a consequence detailed Flood Hazard/Risk Maps had to be prepared in compliance with the requirements of the EU Directive. This provided the opportunity to undertake the detailed structural assessments and flood modelling necessary to remove the uncertainty and establish the actual level of protection offered by these

defences. The detailed flood maps will, therefore, give a more accurate prediction of the flooded areas that may have been over estimated/under estimated or missed by the strategic flood maps.

6.5.3 Catchment Description

The Foyle System is located in Northern Ireland and accounts for a significant portion of the country west of Lough Neagh. There are a large number of tributaries and some of the headwaters are located in the Republic of Ireland.

Only downstream of Strabane to its tidal outfall at Londonderry is the watercourse known as the River Foyle. Upstream of this point various tributaries combine to form the channel, some of which were represented by hydraulic models in a study. The main channel, from its headwaters near Fintona, has a variety of different names discussed below.

At its upstream extent, the main channel which eventually becomes the Foyle is known as the Quiggery River; this has its headwaters around the town of Fintona in County Tyrone, flowing for 16 km until it reaches the town of Omagh. Before reaching Omagh it is briefly known as the Drumragh River. At this point it is joined by the Camowen River (also modelled); this watercourse rises near Six Mile Cross. Downstream of the confluence the watercourse is known as the Strule River and flows for a further 20 km until it is joined by the Owenkillew River at Newtownstewart. Downstream of the town the watercourse is the River Mourne until its confluence with the Finn River at Strabane, after which it is the River Foyle. From Strabane the river is tidal. The catchment at Strabane is shown in Figure 1-1. Another tributary which was modelled as part of the study is the River Derg, which joins the River Mourne near Newtownstewart.

As stated previously, the Foyle study area includes three smaller watercourses which drain the coastal land to the east of Londonderry, all of which discharge to the tidal Lough Foyle. None of these are hydraulically linked with the Foyle catchment. The most easterly of these is the River Roe, flowing through the towns of Dungiven and Limavady. Muff River drains a much smaller catchment (29 km2), flowing through Eglinton. To the west is the River Faughan, a larger system draining 296 km2 of land around Claudy and Drumahoe. These catchments are also shown in Figure 6.5.3.1.

Foyle System

The Foyle is one of the fastest flowing rivers in Europe for its size, and is tidal for its entire length (where the Mourne River joins the Finn at Strabane). Londonderry was developed around the river as a trading port. The Foyle is navigable for much of its length.

Figure 6.5.3.1 – Location of the Foyle River system

In addition to the main channel and tributaries, there are also a number of surface water bodies in the Foyle catchment. Most of these features are small, spread across the large catchment and are likely to have little impact on the attenuation of flood flows. The most significant surface water feature is Lough Derg, in the River Derg tributary catchment. This lake is located across the border in the Republic of Ireland.

Northern Ireland has a temperate climate with relatively mild winters and cool summers. Rainfall in the country is generally associated with Atlantic depressions or with convectional storms. The wetter areas of the country are generally the western counties, including Londonderry and Tyrone (which account for much of the Foyle System). Highest average annual rainfalls in the country of 1950 mm occur near Killeter Forest in County Tyrone (in the River Derg catchment) and the Derg is the wettest catchment.

The majority of the Foyle catchment is underlain by Ordovician-Silurian shale tills with acidic brown soils. In the upper catchment around Omagh there are areas of gleys and sandstone tills. Headwaters of the tributaries contain a variety of soil types and geologies; the western catchments have areas of peat and the eastern catchments have areas of peaty gleys. None of the Foyle catchment is particularly permeable.

Land use in the catchment is predominantly rural. There are a number of large settlements upstream of Strabane including Omagh, Newtownstewart, Sion Mills and Castlederg, but these are small in comparison to the overall catchment area.

To facilitate a more robust assessment of the level of flood risk to Londonderry from rivers, Rivers Agency developed detailed predictive flood models for this source. Details of the models and their output are described in following sections.

6.5.4 Coastal Flood Risk Assessment

Coastal Model

Lough Foyle is a complex tidal estuary with a narrow entrance and many irregular features, including numerous drying shoals. There were numerous channels and fluvial inputs which were accounted for in the model as was the tidal prism of the River Foyle.

The tidal simulations for Lough Foyle were undertaken using the MIKE 21 HD model, which is the basic module in the MIKE 21 package and is a sub-model driven by the Irish Surge and Tidal Model that is used to determine extreme sea levels around the non-estuarine coastline of Ireland. The HD Module is a 2-dimensional, depth averaged hydrodynamic model which simulates the water level variations and flows in response to a variety of forcing functions in lakes, estuaries and coastal areas. The water levels and flows were resolved on a rectangular grid covering the area of interest when provided with the bathymetry, bed resistance coefficient, wind field, hydrographic boundary conditions, etc.

Coastal Flooding Mechanisms

Figures 6.5.4.1 and 6.5.4.2 illustrate the predicted extents and depths of the potential flooding from the River Foyle and details of the impact of the flooding on property and key infrastructure is summarised in Table 6.5.4.2. Londonderry has no formal sea defences, however, the banks/quays act as a form of coastal defence that provides limited protection to the low lying areas of the City. The coastal modelling predicts that at the 10% AEP tidal event flooding would take place due to overtopping of the quay at the Foyle Embankment and the banks at or near the Pennyburn Stream outlet to the Foyle. At the 2% AEP event overtopping of banks/quays would also take place near the Craigavon Bridge, at Queen's Quay and the McFarland Quay. At the other modelled events 1 in 75, 1 in 100, 1 in 200 and 1 in 200 climate change, the extent of the flooded areas increases but the overtopping of the quays/banks would continue in these five areas. Flooding could be up to 1m at the more extreme events. The water levels for various return periods are shown below. There are no flooding hot spots in the vicinity and no records to indicate that Rivers Agency has responded to localised flooding problems. From Table 6.5.4.2, flooding from the 0.5% AEP event is estimated to affect 94 residential and 237 non-residential properties with a damage cost of around £7,635,120. The total water levels for various return periods are shown below in Table 6.5.4.1.

Return Period (Year)	Total Water Level (OD Belfast)
2	2.056
10	2.296
50	2.531
75	2.593
100	2.635
200	2.735
1000	2.971

Table 6.5.4.1 – Return Period/Total Water Level

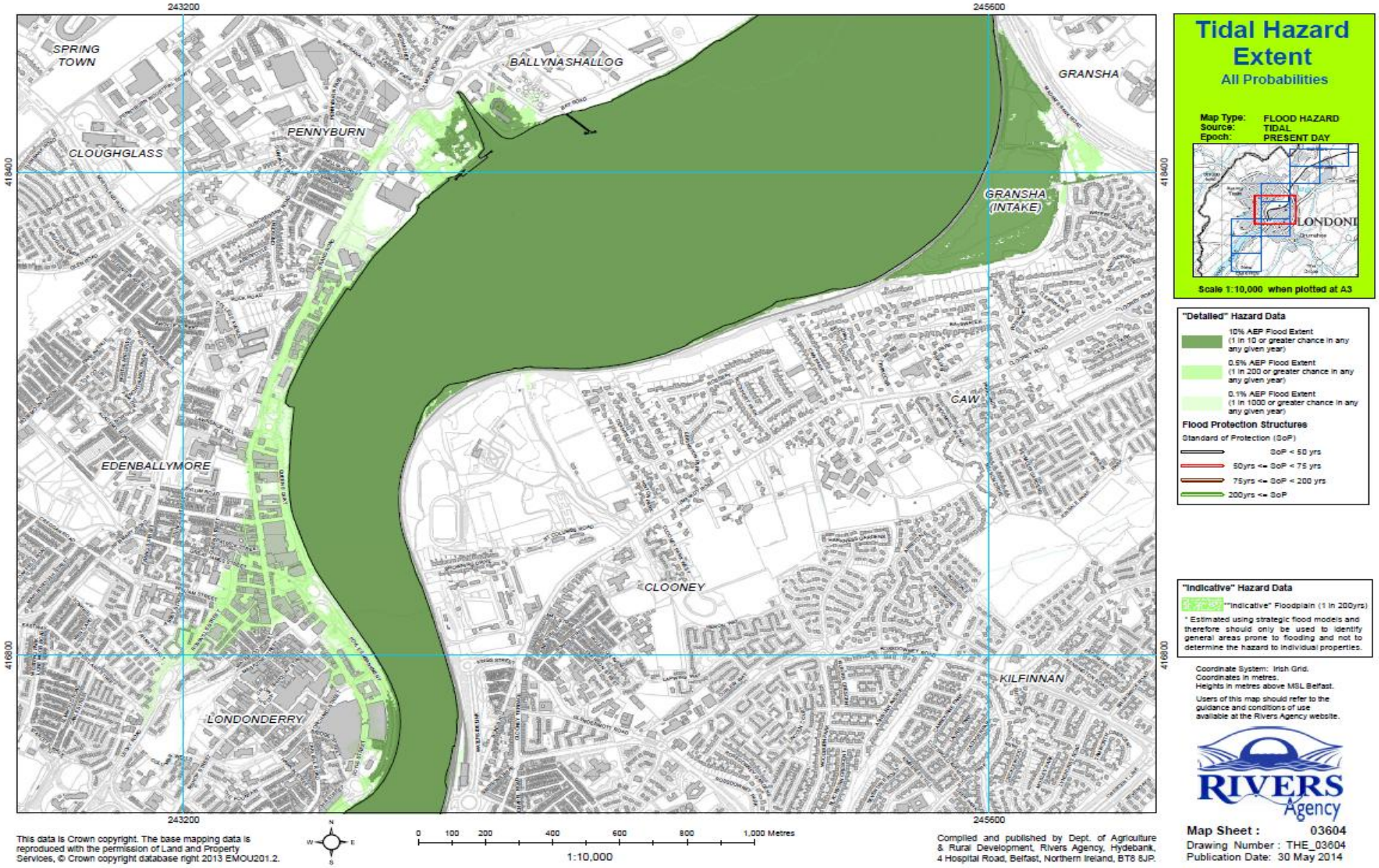


Figure 6.5.4.1 - Londonderry Coastal Hazard Extent Map

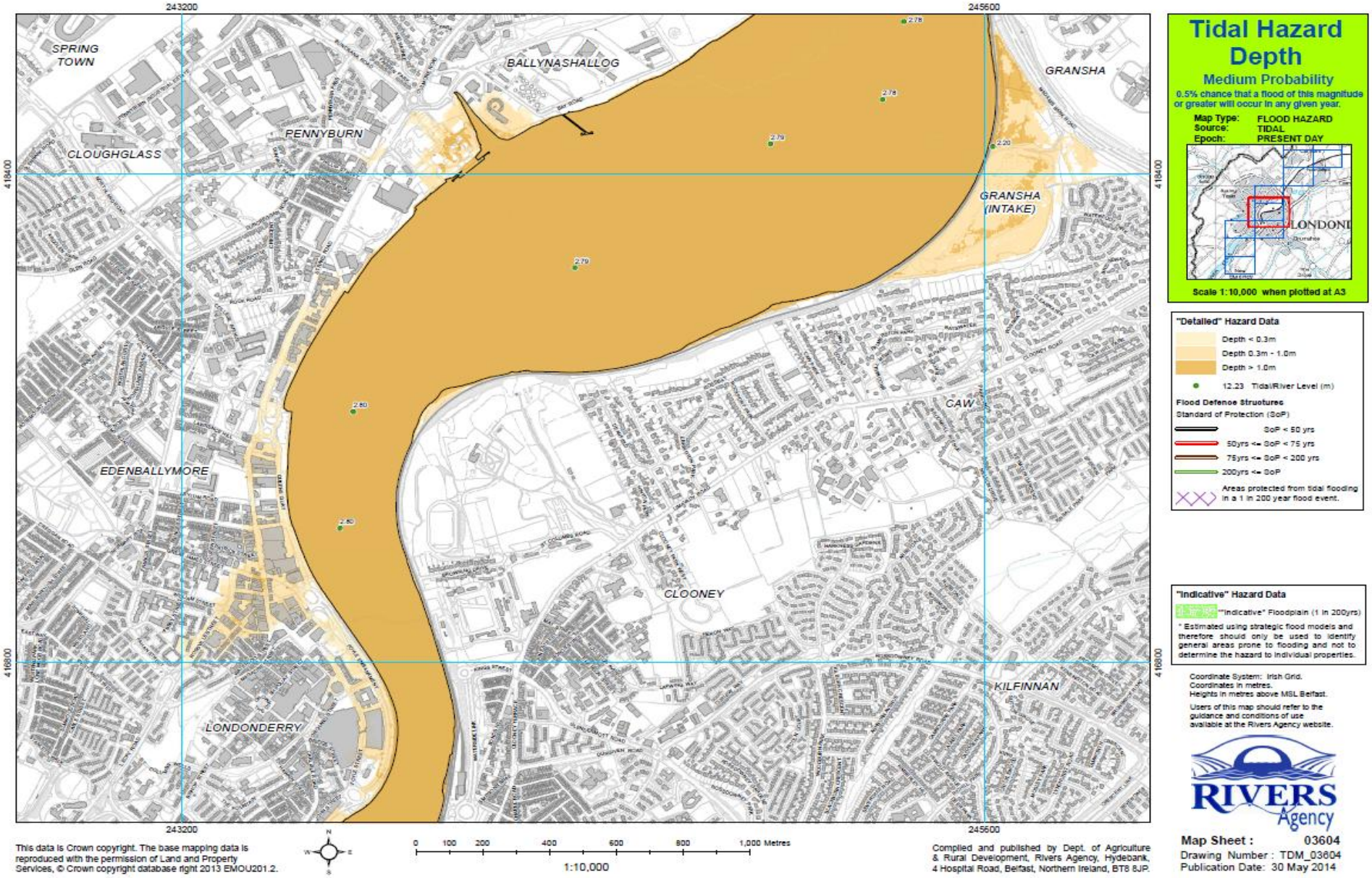


Figure 6.5.4.2 - Londonderry Coastal Hazard Depth Map 0.5%AEP

Table 6.5.4.2 - Londonderry SFRA			
Potential Adverse Consequences – Coastal Flooding			
	Flood Event % AEP		
	10% AEP	**0.5% AEP**	**0.1% AEP**
Residential (Nr)	**2**	94	147
Non Residential (Nr)	**8**	**237**	**281**
Economic Damage (£)	£103,555	£13,339,440	£25,814,915
Annual Average Damage (£)	£254,504		
Present Value (£)	**£7,635,120**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)	**0**	3	3
Care Homes			
GP Surgery's		**2**	**2**
Fire stations			
Hospitals			
Police Stations		**1**	**1**
Schools			
Key Infrastructure (Nr)		**45**	**51**
NIW Wastewater Treatment Works			
NIW Sewage Pumping Stations		**3**	**3**
NIW Water Treatment Work			
NIW Treated Water Pumping Stations			
NIE Substation 6to11kV		**19**	**22**
NIE Substation 33kV			**1**
NIE Substation 275kV			
NIE Substation 110kV			
Road Service - Trunk Road		**23**	**25**
Environmental Designated sites (Nr)		**0**	**0**
AONB			
ASSI			
Environmentally Sensitive Areas			
Maritime Nature Reserve			
Nature Reserve			
RAMSAR			
SAC			
Sites of Local Nature Conservation Importance			
SPA			
RSPB Reserve			
UWT Nature Reserve			
Built Heritage sites (Nr)		**15**	**31**
National Trust			
Listed Buildings		**15**	**27**
Sites and Monuments Records			**4**
Buildings of Special Architectural or Historical Interest			
Areas of Significant Archaeological Interest			
Historic Gardens			

6.5.5 Fluvial Flood Risk Assessment

Flood Model

The model used to assess the fluvial risk to Londonderry settlement is an Infoworks ICM 2D model, developed by a Rivers Agency Consultant. There has been cooperation between the Office of Public Works in the Republic of Ireland and Rivers Agency regarding the sharing of information on the Skeoge which has its source in Donegal.

Fluvial Flooding Mechanisms

Londonderry – East Side of River Foyle

Figure 6.5.5.1 illustrates the predicted extents of the potential flooding from the Ardnabrocky Drain and details of the impact of the flooding on property and key infrastructure is summarised in Table 6.5.5.1. The fluvial modelling predicts that flooding would first take place at the 50% AEP (1 in 2 year) event. There is little change in the extent or depth (less than 300mm) of flooding up to and including the1% AEP (1 in 100 year) event. This may be due to the topography of the site. Storm drainage would have to be taken into consideration (it may significantly reduce the affect of flooding). There is a change in pipe diameter from 250mm to 600mm diameter which may exacerbate the situation. There are no flooding reports. From Table 6.5.5.1, flooding from the 1% AEP event is estimated to affect 4 residential and 6 non-residential properties with a damage cost of around £629,400.

Figure 6.5.5.2 illustrates the predicted extent of the potential flooding from the Burnagibbagh and details of the impact of the flooding on property and key infrastructure is summarised in Table 6.5.5.2. The fluvial modelling predicts that there would be flooding just upstream of the confluence of the Burnagibbagh with the River Faughan. At the 50% AEP (1 in 2 year) event the Burnagibbagh would overflow and at the 4% AEP (1 in 25 year) event, flooding of houses would take place. The 1% AEP (1 in 100 year) event would affect many houses with depths up to 1m. Culverts at Church Brae and Ivy Mead may restrict flows and thus contribute to the flooding. There are no flooding hot spots in the vicinity though records indicate that Rivers Agency has responded to localised flooding problems. From Table 6.5.5.2, flooding from the 1% AEP event is estimated to affect 76 residential and 13 non-residential properties with a damage cost of around £815,820.

Figure 6.5.5.3 illustrates the predicted extent of the potential flooding from the Woodburn Park Stream and details of the impact of the flooding on property and key infrastructure is summarised in Table 6.5.5.3. The fluvial modelling predicts that water would spill from a manhole in Glenshane Road and 3 manholes immediately downstream at the1% AEP (1 in 100 year) event. In this event properties and roads would be affected but generally the flow would be shallow, less than 300mm. There are no hot spots associated with the flooding and there is no evidence of property flooding. The culvert has Structural Grades of 1 or 2 in the

immediate vicinity of the manholes that would overflow, so there are no structural problems nearby. From Table 6.5.5.3, flooding from the 1% AEP event is estimated to affect 74 residential and 41 non-residential properties with a damage cost of around £179,820.

Londonderry – West Side of River Foyle

Watercourses flow into the either the River Foyle or the Skeoge watercourse which enters the Republic of Ireland after a short distance. The Ballymagroarty Headwater Diversion watercourse may be diverted to either the River Foyle or the Skeoge. In the 1990s the Skeoge Diversion Scheme diverted some of the flow which would have passed into the RoI via the Skeoge to the River Foyle. This Scheme enabled extensive development to take place.

Figure 6.5.5.4 illustrates the predicted extents of the potential flooding from the Pennyburn Stream and details of the impact of the flooding on property and key infrastructure is summarised in Table 6.5.5.4. The fluvial modelling predicts that water would spill from manholes near the junction of the Buncrana and Balliniska Road with flooding first appearing at the 20% AEP (1 in 5 year) event. At the 1% AEP (1 in 100) event, large parts of the Balliniska Business Park and a section of the Springtown Industrial Estate would be affected by flooding with depths of up to 1m. There are no flooding hot spots in the vicinity and no records to indicate that Rivers Agency has responded to localised flooding problems. From Table 6.5.5.4, flooding from the 1% AEP event is estimated to affect 55 non-residential properties with a damage cost of around £833,970.

Figure 6.5.5.5 illustrates the predicted extents of the potential flooding from the Creggan Burn and details of the impact of the flooding on property and key infrastructure is summarised in Table 6.5.5.5. The fluvial modeling predicts that flooding would take place in the vicinity of the Glen Road and Northland Road. Initially the roads would be affected at the 50% AEP (1 in 2 year) event. At the 4% AEP (1 in 25) event, houses and other buildings would begin to be affected and at the1% AEP (1 in 100 year) event the depth of the flood water would be generally less than 300mmm but on the Glen Road the depth of water would be up to 1m. Shallow flooding (generally less than 300mm) would also occur in the valley between Glen Road and Creggan Lower Reservoir. The modelling would suggest inadequate capacity in the culvert. It should be noted that the reservoirs may provide some flood attenuation in certain conditions. With respect to the structural condition, most of the culvert between Creggan Lower Reservoir and Northland Road is either Structural Grade 1 or 2. However, a section of culvert near the Creggan Lower Reservoir is Structural Grade 4 and a section at Glen Road is Structural Grade 3. There are no flooding hot spots in the vicinity and no records to indicate that Rivers Agency has responded to localised flooding problems. From Table 6.5 5.5, flooding from the 1% AEP event is estimated to affect 13 residential and 4 non-residential properties with a damage cost of around £33,480.

Coolkeeragh

The Coolkeeragh Power Station is in an area of further study rather than a significant flood risk area. Nevertheless, this area is considered as the Power Station is key infrastructure. The modelling predicts flooding of the Power Station site as the railway embankment is not a designated sea defense and is, therefore, ignored in the modelling. In practice the railway embankment acts as a form of sea defense and the Power Station site is unlikely to flood from the sea. However, there is always a risk that the railway embankment could fail with catastrophic consequences. There are no flooding hot spots in the vicinity and no records to indicate that Rivers Agency has responded to localised flooding problems.

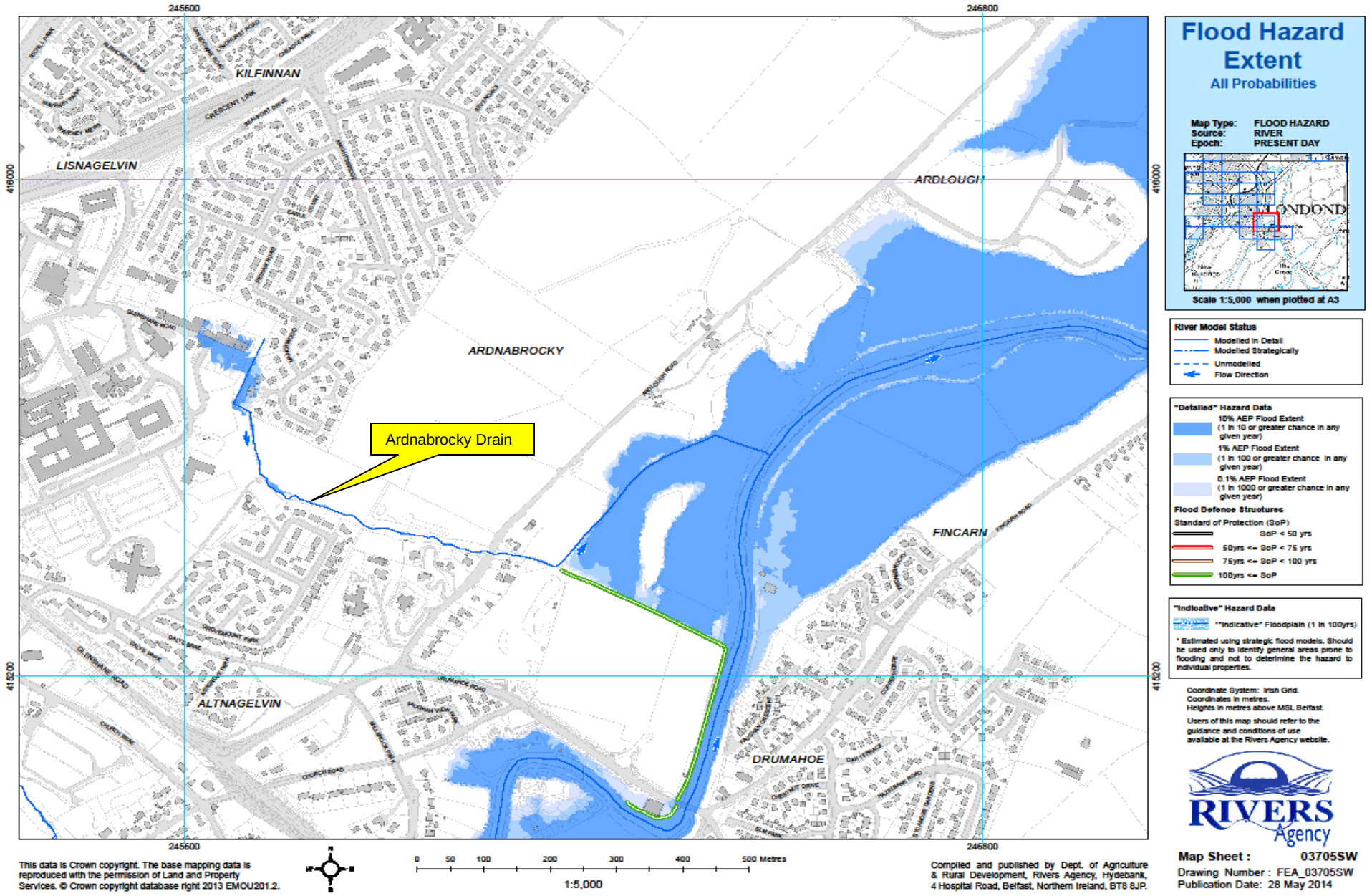


Figure 6.5.5.1 - Flood Hazard Extent Map for Ardnabrocky Drain, Londonderry

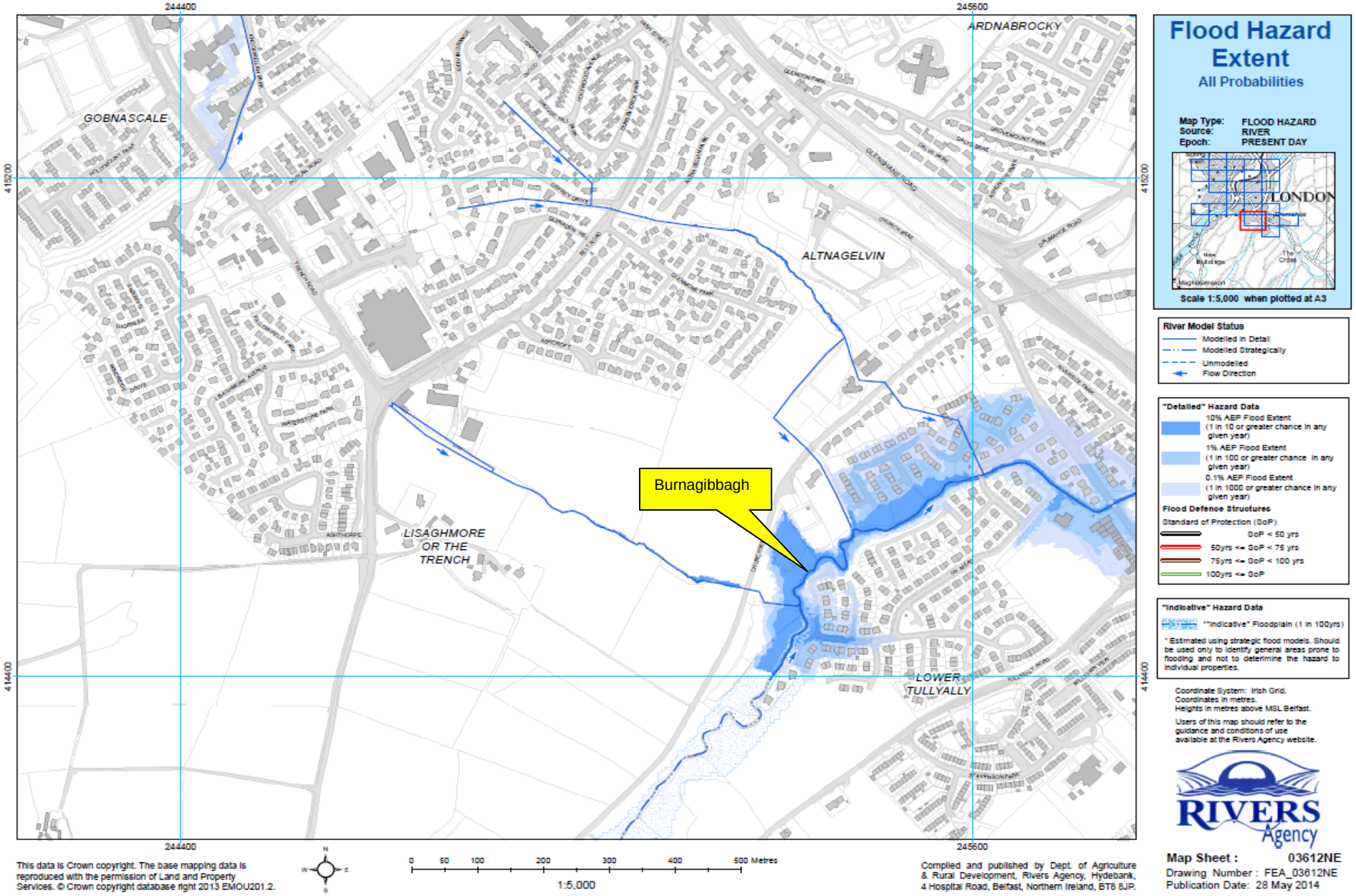


Figure 6.5.5.2 - Flood Hazard Extent Map for Burnagibbagh, Londonderry

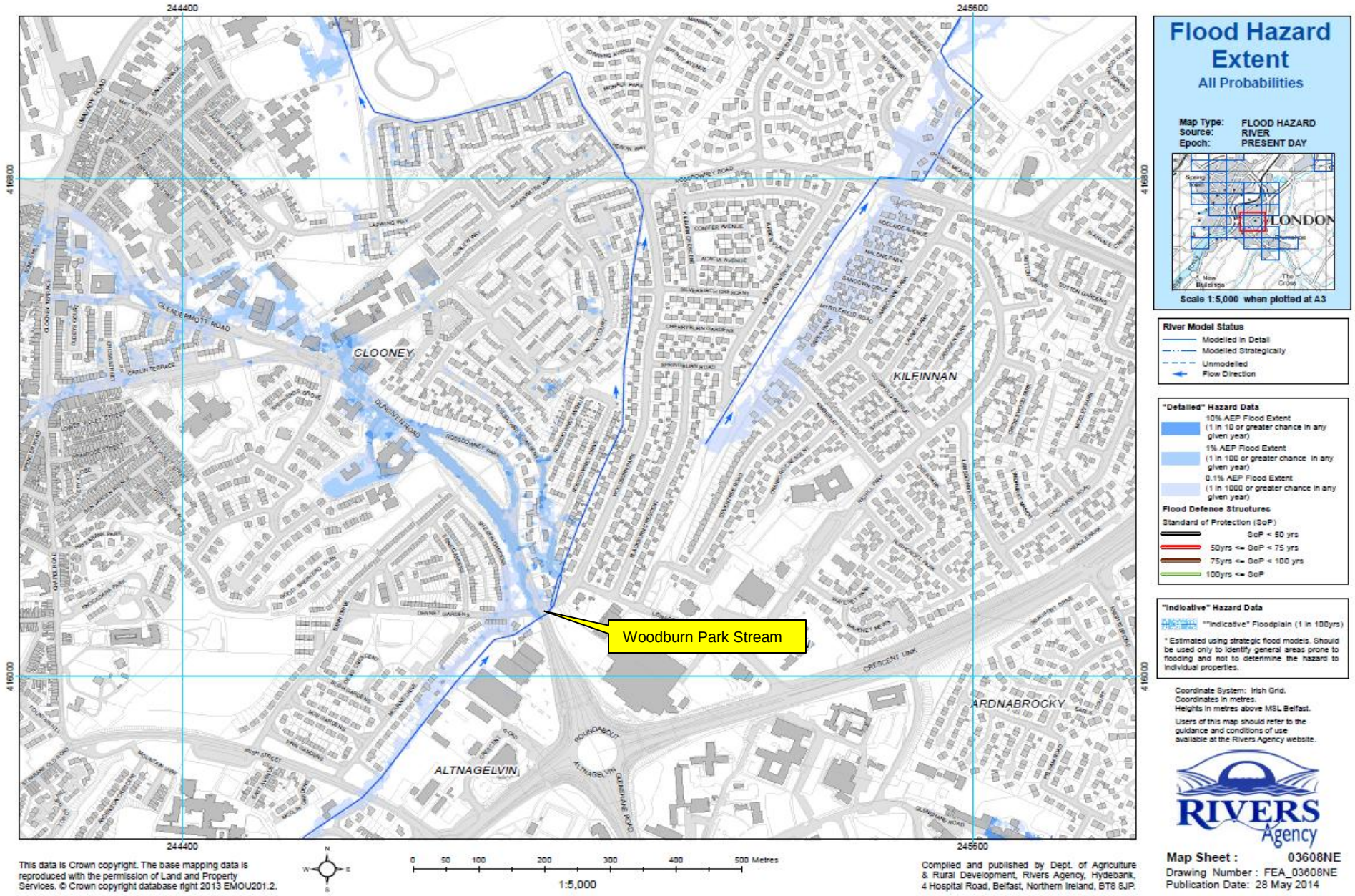


Figure 6.5.5.3 - Flood Hazard Extent Map for Woodburn Park Stream Waterside, Londonderry

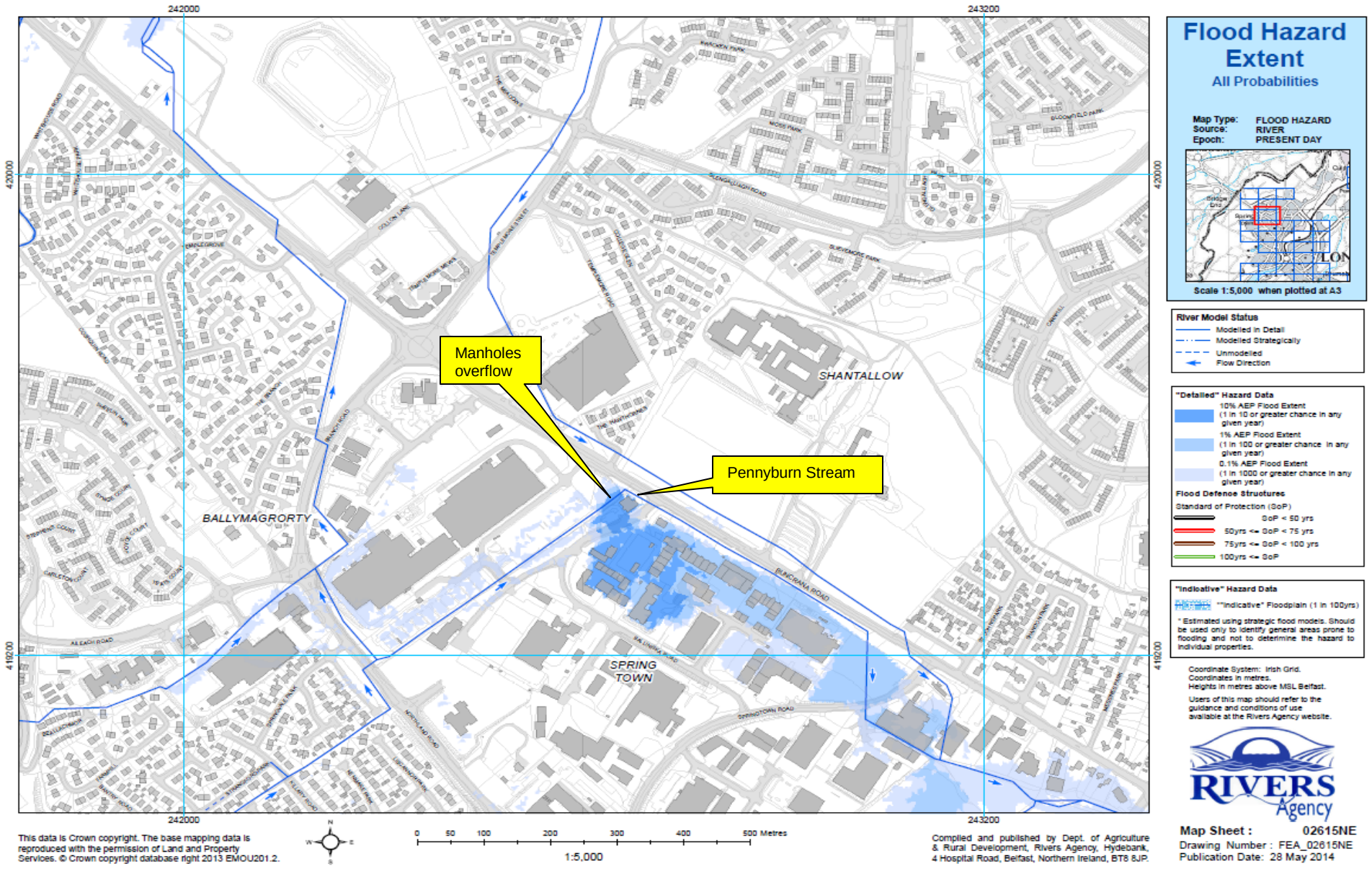


Figure 6.5.5.4 - Flood Hazard Extent Map for Pennyburn Stream, Londonderry

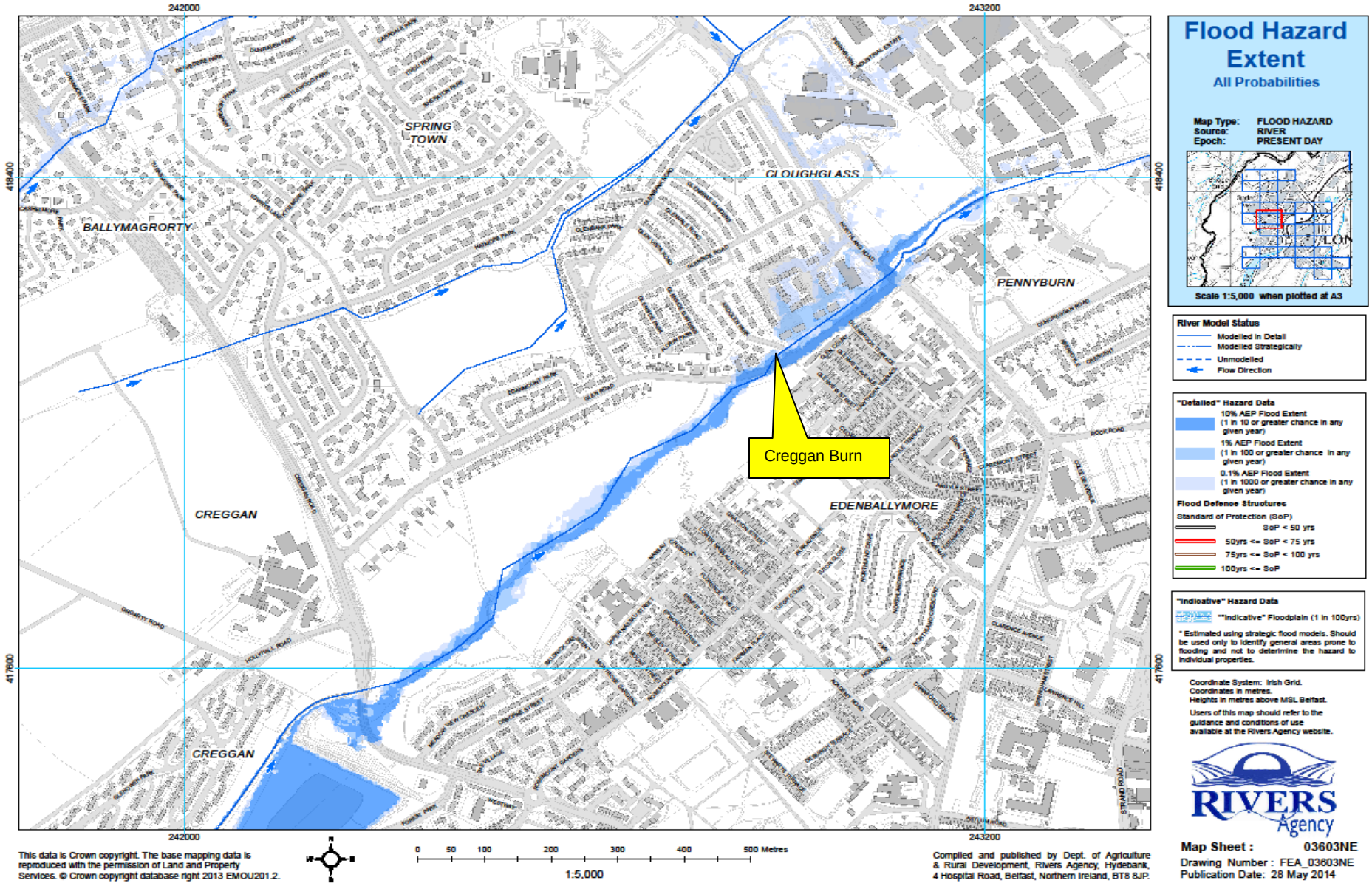


Figure 6.5.5.5 - Flood Hazard Extent Map for Creggan Burn, Londonderry

Table 6.5.5.1 - Londonderry SFRA – Ardnabrocky Drain			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	**4**	**4**	**4**
Non Residential (Nr)	**6**	**6**	**6**
Economic Damage (£)	**£31,142**	**£32,902**	**£39,570**
Annual Average Damage (£)	**£20,980**		
Present Value (£)	**£629,400**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)	**0**	0	0
Care Homes GP Surgery's Fire stations Hospitals Police Stations Schools			
Key Infrastructure (Nr)	**0**	**0**	**0**
NIW Wastewater Treatment Works NIW Sewage Pumping Stations NIW Water Treatment Work NIW Treated Water Pumping Stations NIE Substation 6to11kV NIE Substation 33kV NIE Substation 275kV NIE Substation 110kV Road Service - Trunk Road			
Environmental Designated sites (Nr)	**0**	**0**	**0**
AONB ASSI Environmentally Sensitive Areas Maritime Nature Reserve Nature Reserve RAMSAR SAC Sites of Local Nature Conservation Importance SPA RSPB Reserve UWT Nature Reserve			
Built Heritage sites (Nr)	**0**	**0**	**0**
National Trust Listed Buildings Sites and Monuments Records Buildings of Special Architectural or Historical Interest Areas of Significant Archaeological Interest Historic Gardens			

Table 6.5.5.2 - Londonderry SFRA – Burnagibbagh			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	**1**	**17**	**76**
Non Residential (Nr)	**0**	**0**	**13**
Economic Damage (£)	**0**	**£14,064**	**£409,788**
Annual Average Damage (£)	**£27,194**		
Present Value (£)	**£815,820**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)	**0**	0	0
Care Homes GP Surgery's Fire stations Hospitals Police Stations Schools			
Key Infrastructure (Nr)	**0**	**0**	**2**
NIW Wastewater Treatment Works NIW Sewage Pumping Stations NIW Water Treatment Work NIW Treated Water Pumping Stations NIE Substation 6to11kV NIE Substation 33kV NIE Substation 275kV NIE Substation 110kV Road Service - Trunk Road			**2**
Environmental Designated sites (Nr)	**0**	**0**	**0**
AONB ASSI Environmentally Sensitive Areas Maritime Nature Reserve Nature Reserve RAMSAR SAC Sites of Local Nature Conservation Importance SPA RSPB Reserve UWT Nature Reserve			
Built Heritage sites (Nr)	**0**	**0**	**0**
National Trust Listed Buildings Sites and Monuments Records Buildings of Special Architectural or Historical Interest Areas of Significant Archaeological Interest Historic Gardens			

Table 6.5.5.3 - Londonderry SFRA – Woodside Park Stream			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	**8**	**34**	**74**
Non Residential (Nr)	**6**	**27**	**41**
Economic Damage (£)	**£1,067**	**£40,079**	**£115,324**
Annual Average Damage (£)	**£5,994**		
Present Value (£)	**£179,820**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)	**0**	0	0
Care Homes GP Surgery's Fire stations Hospitals Police Stations Schools			
Key Infrastructure (Nr)	**0**	**4**	**5**
NIW Wastewater Treatment Works NIW Sewage Pumping Stations NIW Water Treatment Work NIW Treated Water Pumping Stations NIE Substation 6to11kV NIE Substation 33kV NIE Substation 275kV NIE Substation 110kV Road Service - Trunk Road		**2** **2**	**2** **3**
Environmental Designated sites (Nr)	**0**	**0**	**0**
AONB ASSI Environmentally Sensitive Areas Maritime Nature Reserve Nature Reserve RAMSAR SAC Sites of Local Nature Conservation Importance SPA RSPB Reserve UWT Nature Reserve			
Built Heritage sites (Nr)		**1**	**1**
National Trust Listed Buildings Sites and Monuments Records Buildings of Special Architectural or Historical Interest Areas of Significant Archaeological Interest Historic Gardens		**1**	**1**

Table 6.5.5.4 - Londonderry SFRA – Pennyburn Stream			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	**0**	**0**	**0**
Non Residential (Nr)	**22**	**45**	**55**
Economic Damage (£)	**£37,064**	**£133,699**	**£592,714**
Annual Average Damage (£)	**£27,799**		
Present Value (£)	**£833,970**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)	**0**	0	0
Care Homes GP Surgery's Fire stations Hospitals Police Stations Schools			
Key Infrastructure (Nr)	**3**	**4**	**7**
NIW Wastewater Treatment Works NIW Sewage Pumping Stations NIW Water Treatment Work NIW Treated Water Pumping Stations NIE Substation 6to11kV NIE Substation 33kV NIE Substation 275kV NIE Substation 110kV Road Service - Trunk Road	 **2** **1**	 **3** **1**	 **6** **1**
Environmental Designated sites (Nr)	**0**	**0**	**0**
AONB ASSI Environmentally Sensitive Areas Maritime Nature Reserve Nature Reserve RAMSAR SAC Sites of Local Nature Conservation Importance SPA RSPB Reserve UWT Nature Reserve			
Built Heritage sites (Nr)	**0**	**0**	**0**
National Trust Listed Buildings Sites and Monuments Records Buildings of Special Architectural or Historical Interest Areas of Significant Archaeological Interest Historic Gardens			

Table 6.5.5.5 - Londonderry SFRA – Creggan Burn			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	**1**	**5**	**13**
Non Residential (Nr)	**1**	**2**	**4**
Economic Damage (£)	**£679**	**£2,962**	**£24,412**
Annual Average Damage (£)	**£1,116**		
Present Value (£)	**£33,480**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)	**0**	0	0
Care Homes GP Surgery's Fire stations Hospitals Police Stations Schools			
Key Infrastructure (Nr)	**1**	**1**	**1**
NIW Wastewater Treatment Works NIW Sewage Pumping Stations NIW Water Treatment Work NIW Treated Water Pumping Stations NIE Substation 6to11kV NIE Substation 33kV NIE Substation 275kV NIE Substation 110kV Road Service - Trunk Road	**1**	**1**	**1**
Environmental Designated sites (Nr)	**0**	**0**	**0**
AONB ASSI Environmentally Sensitive Areas Maritime Nature Reserve Nature Reserve RAMSAR SAC Sites of Local Nature Conservation Importance SPA RSPB Reserve UWT Nature Reserve			
Built Heritage sites (Nr)	**0**	**0**	**0**
National Trust Listed Buildings Sites and Monuments Records Buildings of Special Architectural or Historical Interest Areas of Significant Archaeological Interest Historic Gardens			

6.5.6 Proposed Flood Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Londonderry it is important that the flood risk is not increased by new development in areas of known flood risk. Planning Policy Statement, PPS 15, "Planning and Flood Risk", adopts a precautionary approach to development with the primary aim "to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere".

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the "Exception" rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to "Greenfield" built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new Development Plans for Londonderry, Rivers Agency advises against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 100 year fluvial floodplain/1 in 200 year coastal floodplain/reservoir inundation area or is susceptible elsewhere to surface water flooding.

Rivers Agency shall also review the existing Development Plan for Londonderry with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

The main (undeveloped) flooded areas, amongst others, within the Londonderry Significant Flood Risk Area are:-

- Areas within the floodplain of the River Faughan – for example near Ardlough Road.

Planning Applications

Fluvial/Coastal Areas at Risk

Rivers Agency shall advise against the development of all sites that are located within the 1 in 100 year fluvial floodplain/1 in 200 year coastal floodplain, irrespective of whether they are located within a current development plan or as a single site application outside the plan area.

For those sites within the 100 year fluvial floodplain/1 in 200 year coastal floodplain where the principle of development has been accepted by Planning NI as meeting the "Exception Test", Rivers Agency will further consider the application through the appraisal of an accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The main existing developed areas, amongst others, at flood risk within Londonderry where re-development may be likely to take place are:-

- The low lying areas behind the quays on the west side of the Foyle – for example, Foyle Street, Water Street, Foyle Embankment, Queens Quay, Strand Road and Rossville Street.

Areas at Risk of Surface Water Flooding

For those sites outside the 1 in 100 year AEP fluvial floodplain/1 in 200 year coastal floodplain that are located in an area where there is evidence of a history of surface water flooding (identified by flood hardship payments), Rivers Agency will further consider the application through the appraisal of the accompanying Drainage Assessment that will need to demonstrate suitable flood mitigation measures.

Where there is potential for surface water flooding as indicated in the 'purple' predicted areas on the Surface Water Maps, Rivers Agency will advise that the applicant should assess the flood risk and drainage impact to the site and construct in an appropriate manner.

The main areas identified in Londonderry as being at surface water flood risk are:-

- The low lying areas behind the quays on the west bank of the Foyle – for example, Foyle Street, Strand Road and Rossville Street.

Areas at Risk of Flood Inundation from Reservoirs

For all development proposals that are located within the potential flood inundation area of a controlled reservoir we will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures. If it is a new development proposal we will also need the applicant to demonstrate that the condition, management and maintenance regime of the reservoir is appropriate to provide sufficient assurance regarding reservoir safety.

The controlled reservoirs identified in the Londonderry area are:-

- Creggan Lower; and
- Creggan Upper.

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is, therefore, important that we continue to target investment by providing flood defence, culvert alleviation schemes, and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. The Flood Investment and Planning Group, FIPG, provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a "Flood Risk Metric Tool" (FRISM) is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total "damage avoidance benefits" that the scheme will provide to the property over the scheme's design life. If the benefit/cost ratio is greater than 1 (Net Present Value, NPV, figure is positive) the potential scheme will be referred to Rivers Agency's Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely Rivers Agency's responsibility, or is the responsibility of NI Water or Transport NI such as a local drainage or road infrastructure issue, it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a benefit cost analysis identifies a viable scheme, a scheme will then be placed on a prioritisation list for works with other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take anything from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Within the Londonderry area the following potential schemes have been identified and will be referred to the appropriate bodies for further investigation or detailed feasibility study.

Possible schemes in Londonderry SFRA

Coastal

Given the coastal damages calculated it is proposed that the City is considered for a Flood Alleviation Scheme and it should be prioritised for the Works Study Programme.

Fluvial

Given the fluvial damages calculated it is proposed that the following watercourses are considered for Flood Alleviation Schemes and prioritised for the Works Study Programme:-

- Ardnabrocky Drain;
- Burnagibbagh;
- Woodburn Park Stream; and
- Pennyburn Stream.

As the fluvial damages for the following watercourse is not considered high enough it will not be progressed to the Works Study Programme:-

- Creggan Burn.

However, it will continue to be subject to routine maintenance by Rivers Agency.

Coolkeeragh (Power Station)

There has been ongoing liaison between Rivers Agency and Electricity Supply Board (ESB) regarding the tidal flood risk at this site.

Preparedness

Fluvial

In Londonderry it is not possible to prevent or protect against all flooding. Indeed, even where flood defences exist it is possible in an extreme event that these could be over topped and flooding could still occur.

Having recognised this fact considerable effort in recent years has been made by emergency planners in Government Departments, Councils, and the Emergency Services working together and sharing information to ensure a coordinated response.

However, despite these improvements during significant flood events the emergency response of Government Departments and the Emergency Services can become over stretched. This means that not all calls for assistance during a flood event may be responded to in a timely manner. With this in mind it is important that households and communities, subject to a known flood risk, are prepared. The detail of preparedness actions including flood warning and informing activities planned from a regional perspective are provided in Annex E.

This is not Government withdrawing from any undertaking to respond in emergencies but an additional layer of support to ensure Government Departments and the public work together to reduce the overall impacts of flooding.

From the flood risk assessment there are 4 areas of Londonderry subject to flood risk and may have flooded before. Therefore, they may benefit from the flood warning and informing proposals outlined in Annex D.
A pilot project of community engagement to deliver flood warning and informing, held in 2014, identified basic assessment formulae to assess and score areas that could potentially be a focus for flood warning and informing actions. Based on this scoring these areas did not score high enough to be placed within the top 20 communities to be offered a programme of community engagement during the period of this Plan. However, if communities want to become more resilient, the Department is committed to providing assistance were possible to develop the consistent approach to resilience. The NI Direct website www.nidirect.gov.uk/ will host further information and advice on what to do in advance of flooding, what to do during flooding and how to recover after flooding. The website will also contain templates for communities wishing to develop their own plan.

Coastal Flood Response Plans

Coastal flooding has the potential to have a significant impact in terms of risk to life. This is mainly due to the rate of inundation from the sea at the height of the tidal cycle. In light of this the emergency response to

significant coastal flooding with a risk to life will be led by PSNI and evacuation of potentially affected areas will be a real consideration.

To ensure a co-ordinated approach local, tactical Coastal Flooding Emergency Response Plans are being developed for Londonderry. This will link to a strategic Coastal Flooding Emergency Response Plan.
The Coastal Flood Response Plan aims to provide a pre-planned response to a warning of coastal flooding and outline the graduated incident and co-ordinated inter-agency response to a potential or actual coastal flooding event.

The objectives of the plan are to:-

- Identify activation triggers for responding to a coastal flood warning or incident;
- Document the actions to be taken on receipt of a coastal flood warning;
- Set out the process for a co-ordinated response including the graduated incident management of a potential or actual coastal flooding event; and
- Ensure a common understanding of the potential impacts of a coastal flooding event in each area and act as a reference document for all the agencies involved to provide a pre-planned response at various levels of coastal flood risk.

Section 7

North East River Basin District

Identified Flood Risk

7.1 River Basin Overview

This Flood Risk Management Plan refers to the North Eastern River Basin District which has a land area of just over 3000km², with a further 1000km² of marine waters. It takes in large parts of Counties Antrim, County Down and a small portion of County Londonderry. The District is flanked by the Antrim Plateau and Glens of Antrim to the north and the Mourne Mountains, which include Slieve Donard, the highest peak in Northern Ireland, to the south.

Over 0.7 million people live in the District which includes the most densely populated region of Northern Ireland, the Belfast Metropolitan Area, and surrounding commuter areas including Lisburn, Newtownabbey, Carrickfergus, Bangor and Newtownards. Most of the main urban areas are located beside rivers or on the coast. In rural areas, many people live in small villages or single dwellings. Industry is mainly concentrated around the urban areas with much of the rest of the district given over to farming. Farmland in the Lagan valley and other lowland areas is very productive. Commercial fish farming is also significant in the area, whilst boating is a popular recreational activity.

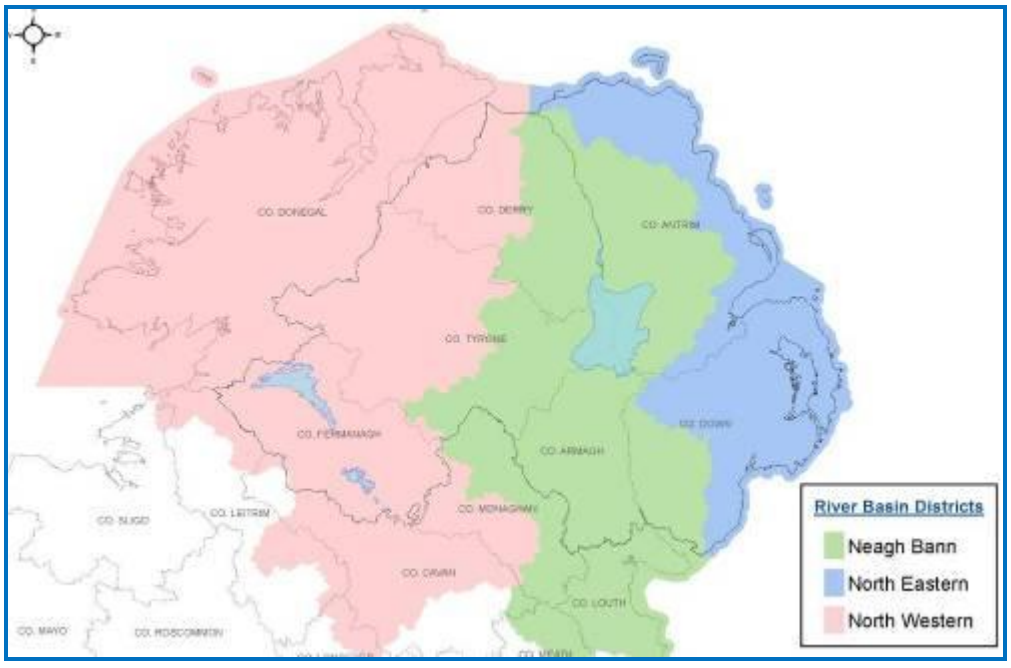


Figure 7.1.1 – North East River Basin District (Blue)

7.2 Areas of Significant Flood Risk

Following the Preliminary Flood Risk Assessment in 2009, twenty areas of potential significant flood risk were identified within Northern Ireland. Eight of the Significant Flood Risk Areas (SFRA) are located in the North East River Basin District and named as follows:

- Belfast
- Downpatrick
- Dundonald
- Bangor
- Newcastle
- Newtownards
- Carrickfergus & Kilroot Power station
- Newtownabbey

7.3 Belfast Significant Flood Risk Area

The geographical extent of the Belfast SFRA, which has been determined through the PFRA, is located within the Belfast Lough and Tidal Lagan Local Flood Management Area and to a lesser extent the Lagan Local Flood Management Area. The boundaries of the SFRA are illustrated in Figure 7.3.1 below.

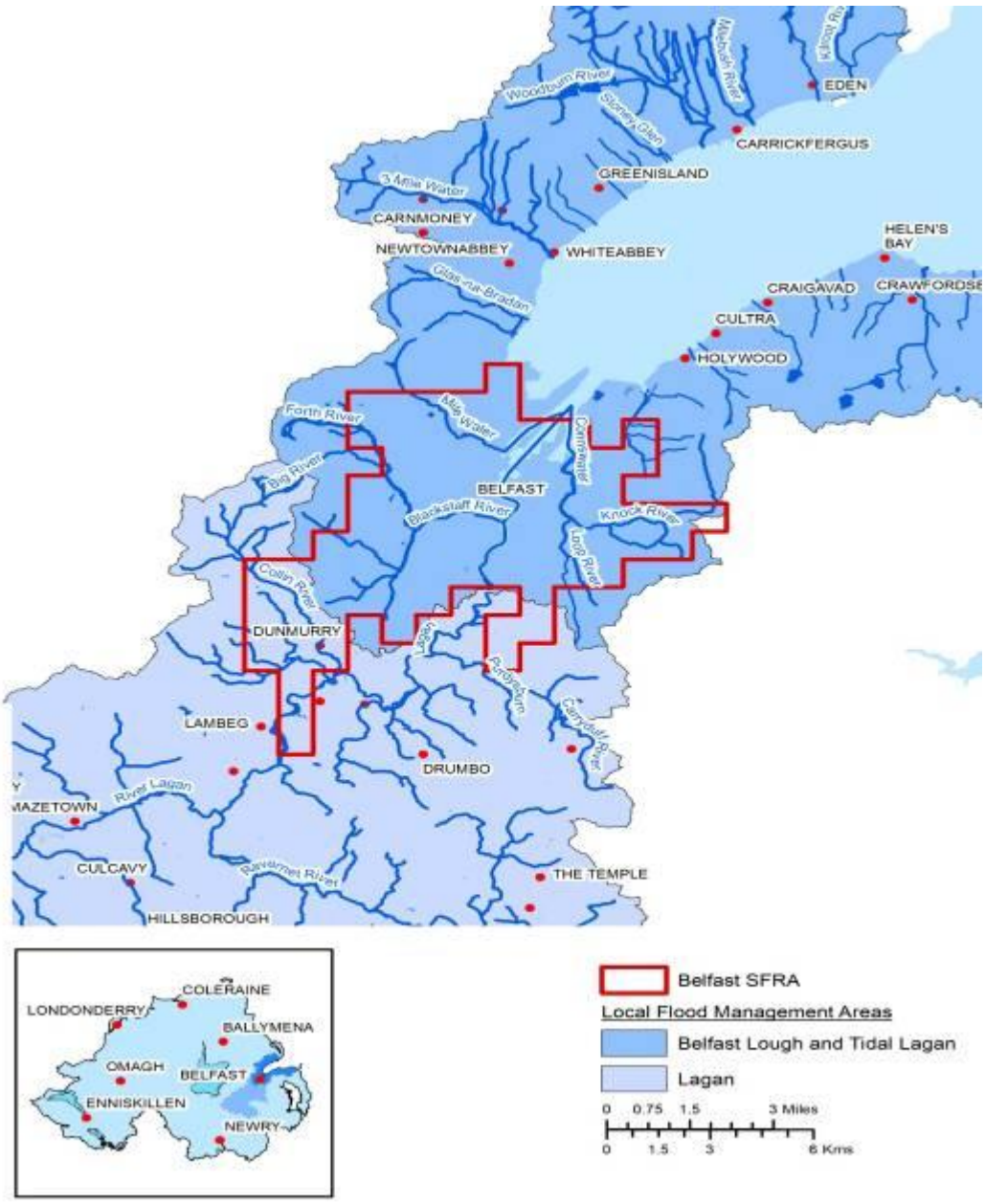


Figure 7.3.1 - Belfast Lough and Tidal Lagan Local Flood Management Area and Belfast SFRA

7.3.1 Flooding History

Early Significant Flooding

There are documented reports of flooding in Belfast as far back as the 1600s. It is notable that in 1656, the Town Landlord insisted that the Farset River at High Street was '*walled in'* to prevent flooding and, as a result of this work, High Street was raised above its original level by around 1m. Historically, the original wide floodplain of the Blackstaff River was regularly flooded in winter and this extended as far as the Victoria Square and Anne Street areas which would often flood to depths of several feet. There are detailed newspaper accounts of two major floods that occurred in 1901 and 1902. In November 1901 a severe rainstorm, which lasted for two days, coupled with an extreme high tide, caused the River Lagan to overtop its banks at a number of locations and flood extensive low lying areas of the city. This flooding was reported in the Belfast Telegraph as *'beyond any like occurrence for 50 years'*. However, only a year later on 3rd Sept 1902, Belfast experienced even greater flooding. Many of the main rivers including the Blackstaff, Pound Burn, Connswater and the Farset surcharged and flooded much of the city centre. Again, this was due to a combination of heavy rainfall and high tides. The floods were described in the newspapers as unprecedented, with reports of enormous property damage and the closure of the majority of the mills and factories in the city. In addition to tidal and fluvial flooding, a dam on the Springfield Road burst and spilled to the nearby Blackstaff River causing it to burst its banks. The newspaper estimated that due to the dam burst, a nearby street flooded to a depth in excess of 4m. In many other locations around the city the flood exceeded window levels and standing water ponded to a depth of 1.5m. The Blackstaff was finally culverted in the early 19th century, after which the likelihood and severity of flooding in the city centre area reduced significantly.

There is also evidence of a major flood event that occurred in May 1916 which caused substantial flooding to several parts of the city including Greencastle, the Grosvenor Road and Connswater (see Photograph 7.3.1.1).

Photo 7.3.1.1 - Belfast Flooding, 25 May 1916

Recent Significant Flooding

On 1 December 2005 an active front moved east across Northern Ireland during the morning and produced several hours of heavy rain in parts of Armagh, Down and south east Antrim. The worst of the rain affected the Belfast area where some parts in the south of the city received 25 to 30mm of rain in a 4 hr period, which is estimated to be a rainfall event with a return period of around 20years. The areas most badly affected were the Lower Ormeau Road and Sydenham where floodwater inundated 40 and 12 homes respectively. All of the flooding on this occasion was related to surface water and/or out-of-sewer flooding. Although the rainfall was quite severe other factors appear to have played a part in the flooding on this occasion. For example, heavy rain had already fallen in the weeks prior to this event and the River Lagan was higher than normal and a high tide coincided with the period of the heaviest rainfall. In addition, a NI Water pumping station, located in the Lower Ormeau area failed, which resulted in a much reduced ability for the local drainage infrastructure to cope with the run-off.

On 12 June 2007 large parts of Northern Ireland experienced extreme 'summer storms' which were high in intensity and relatively short in duration. The intense rainfall caused widespread flooding in East Belfast. The extent of the flooding was exceptional and rivers, sewers and road drainage systems were overwhelmed leading to 48 separate flooding incidents. Although initial estimates put the number of properties flooded at around 400, Belfast City Council made emergency flood relief payments to 959 homeowners. Therefore, given that some homeowners of flooded properties probably didn't claim and the owners of non-residential

properties are not eligible, it is likely that the actual number of flooded properties was substantially higher than 1000. Figure 7.3.1.1, is a 'heat map' that uses the flood relief payments to illustrate the extent to which individual areas were impacted by the flooding.

Figure 7.3.1.1 - Belfast Flooding, 12 June 2007 – 'Heat map' produced using Flood Relief

On 16 August 2008 a significant widespread rainfall event affected most parts of the province and it is estimated that between 80 to 100% of the normal monthly average rainfall occurred in a single day. The rainfall depths were typically in the range 40 to 65mm with the greatest accumulation at Portglenone where 75mm was recorded. Although Belfast was worst affected by the flooding, other areas in Antrim, Ballymena, Down, Newtownabbey, Craigavon, Banbridge, Beragh and Castlereagh were also significantly impacted. The newly completed Broadway underpass was flooded to a depth of around 4.6m when a grille blocked on the River Clowney and, as a result, the West link was closed for 4 days. In addition, more than 100 roads were closed across the province and the Fire and Rescue Service had to rescue people from their cars and homes. There was significant damage to infrastructure, services and property and local councils received in excess of 1600 applications from householders for emergency flood relief payments, around 500 of these relate to property in the Greater Belfast Area. It was estimated that of the main source of flooding was surface water (pluvial) and that this may have contributed to around 60% of the total damage.

Photograph 7.3.1.2 - Flooding of West Link (Broadway Underpass), 16 August 2008

On 27 June 2012 relatively localised torrential rain affected the Belfast area with around 44mm of rain falling in less than 3 hours. This event was estimated by the Met Office to have a return period of between 50 and 100 years. As with the previous large scale event in 2008, the extreme rainfall overwhelmed drainage/sewerage systems and some urban watercourses. On this occasion it is apparent from the payment issued to the owners of flooded homes that in excess of 1400 properties flooded. The flood event severely affected parts of South Belfast with flooding occurring in the Finaghy area at Kinnegar Road, Locksley, Sicily and Priory Parks and at Greystown, Ashton Park and Orchardville.

Following this flooding the Executive asked the Performance and Efficiency Delivery Unit (PEDU) to review the emergency response to this event and make recommendations for improvement. The PEDU report is available on the website of the Northern Ireland Executive at
http://www.northernireland.gov.uk/pedu-review-flood-response-june-2012.pdf

Coordinating the implementation of the recommendations made in the PEDU report was handled by an Implementation Group, which was chaired by the Chief Executive of Rivers Agency with representatives from DRD, Transport NI, NI Water, DOE, Local Government, OFMDFM and NI Direct.

In April 2013 PEDU prepared a *'Follow up Report on Review of Response to Flooding on 27 & 28 June 2012'*. The Executive agreed the follow up report without amendment on 4 July 2013.

Photograph 7.3.1.3 - Belfast Harbour – Tidal Event 3 January 2014

3 January 2014 - Although there hasn't been any significant flooding in Belfast within living memory that can be solely attributed to the sea, there have been a number of near misses the most recent one occurring on 3 January 2014. On this occasion the "UK Coastal Monitoring and Forecasting" service, which provides tidal information and level alerts to Rivers Agency, predicted an extreme tidal surge for Belfast Lough and the rest of the Northern Ireland coastline. This alert triggered a major flood emergency response to prepare for the possibility of serious flooding from the sea. The response was led by the PSNI and involved a number of bodies, including Local Government, Rivers Agency, the Office of the First Minister and Deputy First Minister, Northern Ireland Fire and Rescue Service, Transport NI, NI Water, Belfast Health Trust, NI Electricity, British Telecom and Translink. In this instance a major flood event was narrowly averted as the tide peaked at around 2.75m OD. This was only a few centimetres below the top of various sections of the walls and embankments, which act as a form of coastal defence. However, despite the fact that flooding did not occur, the emergency response operation, led by the PSNI, was considered a success.

In addition there are a large number of small underground and open watercourse systems in Belfast which do not fall within the responsibilities of any of the drainage authorities and as a result may not have been properly maintained or upgraded. This is contributing factor in relation to the significant surface-water flooding that has occurred in recent years particularly during convective, thunderstorm weather conditions

generated in the summer months. These systems proliferate in parts of South and East Belfast the drainage authorities are currently working together to consider viable solutions in these locations.

Therefore, on the basis of the flood history alone, Belfast is evidently at significant risk of flooding from rivers, surface water, urban drainage systems and the sea.

Existing Flood Protection Works

The Blackstaff River System

The Blackstaff River system rises in the Belfast Hills to the south and west of Belfast and approaches the City from the south-west. In the 1950s, the 2.2 km long Blackstaff Relief Culvert was constructed, mainly in tunnel, by Belfast Corporation along a line from west-to-east about 2km south of the City centre. It takes a proportion of the Blackstaff and the connecting Clowney River flows, from Broadway beneath Ulsterville Avenue, College Gardens and Botanic Gardens to outfall into the tidal River Lagan at Stranmillis. Circular in construction and 13 feet in diameter, it is one of the largest river culverts in Belfast and diverts around half of the catchment flow from away from the City centre to outflow safely into the Lagan. This has undoubtedly contributed greatly to the flood protection of the inner City from Blackstaff River flows.

In the 1980s, DARD Rivers Agency undertook a major study of the Blackstaff River and its tributaries. The Lower Blackstaff River Flood Alleviation Scheme was constructed to provide flood alleviation to Belfast City Centre because the area around Great Victoria Street and Grosvenor Road had flooded in the 1960s and 70s and an extensive area around the City Hall, Donegall Place, and Chichester Street was at risk. The Scheme comprised construction of large reinforced concrete 'box' culverts on the Lower Blackstaff, from the West Link dual carriageway through the City Centre connecting to existing large twin brick-arch culverts lower down the system at Dublin Road. It replaced existing inadequate underground culverts which were undersized, hydraulically inefficient and structurally unsound. It also included the culverting of reaches of industrialized, heavily polluted open watercourse. The Scheme availed of a 'window of opportunity' to utilize a clear construction path through the City centre which is now no longer available due to commercial development of the City Centre.

Farset – Glenwood River System

In the past 30 years or so, several schemes to upgrade and improve the Glenwood and Farset culverted systems from a flood alleviation perspective, have been carried out. These have been undertaken as distinct flood alleviation schemes or when opportunities arose, culvert replacements were included within road upgrading works. During this process, a multitude of old brick and masonry arch conduits previously used to feed water from the Farset to industry, have been rationalized and abandoned and so the River Farset now has a more defined drainage path and its culverts are in better structural condition. However, its culverted

reaches upstream of Crumlin Road have not received the same degree of upgrading and flood risk still remains there.

The construction of the West Link dual carriageway in the 1970s / early 1980s impacted significantly on the culverted Farset River because the new road cut through the river at a point where the roadway required an underpass. A bifurcation was constructed on the upstream side adjacent to the proposed road and Farset flow was split in two directions - eastwards along the normal course of the River and southwards into the new Pound Burn culvert system. This system connects Farset flows to the Lower Blackstaff River at the Translink bus and rail station just south of Grosvenor Road; hence flows can be apportioned from the Farset into the Lower Blackstaff system. The normal course of the River towards the City Centre had to be diverted significantly to cope with the West Link alignment. Downstream of the West link, the Farset flows eastwards into Belfast and its flow capacity has been considerably constrained because of the hydraulics and inadequacies of its culverts. It is also impacted upon by tidal conditions in its lower reaches. Therefore, the ability of the Farset to vent flood flows is dependent on capacity in the Lower Blackstaff system because of their inter-connection via the Pound Burn.

NI Water Belfast Sewers Project

Belfast's sewer network which dates back to the Victorian era, had been suffering as a result of sustained under-investment coupled with inadequate capacity due to Belfast's continued expansion. To address this problem, Northern Ireland Water undertook a major £160 million Stormwater Management project called 'The Belfast Sewers Project'. The main project comprised construction of a tunnel approximately 10 Km in length and up to 4 metres in diameter, starting at Cromac Street and ending at a terminal pumping station sited adjacent to the Belfast Wastewater Treatment Works in Duncrue Street. The project provides improvement to water quality in both the River Lagan and Blackstaff River while reducing the risk of flooding within the inner City. It also incorporated the rehabilitation and upgrading of the sewer network to ensure compliance with European Union environmental standards. The project was completed in 2010 and provides benefit to residents and businesses through reduced risk of flooding, enhanced water quality in the River Lagan, and an efficient sewerage infrastructure for future economic development in Greater Belfast

Connswater, Knock and Loop River

The extensive upgrading works which have been undertaken in the 1980s and 1990s on the Blackstaff and Farset systems have provided flood alleviation benefits in north and west Belfast. However, until the current decade, East Belfast had not received a similar level of investment to upgrade river systems for flood alleviation purposes. Since year 2000, regular, recurring flooding in East Belfast around Ladas Drive, Castlereagh and Orangefield areas has led to the development of major alleviation proposals within the catchment of the Connswater which encompasses the Knock and Loop River systems.

Development in the periphery of and infill within East Belfast, has increased flows in these rivers resulting in serious flooding to homes and commercial properties during adverse weather conditions. The Connswater outfalls into Belfast Lough at Sydenham and is therefore subject to tidal influence. An adjacent housing area in Sydenham is sited below tide level and is currently at serious risk from tidal inundation. A severe storm surge in January 2014 highlighted the susceptibility of this developed area to a number of flood risks as it is also situated beside a major sewage and stormwater pumping station for the east side of Belfast. Failures of infrastructure at this station have contributed to repeated serious flooding of homes in Sydenham.

The lagan Weir

The Lagan Weir is owned and operated by the Department of Social Development. The structure contains a series of moveable gates and a regime is in place to operate the gates to reduce the risk of flooding from the river. During normal tidal and river flow conditions the weir gates are raised on each falling tide to impound the river upstream. The gates are then lowered when, on the next tidal cycle, the sea level rises above the impounded control level for the river. The weir gates create an impoundment between Donegall Quay and Stranmillis Weir which reduces the tidal range from 3.1m to around 1.2m for spring tides.

Figure 7.3.1.4 - Belfast SFRA – Lagan Weir

7.3.2 PFRA – Identification of Potentially Significant Flood Sources

According to the Preliminary Flood Risk Assessment (Dec 2011) the city of Belfast, in terms of the potential adverse consequences of flooding, is ranked highest of the twenty SFRA within Northern Ireland (see Figure 4.1). On the basis of this initial assessment, which was undertaken using the Strategic Flood Maps, it was determined that the city was potentially at significant risk from both tidal and fluvial flooding. It was predicted that a large proportion of the city centre lay within the 'undefended' 1 in 200 year coastal floodplain and as many as 8000 properties were potentially at risk of flooding from the sea. The extent of strategic coastal flood plain is illustrated in Figure 7.3.2.1 below.

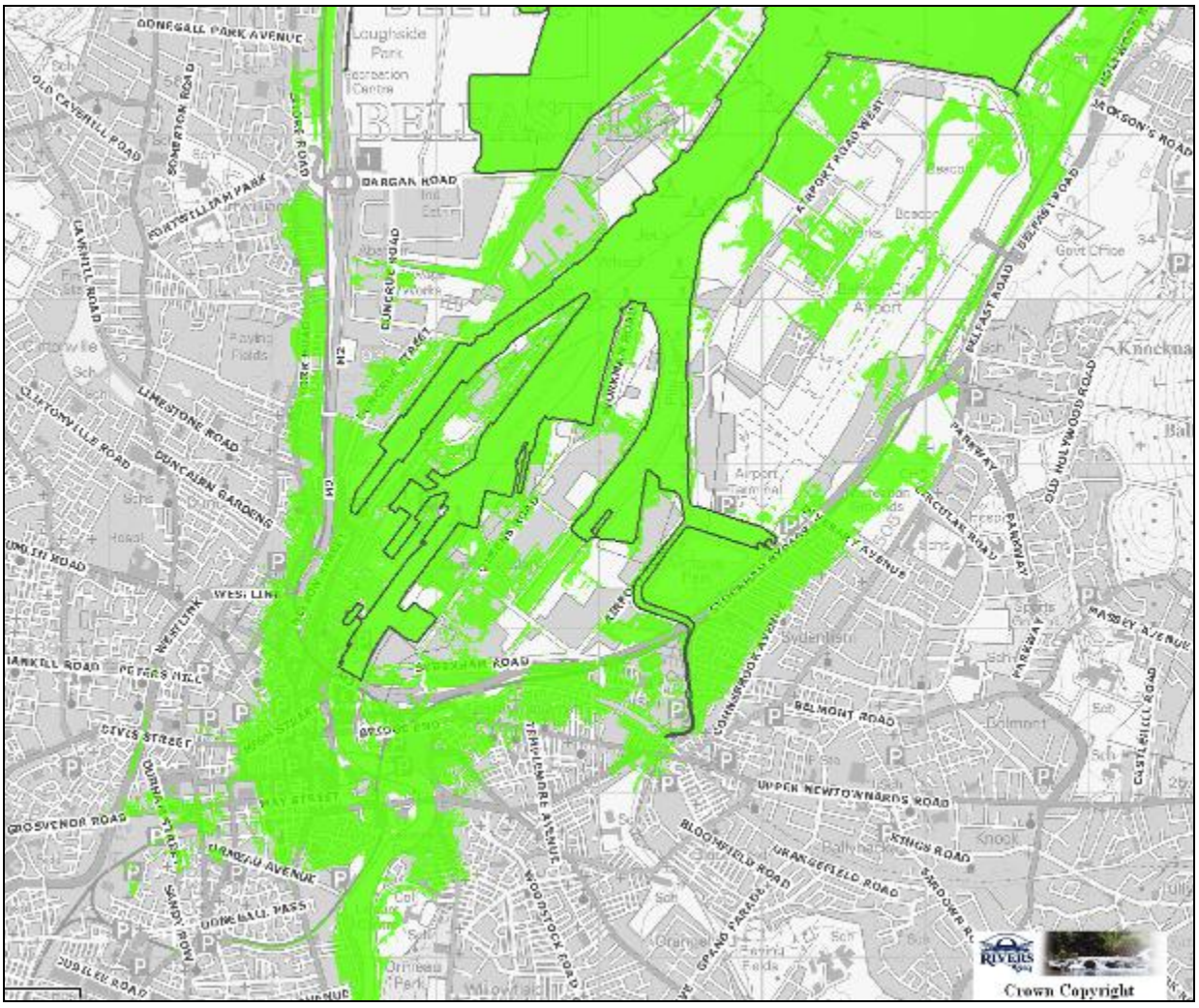


Figure 7.3.2.1 - Belfast SFRA – Undefended Coastal Flood Plain, Strategic (0.5% AEP) 1 in 200 yr

The extents of the fluvial floodplains that were predicted using the strategic models for the rivers and watercourses in the Belfast area are illustrated in Figure 7.3.2.2. On the basis of this initial assessment, it

was estimated that up to 9,800 properties were potentially at significant risk of flooding from rivers. The assessment also indicated that around 6,000 of this number would be at risk of flooding from both rivers and the sea and almost all of these are located within the floodplain of the tidally influenced lower reaches of the River Lagan. Apart from the River Lagan, the other main watercourses which were estimated to contribute substantially to the overall flood risk to property are the Connswater River and its tributaries (Knock River & Loop River) in the east of the city and in the west, the Blackstaff and Clowney rivers and their tributaries

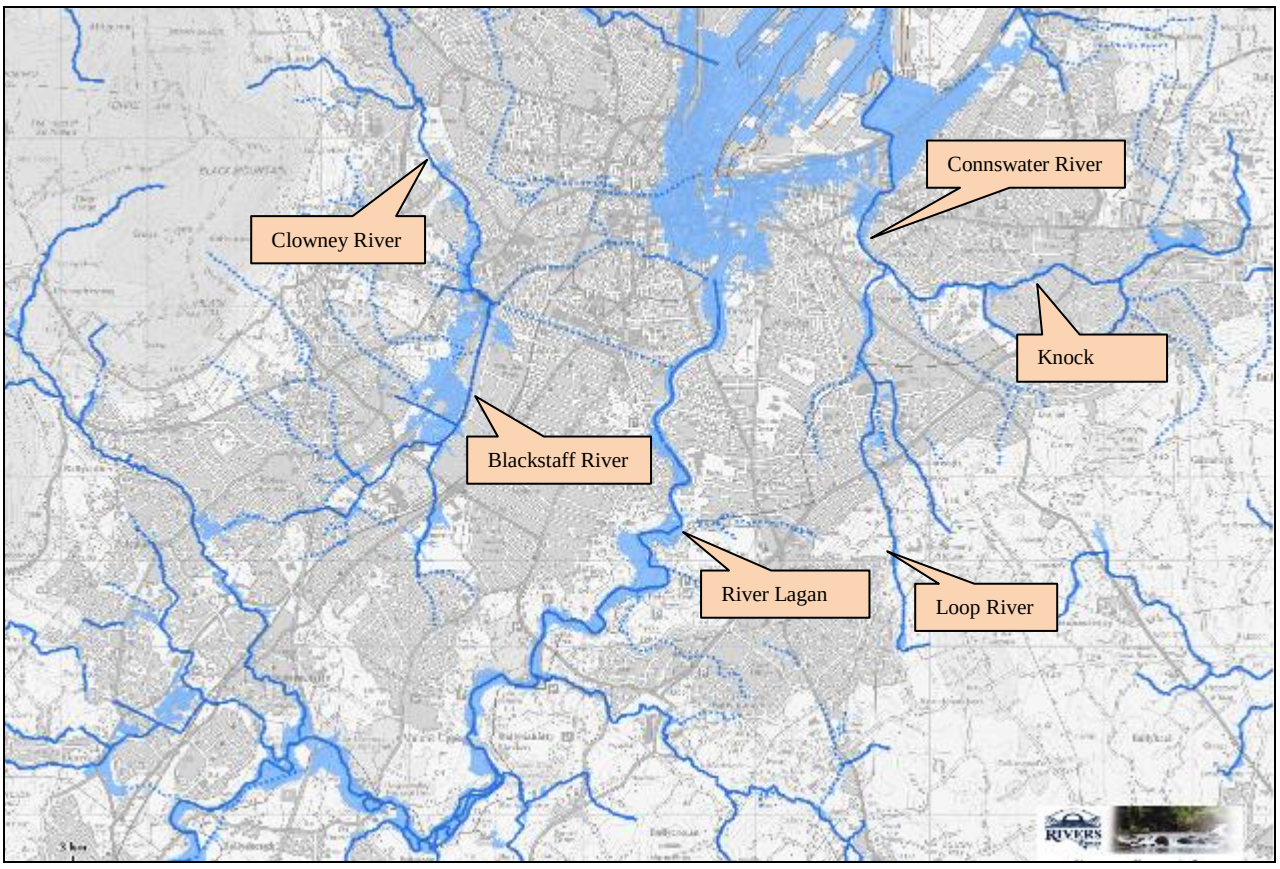


Figure 7.3.2.2 - Belfast SFRA – Undefended Fluvial Flood Plain, Strategic (1% AEP) 1 in 100 yr event

7.3.3 Catchment Description

Belfast, the capital of Northern Ireland, is the largest settlement in the region. It is located at the head of Belfast Lough in the valley of the lower reaches of the River Lagan. It lies in a basin that is flanked to the northwest by the escarpment of the Antrim Plateau and to the southwest by the more gentle slopes of the Castlereagh and Hollywood Hills. The development of the city began in the 17th century with the early settlements established around the mouth of the river to serve as a port and market place for the surrounding areas. As the settlement expanded over the centuries, so too did the harbour and today the walls of the various docks and channels which fringe the extensive harbour area form a significant the proportion of the

Belfast frontage. Although Belfast has no formal sea defences the dock walls at the harbour and channel-side revetments of the rivers serve as a quasi coastal defence which protects extensive low lying areas of the city centre from flooding, in all but the more extreme tidal events.

From a drainage aspect, Belfast is dominated by the River Lagan and its tributaries. The Lagan, which is around 70km long and drains an area in excess of the 600km^2, rises on the western slopes of the Slieve Croob Mountains near Dromara (County Down). It flows from its source in a westerly direction through Donaghcloney after which it turns steeply and continues in a north easterly direction, through Lisburn and on to its tidal outlet at Belfast Lough. Although the river is tidally influenced downstream of the Stranmillis Weir in Belfast, this influence has been limited to extreme high tides only, due to the construction of the Lagan Weir. The Lagan Weir, which was completed in 1994, was placed in the river between the Queen Elizabeth Bridge and the M3 Bridge with the objective of keeping the water level upstream to the Stranmillis Weir artificially constant. Before the construction of the Lagan Weir the water level in this section of the river varied by up to three metres and the mudflats exposed at low tide were unsightly and emitted a strong odour, particularly in the summer months.

Within the city, various tributaries feed into the River Lagan from the west and the east. The East Belfast catchment covers an area of 26km^2 and the two main watercourses draining this area are the Loop and Knock Rivers which combine to the form the Connswater which discharges into the Musgrave Channel in Belfast Harbour. The West Belfast catchment is approximately 55km^2 and the main watercourses draining this area are the Blackstaff and the Farset, which rise in the hills to the north of the city. Within the urban extents of the city, almost all of main watercourses and their tributaries are heavily modified and partially culverted while those on the west side are substantially culverted.

7.3.4 Coastal Flood Risk Assessment

Belfast Lough Flood Model and Levels

For the purposes of producing detailed flood hazard mapping for the tidal inundation of Belfast , the extreme sea water levels for a range of return periods were derived using the methodology described in the Rivers Agency's report *Strangford and Belfast Extreme Tides Boundary Condition (August 2009)*. The table at Figure 7.3.4.1 below gives the estimated value of the extreme sea levels for a range of scenarios. It should be noted that the Rivers Agency's normal design standard for sea defences is to protect to the 1 in 200 year level with appropriate freeboard.

	Belfast Lough – Belfast Estimated Extreme Water levels	
	Annual Exceedance Probability - (Return Period)	**Extreme Water Level (m OD)**
Present Day	10% AEP - (1 in 10 year)	2.50
	1% AEP - (1 in 100 year)	3.07
	0.5% AE - (1 in 200 year)	3.17
	0.1% AEP - (1 in 1000 year)	3.30
Year 2030	10% AEP - (1 in 10 year)	2.57
	1% AEP - (1 in 100 year)	3.14
	0.5% AEP - (1 in 200 year)	3.24
	0.1% AEP - (1 in 1000 year)	3.37
Year 2100	10% AEP - (1 in 10 year)	3.24
	0.5% AEP - (1 in 200 year)	3.92
	0.1% AEP - (1 in 1000 year)	4.05

Figure 7.3.4.1 - Belfast SFRA – Belfast Lough, Estimated Extreme Water Levels

Using these tidal boundary conditions the tidal simulations for Belfast Lough and the lower, tidally dominated reaches of the River Lagan and Connswater River, were undertaken using an Infoworks RS 2D model for the tidal frontage combined with 1D models for the rivers. The details of this model development and its results are contained in Rivers Agency's *Belfast Tidal Modelling – Hydraulic Modelling Technical Report (July 2012)* and copies this report are available on request.

The tidal flood model was run for six tidal surge scenarios for both the present day and predicted future 2030 year sea level and climatic conditions. The scenarios modelled included the predicted 1 in 10 year (T10), T50, T75, T100, T200 and T1000 tidal surge water level profile combined with 1 in 2 year fluvial event in the River Lagan and Connswater. A selection of the tidal hazard maps which include the present day T10, T200 and T1000 are available through the Flood Maps NI.

Tidal Flooding Mechanisms

It is evident, from the improved tidal hazard flood maps, that the Strategic Flood Maps used for the PFRA overestimated the geographical extent of the tidal flood inundation areas. The reason for this difference is simply that the improved tidal model is much more accurate than the strategic model. The strategic model assumed that all land behind the quay walls and channel revetments, that is lower in elevation than the estimated sea water level would flood with water to the same height as the tide. However, this took no account of the fact that these raised structures effectively act as a weir and that the sea flows over these raised structures for a limited period at the 'top' of the tidal cycle and not for long enough to flood all of the low lying areas. This 'real world' flooding mechanism is fully represented in the improved tidal model and results in a substantial contraction of the flood inundation area, when compared with those produced by the strategic model for extreme events with the same return period.

For the most part, the height of the Belfast frontage (which is comprised of the quay walls and channel-side revetments on the River Lagan) is typically greater than 3.0m OD, although there are a number of distinct areas where the levels dip to as low as 2.7m OD. Behind the frontage there are vast areas of the city centre and other areas to the east as far as Victoria Park that are very much lower than the frontage, in some cases up to 2m lower. This low lying basin is occupied by some of the province's most valuable commercial/retail property and residential areas with extremely high density housing.

A number of computerised animations to illustrate where the Belfast frontage is predicted to breach during extreme tidal events and how the floodwater travels across the surface and ponds in the low lying areas, are currently available on the internet through the Vimeo website at http://vimeo.com/floodriskmanagementni/videos . Before the date of the final FRMP (December 2015) Rivers Agency's website will contain a web page with links to all of the strategically important flood model animations that it creates.

Figure 7.3.4.2 below illustrates the geographical extents of each of the discrete areas that are at risk from inundation at the 0.5% AEP (1 in 200 year) tidal surge event.

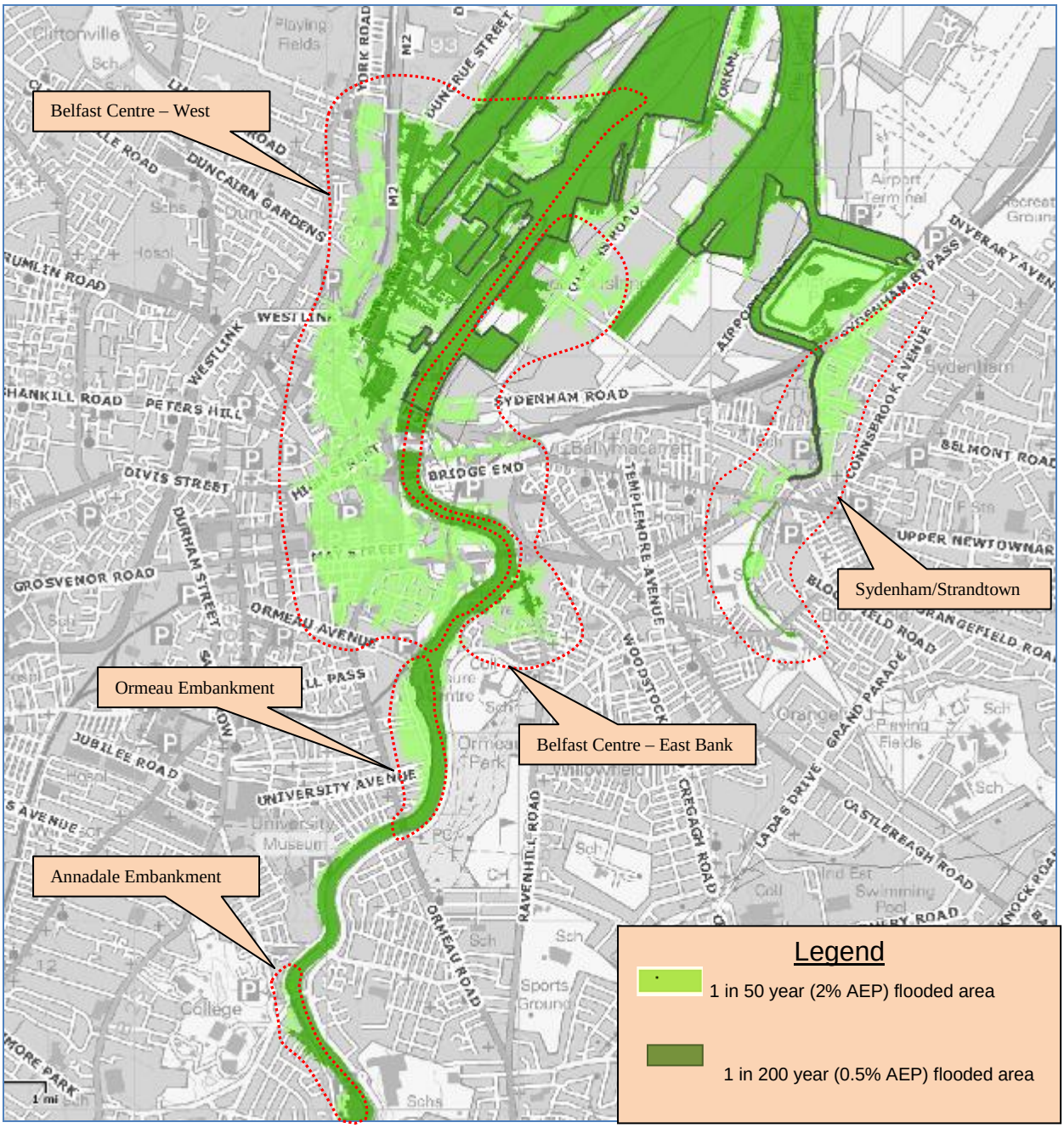


Figure 7.3.4.2 - Belfast SFRA – Main coastal flood inundation areas (1 in 200 year event)

The developed areas in Belfast that are prone to flooding due to tidal inundation, together with a description of the flooding mechanisms are as follows.

Belfast Centre – West Bank

Although the model indicates that shallow flooding to a small number of commercial properties in the immediate vicinity of the docks is estimated to occur at the 1 in 10 year event, it is not until the 1 in 50 year that a substantial breach the tidal frontage occurs. At this extreme event the spill- over points are limited to a few localised low spots in the quay walls at the Pollock Dock and York Dock. Having spilled over the walls the floodwater flows south and ponds to a shallow depth at a number of locations within the general area between the frontage, the M2 Motorway to the west and the M3 to the south. At the more extreme 0.5% AEP (1 in 200 year) tidal event the sea spills over the frontage at numerous locations from Donegal Quay to the Pollock Dock as many sections of the quay walls are lower than the estimated peak tide level of 3.17m OD. At the 1 in 200 year event it is estimated that an area of around 2km^2 within the city centre will be inundated to depths in excess of 2m. Flooding will affect the heart of the retail/commercial centre including the Victoria Square and residential areas such as the Markets and Sailor Town. The potential adverse consequences of the predicted future floods for a range return periods are recorded in Table 7.3.1.3 which shows that the estimated property damages due to future floods have a present day value of around £29m.

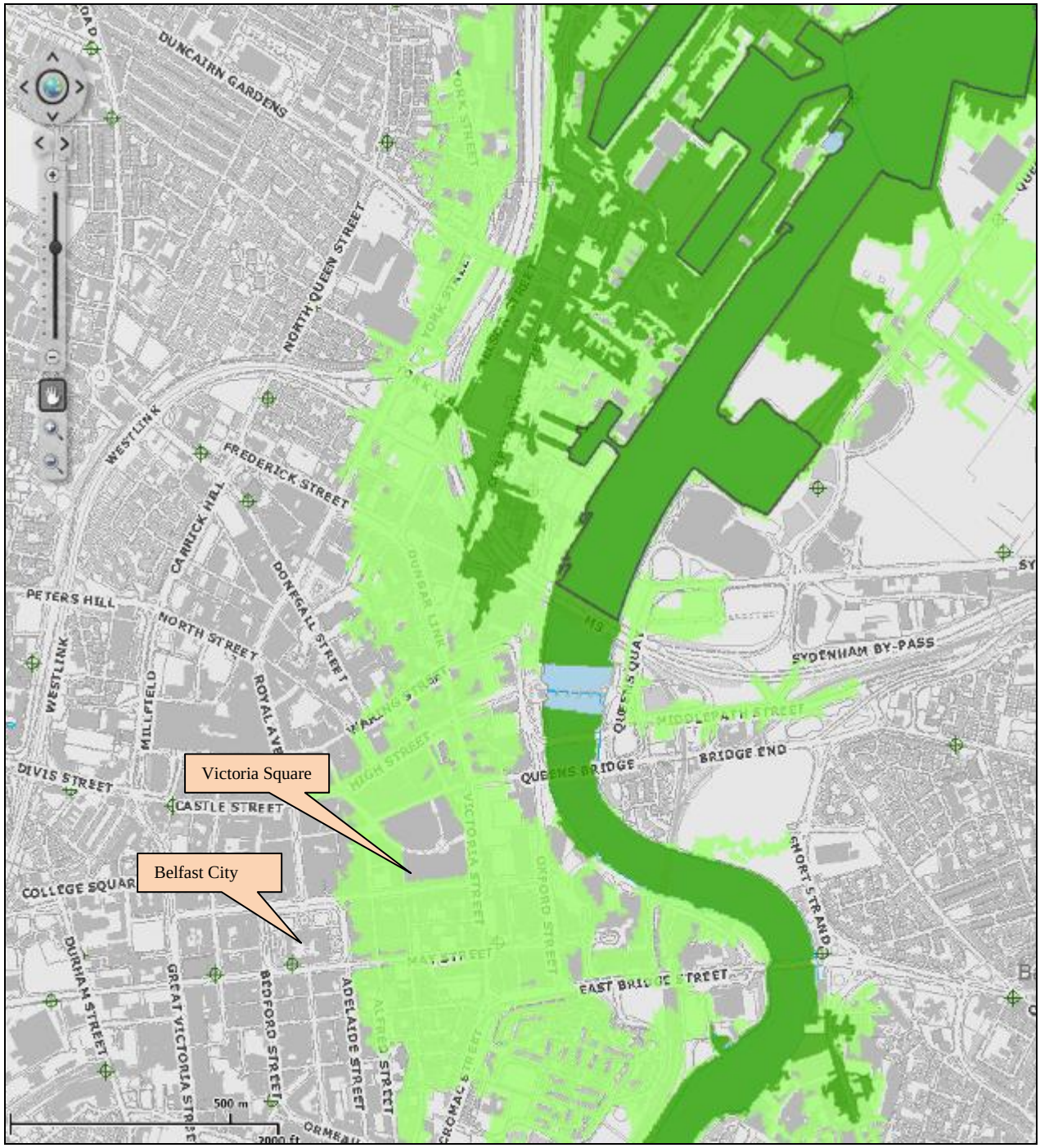


Figure 7.3.4.3 - Belfast SFRA – Tidal Flood Plain (1 in 200 year event) - Belfast Centre West

Ormeau Embankment

The model predicts that at the 1.33% AEP (1 in 75 year) tidal event floodwater begins to overspill the left bank of the lower (tidal) River Lagan between the Ormeau Road Bridge and the railway embankment at Cromac Springs. The height of the cycle path which fronts this section of the river is generally less than 2.8m OD and can therefore be overtopped throughout its length by all tidal events with return periods in excess of the 1 in 75 year event which has an estimated peak level of 2.93m OD. Behind the immediate frontage area (which is occupied by a row of recreational buildings and playing pitches) the land is markedly lower by up to 1m and occupied by high density terraced housing. Although flooding at the 1 in 75 year event is limited to a few residential properties, there is a marked increase in the number of properties affected at the 1 in 100 year event (around 100) and at the 1 in 200 year event it is estimated that as many as 272 residential and 5 non-residential properties will flood to depths of up to 2m. The estimated cost of the property damages due to potential future floods have a present day value of around £918k.

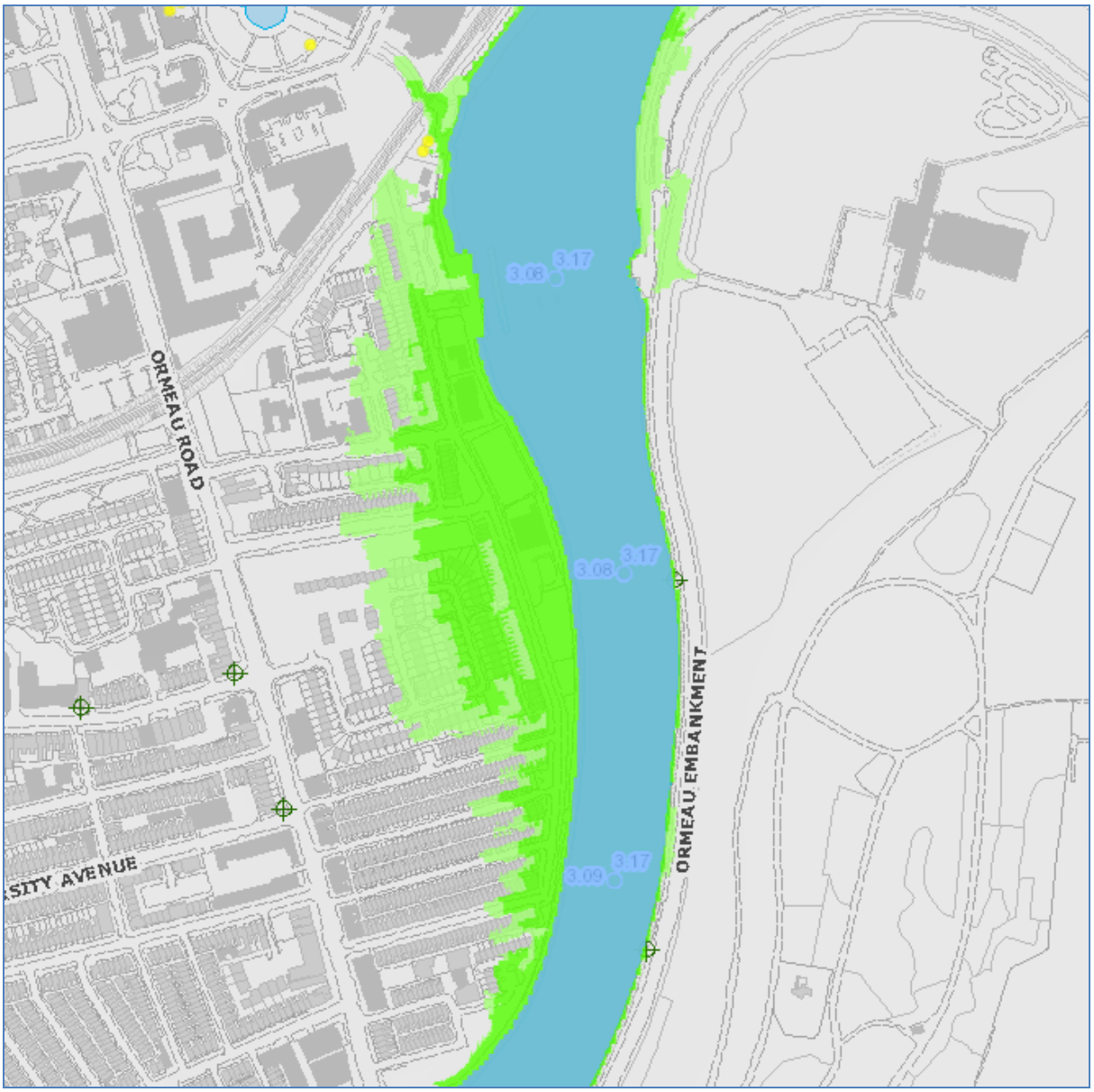


Figure 7.3.4.4 - Belfast SFRA – Tidal Flood Plain (1 in 200 year event) –Ormeau Embankment

Annadale Embankment

The model predicts that at the 10% AEP (1 in 100 year) tidal event, floodwater first begins to overspill the frontage of the tidal River Lagan at a number of locations along a section between the QUB Boat Club and the Belfast Boat Club 600m upstream. At this relatively high frequency event, flooding is limited to the boat houses and surrounds of the various rowing clubs that occupy this section of the frontage and to around 10 terraced houses opposite Cutters Wharf bar/restaurant. Although the extents of the predicted inundation area increases with the severity of the tidal events, even at the 1 in 200 year event the flooding is fairly tightly constrained within a narrow corridor and is estimated to adversely affect 41 residential properties and 9 non-residential properties. The estimated cost of the property damages due to potential future floods have a present day value of around £532k.

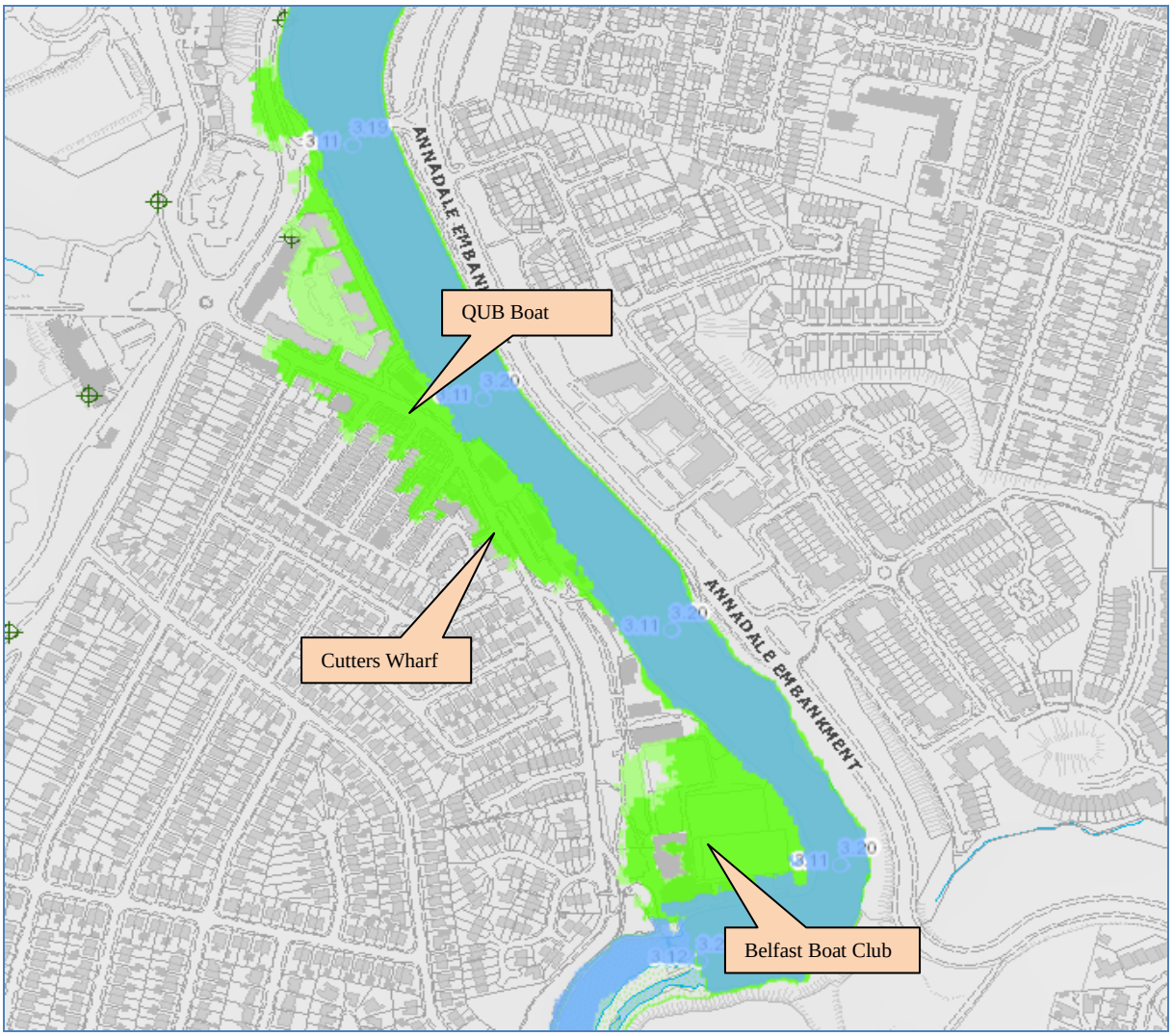


Figure 7.3.4.5 - Belfast SFRA – Tidal Flood Plain (1 in 200 year event) – Annadale Embankment

Sydenham, Strandtown

The Connswater River is tidally dominated in its lower reach from the Connswater Bridge at the Newtownards Road to its sea outfall at the Musgrave Channel behind Victoria Park. There are no formal flood defences along the Connswater River; however the raised embankment surrounding Victoria Park is an informal defence which provides some resistance against the inundation of the park and the subsequent flooding of the Sydenham estate.

The model predicts that flooding of Victoria Park commences at the 2% AEP (1 in 50 year) tidal event via a low spot in the embankment at the north-eastern corner and is overtopped more generally at the 1 in 75 year event. As the water level in Victoria Park rises it begins to flow through a subway under the Sydenham Bypass and inundates large areas of the Sydenham estate which contains high density terraced housing estate.

Floodwater at is also predicted to overspill the right bank of the Connswater from Hollywood Arches to the Sydenham Road Bridge some 750m downstream. The footpath running along this section of the bank sits on top of a raised embankment which is at least 1m higher than the ground level of the residential area which is located immediately behind. However, as the level of this raised bank is typically around 2.85m OD it is predicted to be overtopped by all tidal events equal to or more extreme than the1 in 75 year event which has an estimated height of around 3m. The photo below illustrates how close embankment was to overtopping during the tidal surge event in January 2014 which peaked at around 2.75m OD.

Photograph 7.3.4.1 - Lower Connswater (looking upstream) – Extreme Tidal Event - 3 January

It is estimated that at the 1 in 200 year tidal event the floodwater overspilling the right bank of the lower Connswater will inundate a residential area that extends to around 0.17km^2 and cause flooding to around 500 homes and 50 commercial and retail properties.

Figure 7.3.4.6 - Belfast SFRA – Tidal Flood Plain (1 in 200 year event) – Sydenham/Strandtown

There is also predited to be flooding to property due to overtopping of the left bank in the vacinity of the culvert outlet at the Ballymacarrett Walkway although this is limited to around 20 properties in the vacinity of the Newtownards Road/ Connswater Street Junction. The estimated cost of the property damages due to potential future floods at the locations described have a present day value of around £2.35m.

Belfast Centre – East Bank

Flooding on the east side of the city is limited to Queens Island and the lower Ravenhill Road. Floodwater is predicted to overspill the walls of the various Wharfs and Quays which fringe the east side of Queen's Island at the 1% AEP (1 in 100 year) tidal event. The flooding, even at the 1 in 200 year event, is predicted to be shallow (less than 300mm deep) and mainly limited to hardstanding areas which are sparsely occupied by warehouses and perhaps most notably the Titanic Visitor Centre. The flooding at the lower Ravenhill Road arises from the overtopping of a low section of river wall on the right bank of the River Lagan immediately upstream of the Albert Bridge. It is predicted that floodwater will overspill this wall (which has a height of around 2.5m OD) at the relatively 1 in 50 year event and cause limited shallow depth flooding to the business park at the bottom of the Ravenhill Road. At the 1 in 200 year event the extent of the flood inundation zone is predicted to spread significantly to include a substantial residential area in the vicinity of Ballarat Street. It estimated that 75 homes and 86 non-residential properties are at risk of flooding at the Lower Ravenhill Road and that the cost of the property damages due to potential future floods have a present day value of around £2.35m.

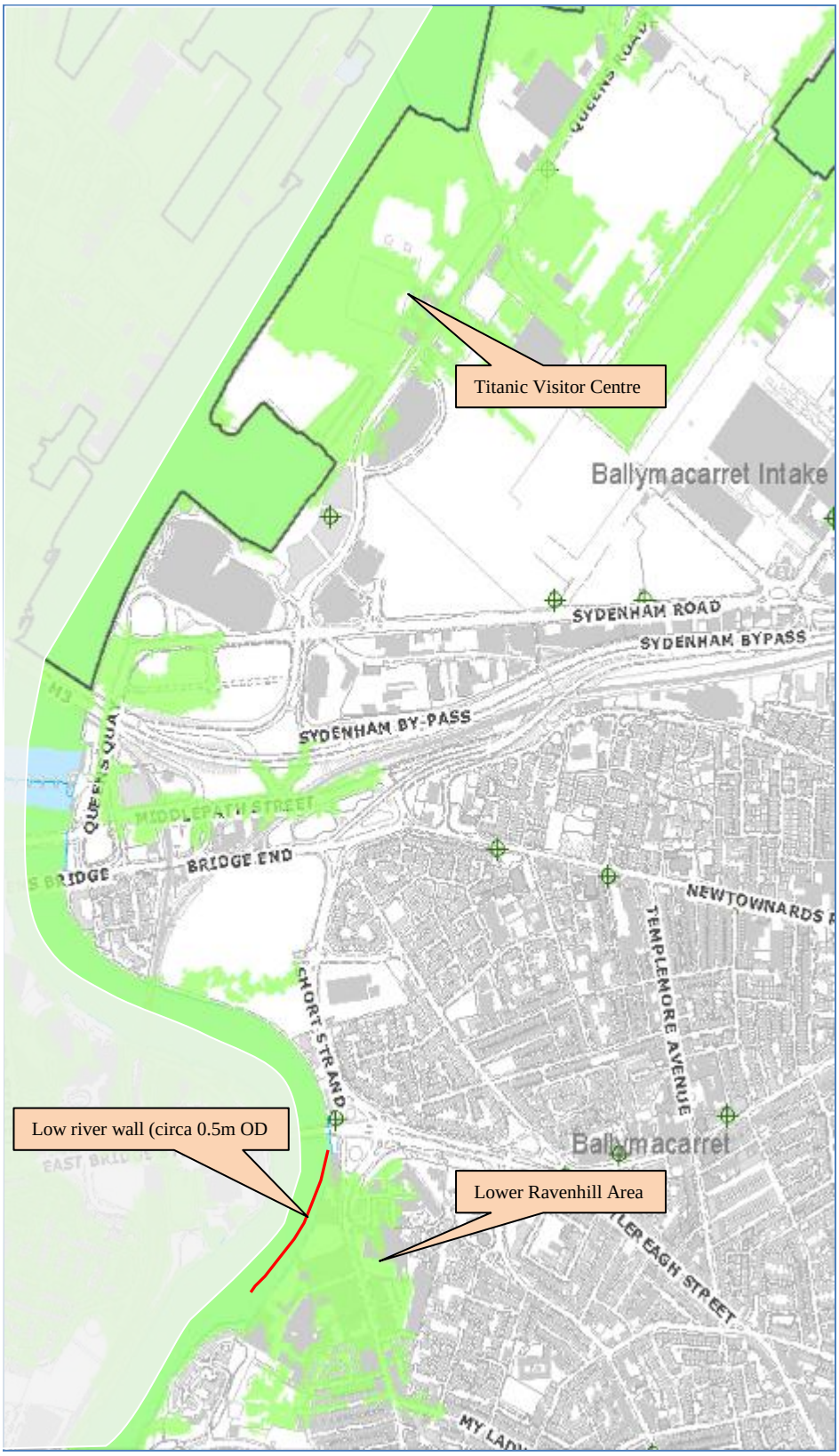


Figure 7.3.4.7 - Belfast SFRA – Tidal Flood Plain (1 in 200 year event) – Belfast Centre, East Side

Table 7.3.4.1 Belfast SFRA			
Potential Adverse Consequences – Coastal Flooding			
Belfast Centre – West Bank			
	Flood Event % AEP		
	10% AEP	**0.5% AEP**	**0.1% AEP**
Residential (Nr)	0	621	794
Non Residential (Nr)	13	713	858
Economic Damage (£)	180k	74.4m	128.9m
Annual Average Damage (£)	968k		
Present Value (£)	**29m**		
Connswater – Sydenham/Strandtown			
	Flood Event % AEP		
	10% AEP	**0.5% AEP**	**0.1% AEP**
Residential (Nr)	0	525	1226
Non Residential (Nr)	0	50	90
Economic Damage (£)	0	3.6m	20.6m
Annual Average Damage (£)	78,319		
Present Value (£)	**2.35m**		
Belfast Centre – East Bank			
	Flood Event % AEP		
	10% AEP	**0.5% AEP**	**0.1% AEP**
Residential (Nr)	1	75	132
Non Residential (Nr)	9	86	132
Economic Damage (£)	306k	2.25m	3.77m
Annual Average Damage (£)	74,060		
Present Value (£)	**2.22m**		
Ormeau Embankment			
	Flood Event % AEP		
	10% AEP	**0.5% AEP**	**0.1% AEP**
Residential (Nr)	0	272	317
Non Residential (Nr)	0	5	7
Economic Damage (£)	0	3.58m	4.57m
Annual Average Damage (£)	30,615		
Present Value (£)	**918k**		
Annadale Embankment			
	Flood Event % AEP		
	10% AEP	**0.5% AEP**	**0.1% AEP**
Residential (Nr)	10	41	53
Non Residential (Nr)	4	9	11
Economic Damage (£)	0	3.58m	1.05m
Annual Average Damage (£)	17,724		
Present Value (£)	**532k**		

7.3.5 Proposed Coastal Flooding Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Belfast it is important that Rivers Agency does not add to the flood risk by allowing new development to take place in areas of known flood risk. Planning Policy Statement, PPS 15, "Planning and Flood Risk", adopts a precautionary approach to development with the primary aim "to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere".

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the development plan and planning application stages. Flood mapping information is used to inform the local development plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the "Exception" rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to "Greenfield" built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new development plans for Belfast Rivers Agency advise against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 200 year coastal floodplain area or is susceptible elsewhere to surface water flooding.
Rivers Agency shall also review the existing development plan for Belfast with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.
The main (undeveloped) flooded areas, amongst others, within the Belfast Significant Flood Risk Area are:-

Planning Applications

Rivers Agency shall advise against the development of all sites that are located within the1 in 200 year coastal floodplain, irrespective of whether they are located within a current development plan or as a single site application outside the plan area.

For those sites within the1in 100 year fluvial floodplain where the principle of development has been accepted by Planning NI as meeting the 'Exception Test' we will further consider the application through the appraisal of an accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The main existing developed areas, amongst others, at coastal flood risk within Belfast were re-development may be likely to take place are:

- York Street, Duncrue Street and Belfast City Centre
- Along the Connswater at Sydenham
- Lower Ravenhill Road

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is therefore important that we continue to target investment by providing flood defence, culvert alleviation schemes and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. The Flood Investment and Planning Group, FIPG, provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a 'Flood Risk Metric Tool', FRISM is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total 'damage avoidance benefits' that the scheme will provide to the property over the scheme's design life. If the benefit/cost ratio is greater than 1 then the potential scheme will be referred to Rivers Agency's Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely, Rivers Agency's responsibility, or is the responsibility of NI Water or Transport NI, such as a local drainage or road infrastructure issue then it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a benefit cost analysis identifies a viable scheme, a scheme will then be placed on a prioritisation list for works with other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take anything from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

The detailed digital tidal model for Belfast Lough predicts that a number of areas within the city are potentially at significant risk of flooding. The model simulations show that flooding occurs due to the sea overtopping various sections of the frontage within the Harbour and the lower reaches of the River Lagan and Connswater River. The model estimates that substantive flooding in some areas, such as the city centre, could occur from tidal surge events with return periods in excess of 1 in 50 years. There is degree of uncertainty with the predicted outcomes from all digital models and as it has not been possible to clearly associate extreme tides as the primary cause for any of the major floods which have affected the city in the past, there is always a possibility that the model has over estimated the likelihood of flooding from the sea. However, tide gauges have been installed to measure the sea level within Belfast Lough since 1901 and the near continuous records which they provide show that six out of the seven highest recorded sea levels have occurred in the last 25 years. The latest of these extreme events occurred in January 2014 and triggered a major flood emergency response plan led by the PSNI. In this instance the tide peaked at around 2.75m OD, which is only few inches below the top of various sections of walls and embankments which form the quasi defences at the frontage, and a major flood event was narrowly averted. Therefore, on the basis of the model findings and the regular occurrence of extreme high tides in recent years there is sound basis upon which to conclude that the tidal risk to Belfast is very real and needs to be managed.

The predicted tidal flooding from the lower reaches of the Connswater River, which affects an extensive and largely residential area at Sydenham/Strandtown, shall be mitigated through the delivery of the ongoing Connswater Community Greenway partnership project. This £40 million investment project which has been developed by the East Belfast Partnership and is being delivered through Belfast City Council will create a 9km linear park along the course of the Knock, Loop and Connswater rivers. Rivers Agency is working in partnership with this project to deliver elements of its £11 million East Belfast Flood Alleviation Scheme which shall be integrated within the overall proposals for the linear park. The East Belfast Flood Alleviation Scheme will prevent the tidal flooding to Sydenham through the construction of steel sheet piled floodwalls and earth embankments/bunds along the banks of the lower Connswater River (from Newtownards Road to Sydenham By-Pass) and by reshaping the landform within Victoria Park to cut off the flow route through the subway under the Sydenham Bypass. The works at Victoria Park were completed in July 2014 and those on Connswater River are currently programmed to commence in the summer 2015 with completion in April 2016. On completion of the flood alleviation scheme Sydenham, which is one of the areas in Northern Ireland that is most vulnerable to coastal flooding, will become one of the better protected. However, the area will still be at risk to some extent from fluvial and surface water flooding.

In addition to the flood alleviation scheme for the Connswater, Rivers Agency awarded a contract to one of its consultants in December 2014 to undertake the Belfast Tidal Flood Risk Study. This study will identify and assess all options for the management of the tidal flood risk in Belfast and shall guide all future capital investment decisions and the development of risk management strategies for the city. The study shall

consider the potential impacts of future developments that may present threats or opportunities to the mitigation of flood risk and include for example, the proposed York Street Interchange and the Belfast Harbour's City Quays project. The study report is programmed for completion in July 2015 and the findings of this report will be taken into consideration in the final version of the FRMP which is due for completion in December 2015.

The output obtained from the detailed tidal model for Belfast has served to confirm that detailed modelling of itself is a vitally important flood risk management tool. Before the development of this detailed model, government was reliant on the strategic tidal model (used for the PFRA) to assess the level of flood risk in Belfast. Based on the strategic model, the number of properties estimated to be at risk of flooding from a 1% AEP (1 in 200 year) tidal storm surge was around 8000. This initial estimate has always been heavily qualified due to obvious inherent uncertainties associated with the early strategic modelling techniques. However, using the detailed tidal model the number of properties estimated to be at risk of flooding from the sea has reduced dramatically to around 2500 and in addition, there is greater certainty with this estimate.

Preparedness

Coastal flooding has the potential to have a significant impact in terms of risk to life. This is mainly due to the rate of inundation from the sea at the height of the tidal cycle. In light of this the emergency response to significant coastal flooding with a risk to life will be led by PSNI and evacuation of potentially affected areas will be a real consideration.

To ensure a coordinated approach local, tactical Coastal Flooding Emergency Response plans are being developed for Belfast. This will link to a strategic Coastal Flooding Emergency Response plan.

The Coastal Flood Response plans aim to provide a pre-planned response to a warning of coastal flooding and outline the graduated incident and coordinated inter-agency response to a potential or actual coastal flooding event.

The objectives of the plan are to:-

- Identify activation triggers for responding to a coastal flood warning or incident.
- Document the actions to be taken on receipt of a coastal flood warning.
- Set out the process for a coordinated response including the graduated incident management of a potential or actual coastal flooding event.
- Ensure a common understanding of the potential impacts of a coastal flooding event in each area and act as a reference document for all the agencies involved to provide a pre-planned response at various levels of coastal flood risk.

7.3.6 Fluvial Flood Risk Assessment

Modelled Watercourses

Fundamental to the detailed fluvial risk assessment was the development of a hydrodynamic model for each of the main watercourses (and tributaries) within the Belfast SFRA. In general the detailed models indicate that the major fluvial flood risk lies within the 3 cluster areas of the Premier Drive Stream, Blackstaff system and the Connswater system. These areas are highlighted in the figure below.

Specific information on the flooding mechanisms for all individual watercourses cannot be given at this stage as Rivers Agency is still receiving and processing new data and information from the consultant that is undertaking the fluvial modelling study for Belfast. When all of this information this is received and the cause of the predicted flooding to individual watercourses is clear, this section shall be revised as appropriate, and the details included in the final Plan (Dec 2015). Although all of the information to determine the flooding mechanisms is currently unavailable, the predictive models are nonetheless complete and these have been used to produce the detailed Flood Hazard maps which are available through Flood Maps NI. Therefore, the data is currently available to determine the flood risk from all of the watercourses within Belfast. In the meantime, Rivers Agency will take the opportunity to discuss any further findings and progress at our forthcoming Flood Forum meetings.

Figure 7.3.6.1 illustrates the locations of the watercourses within Belfast that have been modelled and the geographical extents of the flood inundation areas predicted by the models for 1% AEP (1 in 100 year) flood event.

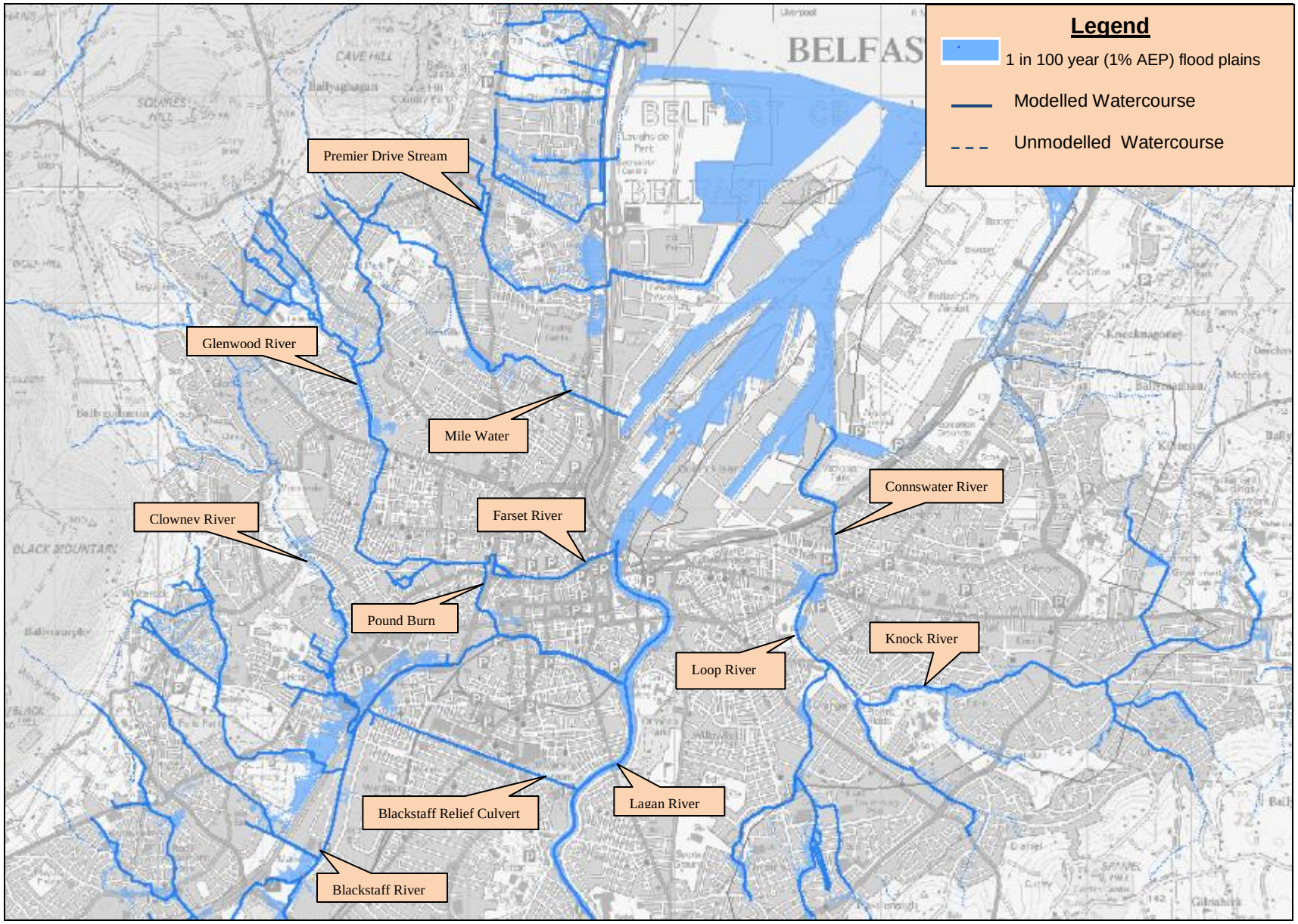


Figure 7.3.6.1 - Belfast SFRA – Modelled watercourse Locations and predicted flood inundation areas for 1% AEP (1 in 100 year) event

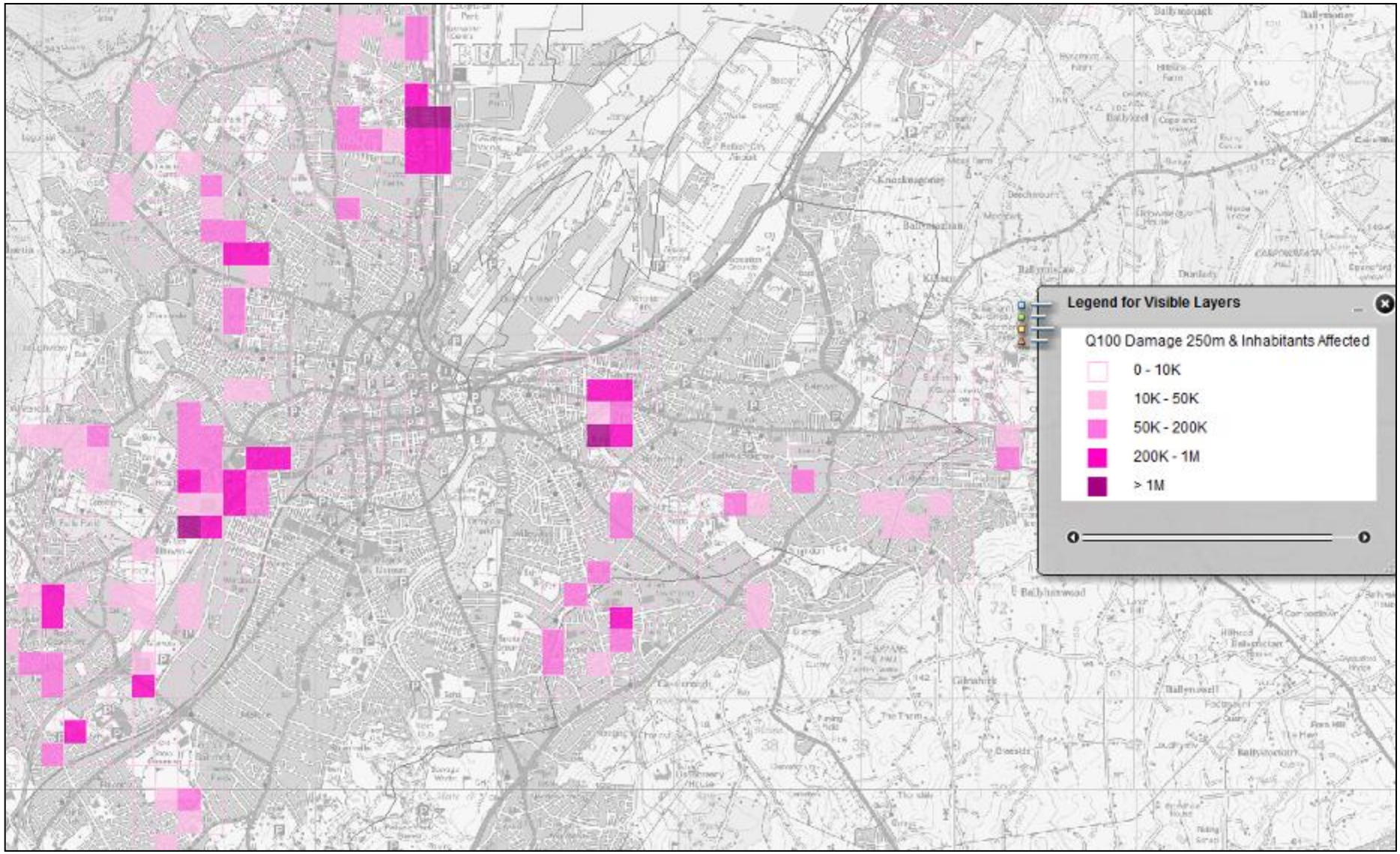


Figure 7.3.6.2 - Belfast SFRA – Locations with very high fluvial flood damages

Belfast – All Watercourses

The models show that across the whole of the Belfast Area, in excess of 5,000 properties are estimated to be located within the areas that are predicted to flood from all of the watercourses at the medium probability, 1% AEP (1 in 100 year), flood event. Based on the flood maps it is calculated that the present value of the damage costs from all future flood events is £63m. These figures are included in the Table 7.3.6.1 below.

Connswater System

Flooding is predicted to take place in a number of areas. The main flooded areas are indicated at the Newtownards Road and Ballyhackamore on the Connswater; Ladas Drive and Mount Merrion Avenue on the Loop and to areas South of Montgomery Road on the Glenbrook River. The flooding is likely to be due to inadequate capacity in the river culvert and local drainage systems. The model predicted that at the medium probability flood event, 1% AEP (1in 100 year), a total of 694 residential properties and 101 non residential properties are inundated by floodwater. Based on the flood maps it is calculated that the present value of the damage costs from all future flood events is £11m. These figures are included in the Table 7.3.6.2 below.

Blackstaff System

The model predicts significant flooding along the Blackstaff River and its tributaries. The main flooding occurs along the lower reaches of the river at the Village area, along the extents of the West Link and extending past the Broad Meadows to Kennedy Way. There is also flooding indicated along the Clowney River from its outlet to as far up as the Millennium Way crossing. The model shows at the medium probability flood event, 1% AEP (1 in 100 year), a total of 2691 residential properties and 259 non residential properties may be inundated by floodwater. Based on the flood maps it is calculated that the present value of the damage costs from all future flood events is £16.8m. These figures are included in the Table 7.3.6.2 below.

Premier Drive Stream

The model shows significant flooding to the North of Skegoneill Avenue and along Premier Drive. It appears that part of the flood water from the culverted system also flows along the road systems and then collects in the low lying flat areas along the Shore Road and between the Shore Road and the railway line. The model predicts that at the medium probability flood event, 1% AEP (1 in 100 year), that a total of 779 residential properties and 69 non residential properties may be inundated by floodwater. Based on the flood maps it is calculated that the present value of the flood damage costs from all future flood events is £34m. These figures are included in the Table 7.3.6.2 below.

Table 7.3.6.1 **Belfast SFRA – All Watercourses**			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	1950	2488	4580
Non Residential (Nr)	175	237	461
Economic Damage (£)	3.75m	5.86m	22.92m
Annual Average Damage (£)	2.1m		
Present Value (£)	**63m**		
IPPC sites (Nr)	**0**	**1**	**1**
Community Assets (Nr)	**1**	**2**	**3**
Care Homes			
GP Surgery's	1	1	1
Fire stations			
Hospitals			
Police Stations			
Schools		1	2
Key Infrastructure (Nr)	**23**	**33**	**57**
NIW Wastewater Treatment Works			
NIW Sewage Pumping Stations			3
NIW Water Treatment Work			
NIW Treated Water Pumping Stations			
NIE Substation 6to11kV	20	30	51
NIE Substation 33kV	2	2	2
NIE Substation 275kV			
NIE Substation 110kV			
Road Service - Trunk Road	1	1	1
Environmental Designated sites (Nr)	**0**	**0**	**0**
AONB			
ASSI			
Environmentally Sensitive Areas			
Maritime Nature Reserve			
Nature Reserve			
RAMSAR			
SAC			
Sites of Local Nature Conservation Importance			
SPA			
RSPB Reserve			
UWT Nature Reserve			
Built Heritage sites (Nr)	**4**	**4**	**8**
National Trust			
Listed Buildings	4	4	7
Sites and Monuments Records			1
Buildings of Special Architectural or Historical Interest			
Areas of Significant Archaeological Interest			
Historic Gardens			

Table 7.3.6.2 Potential Adverse Consequences – Fluvial Flooding High Consequence Watercourses			
Belfast SFRA – Connswater (and tributaries)			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	246	366	694
Non Residential (Nr)	34	46	101
Economic Damage (£)	482k	1.47m	5.96m
Annual Average Damage (£)	365k		
Present Value (£)	**11m**		
Belfast SFRA – Blackstaff (and tributaries)			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	966	539	2691
Non Residential (Nr)	77	123	259
Economic Damage (£)	911k	1.85m	9.24m
Annual Average Damage (£)	561k		
Present Value (£)	**17m**		
Belfast SFRA – Premier Drive Stream			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	530	539	779
Non Residential (Nr)	47	50	69
Economic Damage (£)	2.25m	2.42m	7.25m
Annual Average Damage (£)	1.14m		
Present Value (£)	**34m**		

7.3.7 Proposed Fluvial Flooding Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Belfast it is important that Rivers Agency does not add to the flood risk by allowing new development to take place in areas of known flood risk. Planning Policy Statement, PPS 15, Planning and Flood Risk, adopts a precautionary approach to development with the primary aim *'to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere'*.

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the 'Exception' rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to 'Greenfield' built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new development plans for Belfast Rivers Agency will advise against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 100 year fluvial floodplain, reservoir inundation area or is susceptible elsewhere to surface water flooding.

Rivers Agency shall also review the existing Development Plan for Belfast (Belfast and Metropolitan Area Plan, 2015) with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

The main (undeveloped) flooded areas, amongst others, within the Belfast Significant Flood Risk Area are:-

- Lagan Valley Regional Park
- Orangefield Park, East Belfast

Planning Applications

Fluvial Areas at Risk

Rivers Agency shall advise against the development of all sites that are located within the1 in 100 year fluvial floodplain, irrespective of whether they are located within a current development plan or as a single site application outside the plan area.

For those sites within the1 in 100 year fluvial floodplain where the principle of development has been accepted by Planning NI as meeting the 'Exception Test', Rivers Agency shall further consider the application through the appraisal of an accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The <u>main</u> existing developed areas, amongst others, at flood risk within Belfast were re-development may be likely to take place are:-

<u>Premier Drive Stream, North Belfast</u>

- Along Premier Drive/Fortwilliam Parade and to the North of Skegoneill Avenue
- Along York Street/Shore Road and to the West of the railway line.

<u>Blackstaff System, South Belfast</u>

- Along the Blackstaff River, particularly West of the West Link and the Village area,
- Along the Clowney Stream, West Belfast

- Along the Ballymurphy Stream, West Belfast

Connswater System

- Along the Connswater, at the Newtownards Road, East Belfast
- Along the Connswater at Ballyhackamore, East Belfast
- Along the Loop River at the Castlereagh Road, East Belfast
- Along the Loop River, at Ladas Drive and Mount Merrion Avenue, East Belfast
- Along the Glenbrook River between Montgomery Road and the Cregagh Road
- Along the Knock River at Orangefield Park

Areas at Risk of Surface Water Flooding

For those sites outside the 1 in 100 year fluvial floodplain that are located in an area where there is evidence of a history of surface water flooding (identified by flood hardship payments) Rivers Agency will further consider the application through the appraisal of the accompanying Drainage Assessment that will need to demonstrate suitable flood mitigation measures.

Where there is potential for surface water flooding as indicated in the Surface Water Map 'areas highlighted purple' Rivers Agency will advise that the applicant should assess the flood risk and drainage impact to the site and construct in an appropriate manner.

The main areas identified in Belfast Area as being at surface water flood risk are:-

- Sicilly Park Area, Marguerite Park, South Belfast
- Ballynafeigh, Upper Ormeau Road, South Belfast
- Between Mount Merrion Avenue and the Cregagh Road, East Belfast

Areas at Risk of Flood Inundation from Reservoirs

For all development proposals that are located within the potential flood inundation area of a controlled reservoir Rivers Agency will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures. If it is a new development proposal Rivers Agency will also need the applicant to demonstrate that the condition, management and maintenance regime of the reservoir is appropriate to provide sufficient assurance regarding reservoir safety.

Controlled reservoirs identified in the Belfast area are as follows:

- Waterworks (Antrim Road)
- Springfield (Mackies)
- Galwally

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is therefore important that we continue to target investment by providing flood defence, culvert alleviation schemes and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. The Flood Investment and Planning Group, FIPG, provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities. The draft terms of reference for the FIPG can be found in Annex G.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a 'Flood Risk Metric Tool', FRISM is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total 'damage avoidance benefits' that the scheme will provide to the property over the scheme's design life. If the benefit/cost ratio is greater than 1, then the potential scheme will be referred to Rivers Agency, Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely, Rivers Agency's responsibility, or is the responsibility of NI Water or Transport NI, such as a local drainage or road infrastructure issue then it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a benefit cost analysis identifies a viable scheme, a scheme will then be placed on a prioritisation list for works with other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take anything from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Within the Belfast area the following potential schemes have been identified and will be referred to the appropriate bodies for further investigation or detailed feasibility study.

Possible Schemes in Belfast SFRA

General

A number of other studies may be recommended in the Final Plans as new information on flood models, flooded areas and the flow mechanisms become available.

Surfacewater

South Belfast

Kinnegar Road/Locksley Park Culverts

Since June 2012, NI Water in South Belfast have carried out CCTV surveys on the majority of the Kinnegar/ Locksley Park culverts and along with other utility service providers have removed obstructing services. Rivers Agency and other agencies have carried out localised, emergency culvert repair works.

As part of NIW developing plans to upgrade the drainage and sewerage network in the affected areas, Rivers Agency has recently completed a Business Case to assess the viability of a scheme to repair the Kinnegar Road / Locksley Park culverts. This should progress to detail design stage in 2015/16, subject to the necessary approvals.

Sicily Park and Greystown

NI Water and River Agency are working in partnership on an integrated project to address flooding issues in Sicily Park and Greystown areas of South Belfast. The proposed scheme involves upgrading existing watercourse and sewerage infrastructure and a joint Business Case is being prepared by NI Water to establish the most cost-effective options.

Ashton Park and Orchardville

Due to local drainage inadequacies the Ashton Park and Orchardville areas have been severely affected by flooding to many properties. Although maintenance works have been carried out, the risk of flooding in severe weather remains. There is a need to progress a study to look at a range of possible solutions. NI Water may be able to take this forward in the long term as part of their Glenmachen Project.

Connswater System

Following collaborative studies, a major East Belfast Flood Alleviation Scheme is currently underway which is being undertaken in-tandem with the Connswater Community 'Greenway', a multi-million pound environmental enhancement scheme along river corridors in East Belfast. The flood alleviation scheme is due for completion in 2016 and will resolve many of the flooding issues in the inner City parts of the catchment. However, there are further flooding issues, particularly upstream of the Knock dual carriageway, to be resolved upstream in these catchments and along other watercourses in East Belfast. These issues will require further studies and investment in the future. With regard to the NI Water pumping station, interim upgrading of the pumping infrastructure has been undertaken but it may be some years before a new pumping station is built with necessary capacity and redundancy to fully protect the community from flooding from this source.

Blackstaff System

Blackstaff

It is recommended that further studies are carried out on the lower reaches of the Blackstaff, which may include the Farset River.

Clowney River

It is recommended that a study takes place on the lower reaches of the Clowney River to look at the flooding mechanisms/ flow paths as far up as the Millennium Way crossing.

Premier Drive Stream

It is recommended that a study takes place on the watercourse to look at and propose solutions to the out of sewer flooding mechanisms/ flow paths, particularly accumulating along the Shore Road/York Street.

Preparedness

In Belfast it is not possible to prevent or protect against all flooding. Indeed even where flood defences exist it is possible in an extreme event that these could be over topped and flooding could still occur.

Having recognised this fact, considerable effort in recent years has been made by emergency planners in a Government Departments, Councils and the Emergency Services working together and sharing information to ensure a coordinated response.

However, despite these improvements during significant flood events the emergency response of Government Departments and the Emergency Services can become over stretched. This means that not all calls for assistance during a flood event can be responded to in a timely manner. With this in mind it is important that households and communities, subject to a known flood risk, are prepared. The detail of preparedness actions including flood warning and informing activities planned from a regional perspective are provided in Annex E.

This is not Government withdrawing from any undertaking to respond in emergencies but an additional layer of support to ensure Government Departments and the public work together to reduce the overall impacts of flooding.

From the flood risk assessment there are at least 17 areas in Belfast that have flooded in the recent past that may benefit from the flood warning and informing proposals, outlined in Annex D.

A pilot project of community engagement to deliver flood warning and informing, held in 2014, identified basic assessment formulae to assess and score areas that could potentially be a focus for flood warning and informing actions. As part of this pilot project, community engagement has been carried out with the community in the Cregagh area. Based on this scoring the following areas could be considered suitable for being included in a programme of community engagement to deliver flood warning and informing initiatives:-

- Clarawood Park area
- Stockmans Lane
- Finaghy Road North area
- Gilnahirk Road / Kingsway Park area
- Greystown Avenue / Finton Gardens area
- York Park / Pittsburg Street area
- Montgomery Road area
- Loopland Park area

Key activities that could be undertaken are:-

- Explaining the potential and limitations of Community Resilience.
- Briefing communities on information available, particulary from the Met Office.
- The facilitation of self-help initiatives, including remote sandbag storage; and
- Reviewing and validating all elements of the Community Engagement Plan to help the community communicate effectively in an emergency and work together.

A table in Annex J shows how this community's rank in the overall context of the 20 FRA's in this plan. It should be noted that this is an indicative assessment which may change subject to further information on flood risk becoming available.

The rollout of this work is dependent on funding being available.

7.4 Downpatrick Significant Flood Risk Area

The core boundary of the Downpatrick SFRA, which has been determined through the PFRA, is located within the Quoile Local Flood Management Area and illustrated in Figure 7.4.1 below.

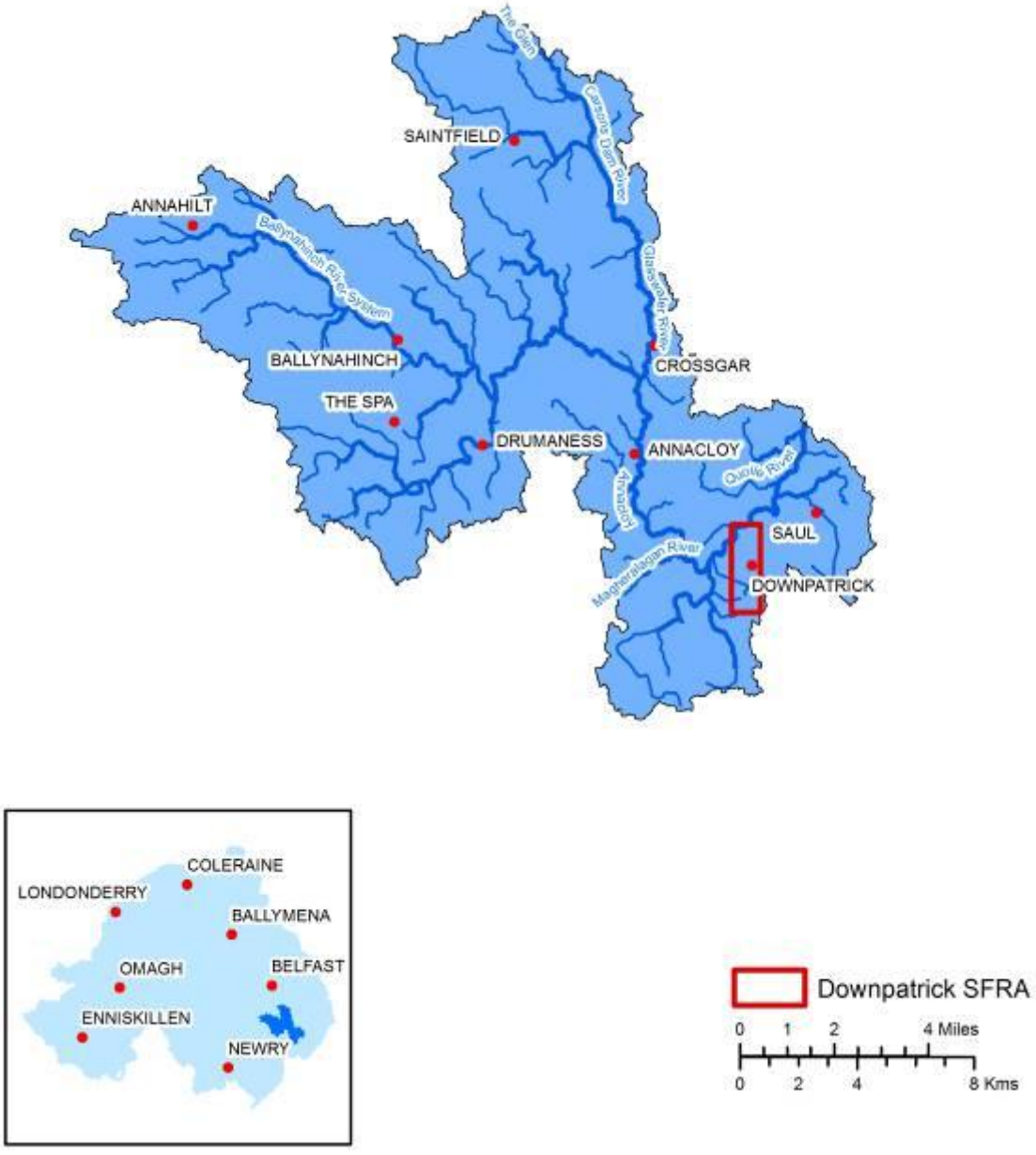


Figure 7.4.1 - Quoile LFMA and Downpatrick SFRA

7.4.1 Flooding History

There have been numerous instances of flooding to low lying areas of the Downpatrick since construction of the Quoile Tidal Barrier in 1957. The details of many of these flooding incidents have been recounted in the local newspapers and more recently, documented in media reports which are available on the internet. There is a continuing theme throughout these reports that points towards a failure of the urban drainage systems, which are unable to vent the runoff arising from heavy rainfall events, particularly at times whenever the water levels in the Quoile Pondage are high. Notable reports of flooding have occurred in 1963, 1966 (see Photo 7.4.1.1 below), 1978 and on a number of occasions within the last decade, most recently on 10 April 2013. The low lying areas of the town most frequently affected by the flooding are in the vicinity of Market Street, Ballyduggan Road and Church Street. Since the introduction of the flooding hardship payment scheme in 2007 there have been no payments issued to homeowners in the Downpatrick SFRA. However, this is because the hardship payment scheme is not open to the owners of flooded business premises, such as those in the Market Street area which have flooded since 2007.

Photo 7.4.1.1 - Downpatrick's Market Street, May 1966

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7.4.2 PFRA – Identification of Potentially Significant Flood Sources

According to the Preliminary Flood Risk Assessment (Dec 2011) the town of Downpatrick, in terms of the potential adverse consequences of flooding, is ranked eighteenth of the twenty SFRA within Northern Ireland (see Figure 4.1). On the basis of this initial assessment, which was undertaken using the strategic flood maps, the predominant flood risk to the town was considered to arise from tidal inundation and, to a much lesser extent, from fluvial flooding.

It should be noted that the PFRA flagged up the potential for significant tidal inundation at Downpatrick because this national assessment is based on strategic 'undefended' flood models which ignore the presence of existing flood defence systems such as the Quoile Barrier. Therefore, the assessment is in effect based on the worst case scenario, as it assumes there is no benefit from the defences. This precautionary approach has been taken because, at the time of the assessment, there was a degree of uncertainty about the level of protection that each of the existing flood defence systems provides. By adopting this approach, the urban areas that are located behind existing flood defence structures were determined to be SFRA by default and as a consequence detailed Flood Hazard/Risk Maps had to be prepared in compliance with the requirements of the Directive. This provided the opportunity to undertake the detailed structural assessments and flood modelling necessary to remove the uncertainty and establish the actual level of protection offered by these defences.

To facilitate a more robust assessment of the level of flood risk to Downpatrick from rivers and the sea, Rivers Agency developed detailed predictive flood models for each of these sources. It is considered that the flood hazard maps produced from these models will give a more accurate prediction of the flooded areas which may have been over or under estimated by the strategic flood maps. Details of the models and their output are described in the following sections.

7.4.3 Catchment Characteristics

The Quoile Local Flood Management Area (LMFA) is in the North Eastern River Basin District and covers an area of approximately 245km2. The major towns in Quoile LFMA are Downpatrick, Saintfield, Ballynahinch and Crossgar with smaller towns including Annahilt and Annacloy. The main land cover is represented by improved grassland, with a small amount of arable horticulture and neutral grass. The area has a range of habitats that have protected status and is a National Nature Reserve. It also supports a range of recreational activities such as bird watching, walking, angling, tourism, canoeing and yachting. The catchment drains two significant river systems, the Glasswater River which rises near Saintfield town, around 18km to the north of Downpatrick and the Ballynahinch River, which rises close to Annahilt, 22km to the northwest. The Ballynahinch River flows southward through Ballynahinch towards its confluence with Glasswater River at Kilmore where it becomes the Annacloy River. The river turns east then north east before reaching Downpatrick where it becomes the Quoile River and flows into the Quoile Pondage.

Up until the middle of the 18th century, Downpatrick was in effect a seaside town. The tidal waters of Strangford Lough extended up to and almost encircled the town. In an effort to reclaim land from the sea,

the local landowner Edward Southwell erected the first tidal barrage across the estuary of the Quoile River in 1745 at a site near the bridge on the Old Belfast Road. To improve the protection against flooding, a new structure, equipped with self-actuating gates was constructed in 1934 and finally, in 1957 the Quoile Tidal Barrier (pictured below) was constructed at the mouth of the River Quoile at Hare Island.

Photo 7.4.3.1 - Quoile Barrier (sea facing aspect)

The location of the Quoile Barrier at the mouth of the natural estuary of the River Quoile is highlighted in Figure 7.4.3.1 below.

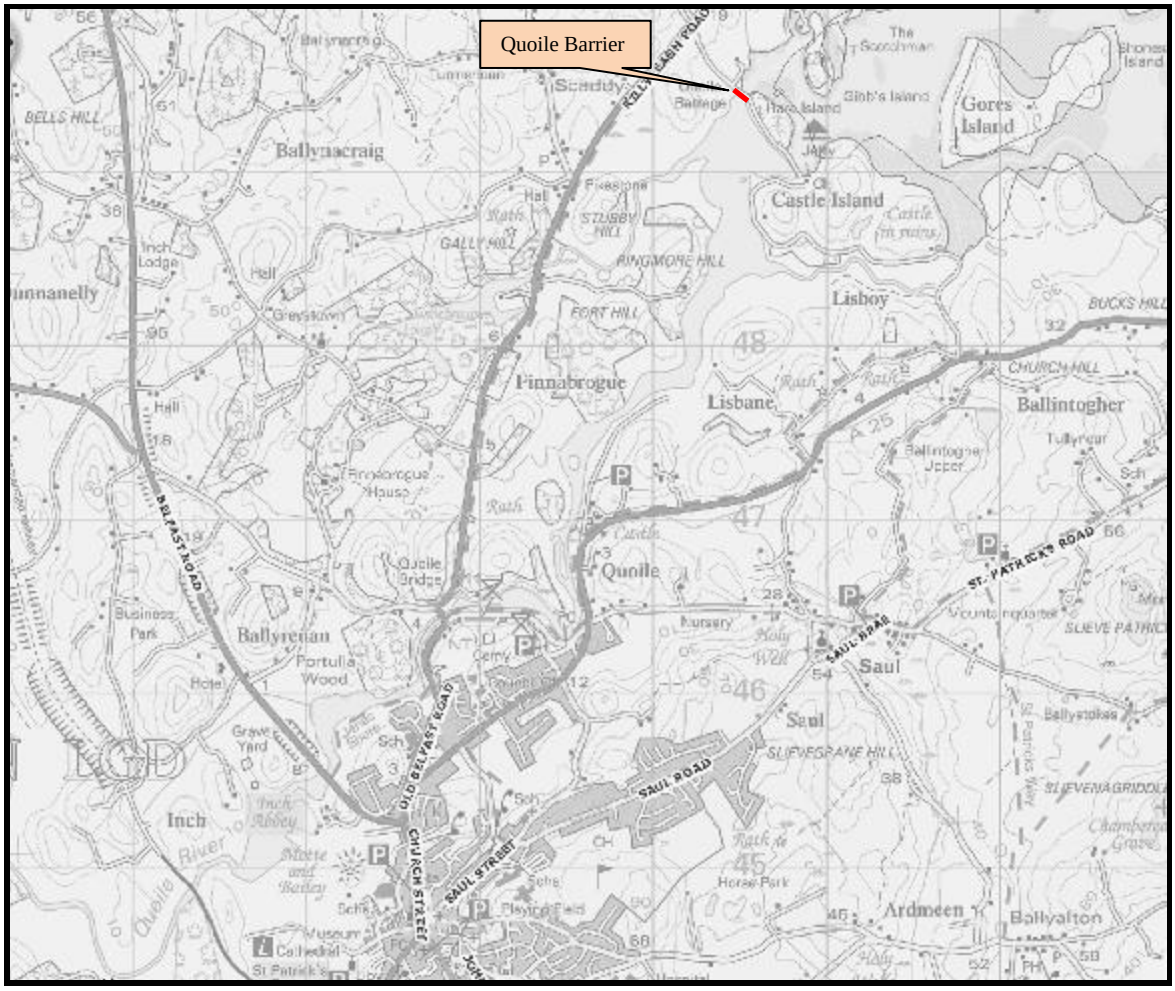


Figure 7.4.3.1 - Location of Quoile Barrier

The lower reach of the Quoile River from the Tidal Barrier upstream to Annacloy, a distance of 14km, has a very shallow gradient with the bed rising marginally to a height of 0.86m AOD. Much of the natural flood plain along this reach is below mean sea level and, as a result, would be inundated on a regular basis during normal high tides, if the tidal barrier was not present. The tidal barrier effectively eliminates the tidal inundation of this stretch and creates a freshwater pondage with more a stable and substantially lower water level. The impounded water discharges to Strangford Lough through a series of 16 flap gates in the tidal barrier at stages in the tidal cycle when the sea level is lower than the pondage level. This passive system does not enable levels in the pondage area to be regulated or controlled by Rivers Agency. However, it generally maintains levels within a 1m range (typically -0.7m to 0.5m AOD), but occasional extreme levels outside of this range occur in most years.

7.4.4 Coastal Flood Risk Assessment

For the purposes of producing inundation flood mapping for the overtopping of the Quoile Barrier, extreme sea water levels for a range of return periods were derived using the methodology described in the Rivers Agency's report S*trangford and Belfast Extreme Tides Boundary Condition (August 2009)*. The tidal simulations for Strangford Lough were undertaken using a detailed MIKE 21 HD model which is a sub-model

driven by the Irish Surge and Tidal Model that is used to determine extreme sea levels around the non-estuarine coastline of Ireland. Based on the Strangford tidal model the estimated extreme tidal levels at the Quoile Barrier are shown in Table 7.4.4.1 below.

Strangford Lough (Quoile) - Estimated Extreme Sea Levels

	Annual Exceedance Probability - (Return Period)	Extreme Water Level (m OD)
Present Day	10% AEP - (1 in 10 year)	2.954
	0.5% AE - (1 in 200 year)	3.202
	0.1% AEP - (1 in 1000 year)	3.445
Year 2030	10% AEP - (1 in 10 year)	3.029
	0.5% AEP - (1 in 200 year)	3.277
	0.1% AEP - (1 in 1000 year)	3.520
Year 2100	10% AEP - (1 in 10 year)	3.706
	0.5% AEP - (1 in 200 year)	3.954
	0.1% AEP - (1 in 1000 year)	4.197

Table 7.4.4.1 – Strangford Lough (Quoile) Estimated Extreme Sea levels

Coastal Flood Mechanism

As the crest level of the Quoile Barrier is 3.4m OD, which is higher than the estimated extreme level of a 1 in 200 year tidal event at both the Present Day and 2030 yr scenarios (3.202m and 3.277m respectively) there is no significant risk of the sea overtopping this defence in the medium term and consequently no significant risk of coastal flooding to Downpatrick from the sea. However, based on current climate change predictions, it is anticipated that coastal flood risk will increase with time and the model shows that by the year 2100 the annual chance of the sea overtopping the Quoile Barrier may be greater than 10%.

7.4.5 Proposed Coastal Flooding Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Downpatrick it is important flood risk is not increased by allowing new development in areas of known flood risk. Planning Policy Statement, PPS 15, “Planning and Flood Risk”, adopts a precautionary approach to development with the primary aim “to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere”.

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the "Exception" rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to "Greenfield" built development in coastal defended areas are unlikely to be accepted.

Development Plans

In the preparation of new Development Plans for Downpatrick, Rivers Agency advise against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 200 year coastal floodplain.

We shall also review the existing development plan for Downpatrick (Ards and Down Area Plan) with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

The main (undeveloped) coastal flooded areas, within the Downpatrick Significant Flood Risk Area are:-

- along the Quoile River and to the west of the town and in particular those to the north of the town that are closer to the Quoile Barrier.

Planning Applications - Coastal Areas at risk

Rivers Agency shall advise against the development of all sites that are located within the 1 in 200 year coastal floodplain, irrespective of whether they are located within a current development plan or as a single site application outside the plan area.

For those sites within the 1 in 200 year coastal floodplain where the principle of development has been accepted by Planning NI as meeting the "Exception Test" we will further consider the application through the appraisal of an accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The main areas, amongst others, at coastal flood risk within Downpatrick where development may be likely to take place are:-

- the coastal inundation areas along the Quoile River but excluding those 'Greenfield' areas in the proximity of the Quoile Barrier, which may be deemed as being within a defended area.

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is therefore important that we continue to target investment by providing flood defence, culvert alleviation schemes and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. **The Flood Investment and Planning Group**, FIPG, provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a Flood Risk Metric Tool (FRISM) is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total "damage avoidance benefits" that the scheme will provide to the property over the scheme's design life. If the benefit/cost ratio is greater than 1 then the potential scheme will be referred to Rivers Agency, Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely, Rivers Agency's responsibility, or is the responsibility of NI Water or Transport NI, such as a local drainage or road infrastructure issue then it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a benefit cost analysis identifies a viable scheme, a scheme will then be placed on a prioritisation list for works with other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take anything from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Having conducted a detailed assessment of the coastal flood risk to Downpatrick, Rivers Agency has determined that the Quoile Barrier is currently protecting the town of Downpatrick from extreme tidal surges up to the predicted 1 in 1000 year event which is substantially higher than the normal design standard of 1 in 200 year adopted by Rivers Agency for the construction of sea defences. However, based on current climate change predictions, it is anticipated that coastal flood risk will increase with time and the model shows that by the year 2100 the annual chance of the sea overtopping the Quoile Barrier may be greater than 10%. Then again, due to the high degree of uncertainty associated with climate change predictions it would not be proportionate to commit valuable public resources to undertake a scheme to raise the level of the Quoile Barrier to protect against a potential future flood risk that may not arise. As the coastal flood modelling will be continually updated as new techniques and data become available there will be an opportunity to re-assess the risk to Downpatrick from tidal flooding in future PFRA cycles (i.e. on a six yearly

basis). Therefore, based on the information available at this time there is no reason to include additional structural mitigation measures to reduce coastal flood risk in this plan.

Preparedness

The level of coastal flood risk to Downpatrick is extremely low and does not justify a local tactical Coastal Flooding Emergency Response plan.

7.4.6 Fluvial Flood Risk Assessment

Fluvial Model

The hydrodynamic model used for the assessment of fluvial flood risk was developed using Infoworks RS 1d/2d for the largely open watercourse sections which included the Quoile River from Kilmore to the Pondage, the Ballynahinch River from Ballynahinch to Kilmore, the Glasswater River from upstream of Crossgar to Kilmore and the Drumaness River from upstream of Drumaness to its confluence with the Ballynahinch River. Minor urban tributaries within the town of Downpatrick including the Plank Drain, Town Drain, Saul Street Stream, and the Strangford Road Stream which are substantially culverted, were modelled using Infoworks ICM. The location and extents of the watercourses modelled are illustrated in Figure 7.4.6.1

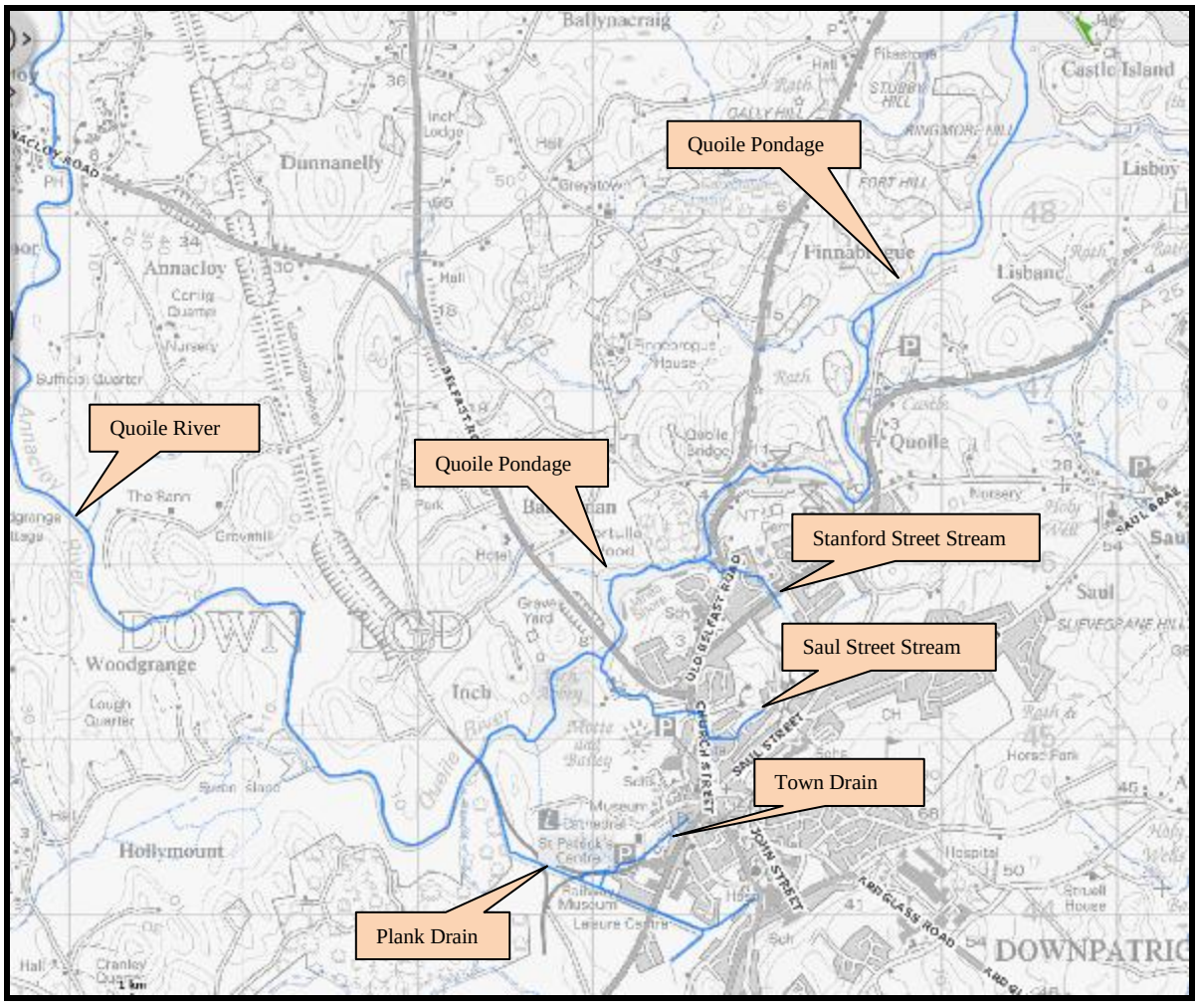


Figure 7.4.6.1 - Downpatrick SFRA - Modelled Watercourses

Modelled Watercourse Descriptions

Quoile Pondage

The water level of the Quoile Pondage and the geographical extent of its inundation area constantly fluctuate in response to the antecedent weather conditions and tidal conditions. These affect the flows from the watercourses which discharge to it, the direct run-off from the surrounding land and the Quoile Barrier's capacity to discharge to Strangford Lough.

It proved impossible to produce an acceptable hydrodynamic model that adequately represented the rise and fall of the water level in response to the combined influence of the various factors. Therefore, the water levels of the pondage for extreme events (with a range of return periods) were estimated using a statistical analysis of the continuous 30 year record of water levels within the Pondage that are measured by the Hare's Island Gauging Station. On the basis of this analysis the estimated water levels for the Pondage used within the fluvial model are as follow:

- 10% AEP (1 in 10 year) 1.26m OD
- 1% AEP (1 in 100 year) 1.93m OD
- 0.1% AEP (1 in 1000 year) 2.57m OD

Quoile River (and main tributaries)

The modelled reach of the Quoile River from Kilmore to the start of the Pondage Area has a length of 13.5km. From Annacloy to the tidal barrier at Hares Island (some 14 km downstream) the channel has a very shallow hydraulic gradient. Much of the flood plain along this stretch is below mean sea level and, where it not for the presence of the tidal barrage, these low lying areas would be inundated on a regular basis during high tides,. The barrage eliminates the tidal inundation along this stretch and maintains a fairly constant pondage area between Downpatrick and the structure at Hares Island. Moving upstream from Annacloy, the Quoile River rises substantially to Kilmore where branches and the Ballynahinch and Glasswater rivers converge.

Minor Urban Tributaries (Downpatrick Centre)

The designated Plank Drain fringes the southern end of Downpatrick's town centre and flows from the east of the town to meet Quoile River just upstream of the railway bridge. The watercourse is open from its confluence with the Quoile to the outskirts of the town at Ballyduggan Road after which it is largely culverted. The lower section under the playing fields is twin 900mm diameter concrete pipes and has not been structurally graded because the pipes are partially filled with silt and/or standing water due to backflow from the Quoile Pondage. Upstream of the pitches, the Plank Drain receives a small open watercourse (the designated Pemberton Park) , at this point the size of the culvert reduces substantially (typically 450mm diameter concrete pipes) and these are in good structural condition apart from one relatively short section near the head of the system.

The Town Drain, which is a sizeable tributary of the Plank Drain, fringes the west side of the town centre and flows south from the rear of the Grove Shopping Centre at Market Street to its confluence with the Plank

Drain at the vicinity of the Asda Store. The Town Drain is culverted with concrete pipes (typically 675-750mm diameter) for the whole of its length. The condition of the culvert is generally in poor condition (most sections structural grade 4 or 5) and as with the Plank Drain the lower sections have not been inspected due to standing water and/or siltation.

The Saul Street Stream borders the north side of the town. It flows from the Meadowlands housing estate to the Quoile River just upstream of the Belfast Road Bridge at the sewerage treatment works. The watercourse is culverted throughout the Meadowlands estate along Church Road where it issues to an open section at the west side of New Bridge Street just north of the Downpatrick Business Park. The culverts are typically 675mm to 1350mm diameter concrete pipes with an occasional section of box culvert and are generally in good structural condition.

The Strangford Road Stream is located at the northern side of the town. This designated watercourse is culverted for approximately 400m of its 600m length. The culverted section begins at the upstream side of the Strangford Road, runs throughout the length of the Orchard housing estate, under the Old Belfast Road where it flows to a short open section (approx. 100m) that discharges to the Quoile Pondage. The culverts are typically 1350mm diameter and generally in good structural condition.

Fluvial Flooding Mechanisms

Figure 7.4.6.2 illustrates the predicted extents of the potential fluvial flooding at Downpatrick and details of the potential impact of the flooding on property and key infrastructure is summarised in Table 7.4.6.1. The model shows that at the relatively high frequency 10% AEP flood event, floodwater is predicted to spill from all of the culverted watercourses within the town and that the resulting surface water flow will pond to shallow depths up to 300mm in the low lying areas most notably at Market Street, Church Street, Ballyduggan Road. The main cause of flooding from the watercourses in the Downpatrick area is likely to be related to the fact that, for much of the time, the water level in the Quoile Pondage is substantially higher that the invert levels of the culvert outfalls. The submersion of the outfalls severely limits the flow carrying capacity of the culverts and during extreme events, water from the Quoile Pondage will backflow through the culvert networks and spill onto the surface via manholes in the low lying areas of the town. On the basis of the predictive model it is estimated that at the relatively frequent 10% AEP (1 in 10 year) event, 10 residential and 37 commercial properties could be internally flooded and cause damages in excess of £376k. At the more extreme 1% AEP (1 in 100 year) event the predicted flooding is generally confined to the same locations, although the flood inundation areas are more extensive and deeper (up to 1m deep) particularly in the vicinity of Market Street. Flooding from the 1% AEP event is estimated to affect 63 residential and 113 commercial properties at a cost of around £1.7m. The present day value of the total cost of future flood damages is calculated to around £3 million.

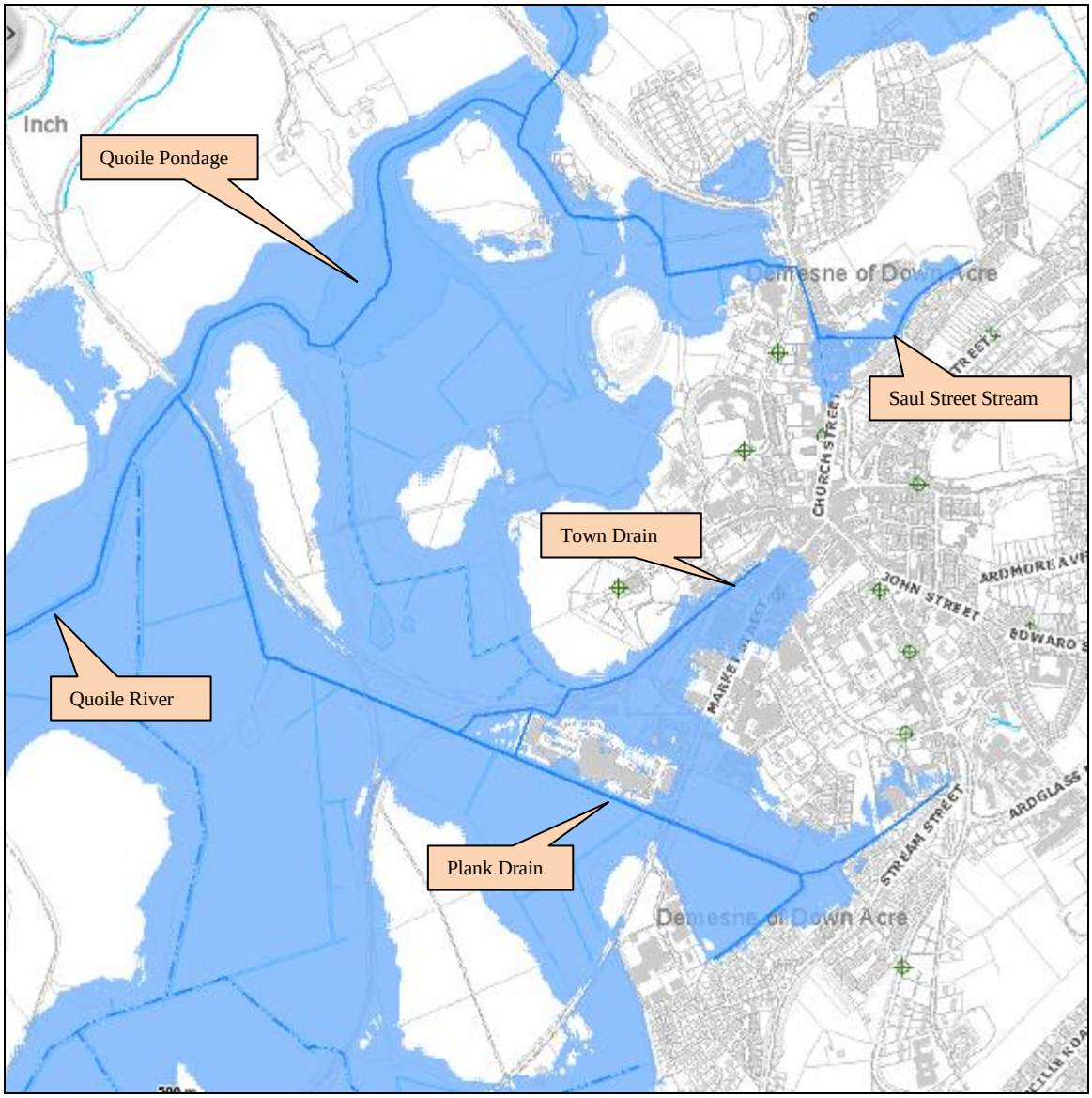


Figure 7.4.6.2 - Downpatrick SFRA – Fluvial Flood Plains 1% AEP (1 in 100 year)

Table 7.4.6.1 **Downpatrick SFRA**			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	10	40	63
Non Residential (Nr)	37	70	113
Economic Damage (£)	376k	70k	1.7m
Annual Average Damage (£)	100k		
Present Value (£)	**3.0 million**		
IPPC sites (Nr)	**0**		**0**
Community Assets (Nr)	**0**		**0**
Care Homes	**0**		**0**
GP Surgery's	**0**		**0**
Fire stations	**0**		**0**
Hospitals	**0**		**0**
Police Stations	**0**		**0**
Schools	**0**		**0**
Key Infrastructure (Nr)	**1**		**13**
NIW Wastewater Treatment Works	**0**		**0**
NIW Sewage Pumping Stations	**0**		**3**
NIW Water Treatment Work	**0**		**0**
NIW Treated Water Pumping Stations	**0**		**0**
NIE Substation 6to11kV	**0**		**7**
NIE Substation 33kV	**0**		**0**
NIE Substation 275kV	**0**		**0**
NIE Substation 110kV	**0**		**0**
Road Service - Trunk Road	**1**		**3**
Environmental Designated sites (Nr)	**10**		**10**
AONB	**1**		**1**
ASSI	**2**		**2**
Environmentally Sensitive Areas	**0**		**0**
Maritime Nature Reserve	**0**		**0**
Nature Reserve	**1**		**1**
RAMSAR	**1**		**1**
SAC	**1**		**1**
Sites of Local Nature Conservation Importance	**3**		**3**
SPA	**1**		**1**
RSPB Reserve	**0**		**0**
UWT Nature Reserve	**0**		**0**
Built Heritage sites (Nr)	**11**		**14**
National Trust	**0**		**0**
Listed Buildings	**0**		**0**
Sites and Monuments Records	**7**		**9**
Buildings of Special Architectural or Historical Interest	**2**		**3**
Areas of Significant Archaeological Interest	**1**		**1**
Historic Gardens	**1**		**1**

7.4.7 Proposed Fluvial Flood Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Downpatrick it is important the flood risk is not increased by allowing new development in areas of known flood risk. Planning Policy Statement, PPS 15, Planning and Flood Risk, adopts a precautionary approach to development with the primary aim *'to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere'*.

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the 'Exception' rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to 'Greenfield' built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new Development Plans for Downpatrick, Rivers Agency will advise against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 100 year fluvial floodplain, reservoir inundation area or is susceptible elsewhere to surface water flooding.

Rivers Agency shall also review the existing Development Plan for Downpatrick (Ards and Down Area Plan) with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

The main (undeveloped) flooded areas, amongst others, within the Downpatrick Significant Flood Risk Area are:

- West of the town, between the urban fringe and the Quoile River
- South of the town along both sides of Market Street
- North of the town between the urban fringe and the Belfast Road
- North of the town at the Belfast Road and junction with Bridge Street
- Both sides of the Strangford Road near the junction with the Old Belfast Road
- West of the town between Meadowlands and Drumdoon Walk

Planning Applications

Fluvial Areas at risk

Rivers Agency shall advise against the development of all sites that are located within the 1 in 100 year fluvial floodplain, irrespective of whether they are located within a current development plan or as a single site application outside the plan area.

For those sites within the 1 in 100 year fluvial floodplain where the principle of development has been accepted by Planning NI as meeting the 'Exception Test' Rivers Agency will further consider the application through the appraisal of an accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The main existing developed areas, amongst others, at flood risk within Downpatrick where re-development may be likely to take place are in the vicinity of:

- Market Street / St Patrick's Avenue/ Ballydougan Road
- Church Street

Areas at Risk of Surface Water flooding

For those sites outside the 1 in 100 year fluvial floodplain that are located in an area where there is evidence of a history of surface water flooding (identified by flood hardship payments) Rivers Agency will further consider the application through the appraisal of the accompanying Drainage Assessment that will need to demonstrate suitable flood mitigation measures.

Where there is potential for surface water flooding as indicated in the 'purple' predicted areas on the Surface Water Maps, Rivers Agency will advise that the applicant should assess the flood risk and drainage impact to the site and construct in an appropriate manner.

The main areas with a flood history, identified in Downpatrick as being at surface water flood risk are:

- Market Street/ Saul Street
- Church Street
- Playing fields between Ardglass Road and St Dillon's Avenue
- Playing fields east of Ballydougan Road

Areas at Risk of Flood Inundation from Reservoirs

For all development proposals that are located within the potential flood inundation area of a controlled reservoir we will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures. If it is a new development proposal Rivers Agency will also need the applicant to demonstrate that the condition, management and maintenance regime of the reservoir is appropriate to provide sufficient assurance regarding reservoir safety. Controlled reservoirs identified in the Downpatrick area are as follows:

- Finnebrogue Lough

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is therefore important that we continue to target investment by providing flood defence, culvert alleviation schemes and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. **The Flood Investment and Planning Group**, FIPG, provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a 'Flood Risk Metric Tool' (FRISM) is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total 'damage avoidance benefits' that the scheme will provide to the property over the scheme's design life. If the benefit/cost ratio is greater than 1 then the potential scheme will be referred to Rivers Agency's Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely Rivers Agency's responsibility, or is the responsibility of NI Water or Transport NI, such as a local drainage or road infrastructure issue, it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a benefit cost analysis identifies a viable scheme, a scheme will be placed on a prioritisation list for works with other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take anything from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Having conducted a detailed assessment of the fluvial flood risk to Downpatrick, Rivers Agency has determined that a potential flood alleviation schemes to reduce the food risk to property arising from all of the minor urban watercourses which discharge to the Quoile Pondage may be justified. Any flood study to identify viable solutions must take into consideration the wider impacts on the urban drainage systems within the town. See below for details.

Downpatrick Integrated Urban Drainage Study

The predictive flood model used to produce the fluvial flood hazard maps took account of discharges from NI Water's sewerage network using a generalised approach that gives rise to a degree of uncertainty that may impact on the accuracy of the model. NI Water has commenced a major sewerage infrastructure

improvement project in Downpatrick that is designed to reduce the risk of out of sewer flooding. Therefore, to ensure that this investment is not compromised River Agency shall cooperate with NI Water to develop a more refined integrated urban drainage model (IUDM) that will examine the potential flood mechanisms arising from the interaction between the various drainage systems i.e. sewerage, watercourses and pondage.

The IUDM will be used to identify any potential improvements that may be required to NI Water's sewerage network to further reduce the risk from out of sewer flooding and as the basis for a detailed flood study, to be undertaken by Rivers Agency, to identify if a publicly funded flood alleviation scheme to reduce the risk of flooding from the pondage and watercourses is cost beneficial.

An initial assessment of the potential options indicates that it highly unlikely that modifications could be made to the Quoile Barrier to affect control over the water level in the Quoile Pondage to the extent that the culvert outfalls will not be drowned out. Therefore, whilst it may be necessary to improve the condition and/or increase the size of the culverts, this of itself would not be an effective solution unless supported by additional measures such fitting flap valves to outfalls, installing back drainage pumping stations and constructing flood banks to contain direct flows from the pondage.

Preparedness

In Downpatrick it is not possible to prevent or protect against all flooding. Indeed even where flood defences exist it is possible in an extreme event that these could be over topped and flooding could still occur.

Having recognised this fact, considerable effort in recent years has been made by emergency planners in a Government Departments, Councils and the Emergency Services working together and sharing information to ensure a coordinated response.

However, despite these improvements during significant flood events the emergency response of Government Departments and the Emergency Services can become over stretched. This means that not all calls for assistance during a flood event may be responded to in a timely manner. With this in mind it is important that households and communities, subject to a known flood risk, are prepared. The detail of preparedness actions, including flood warning and informing activities planned from a regional perspective, are provided in Annex E.

This is not Government withdrawing from any undertaking to respond in emergencies but an additional layer of support to ensure Government Departments and the public work together to reduce the overall impacts of flooding.

From the flood risk assessment it would appear that there are 3 main areas within Downpatrick that have flooded in the recent before and benefit from the flood warning and informing proposals outlined in Annex D.

A pilot project of community engagement to deliver flood warning and informing, held in 2014, identified basic assessment formulae to assess and score areas that could potentially be a focus for flood warning and

informing actions. Based on this scoring these areas did not score high enough to be placed within the top 20 communities to be offered a programme of community engagement during the period of this plan. However, if communities want to become more resilient, the Department is committed to providing assistance were possible to develop the consistent approach to resilience. The NI Direct website www.nidirect.gov.uk/ will host further information and advice on what to do in advance of flooding, what to do during flooding and how to recover after flooding. The website will also contain templates for communities wishing to develop their own plan.

7.5 Dundonald Significant Flood Risk Area

The core boundary of the Dundonald SFRA, which has been determined through the PFRA, is located within the Strangford Lough Local Flood Management Area and is illustrated in Figure 7.5.1 below.

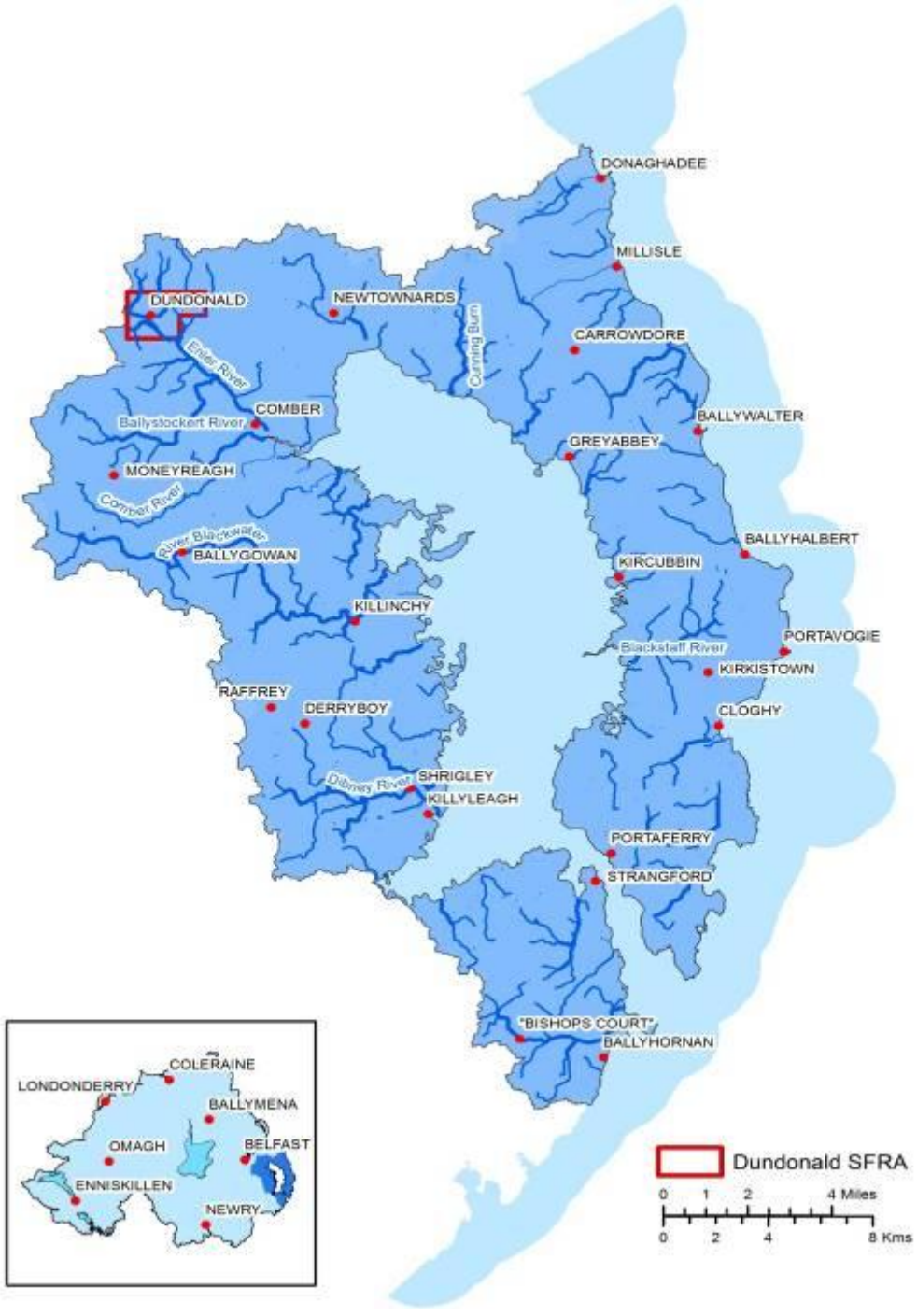


Figure 7.5.1 Strangford Lough Local Flood Management Area and Dundonald SFRA

7.5.1 Flooding History

A review of the readily available archived historical flood data, including the local and regional newspapers would not suggest that Dundonald is not prone to frequent flooding as it was not possible to identify any major flood events prior to 2007.

Figure 7.5.1.1 - Flooding at Dundonald Ice Bowl, 27 June 2012

Since the introduction of the flooding hardship payment scheme in 2007 there have been 37 payments issued to homeowners in the Dundonald SFRA. The majority of these payments (23 in number) relate to the extreme flooding on 27 June 2012 which affected large parts of the central and to a lesser extent, eastern parts of the province. Most of the flooding that occurred on this day was estimated to have a return period in excess of a 1 in 100 year event. The properties affected during this particular event where mainly clustered in a few spots, most notably in the vicinity of Dunleady Park/Canberra Park (18 properties), Wanstead Road/Ferndeane Road (5 properties) and Old Dundonald Road (3 properties). Also flooded at this time were the Dundonald Ice Bowl (pictured above) and DARD's Dundonald House within the Stormont Estate. A previous event in flood event in June 2007 resulted in hardship claims from 6 properties in the Dundonald area. On this occasion the flooded properties were widely scattered, which is reflective of the fact that the flooding was due to a high intensity, short duration rainfall event and most likely related to the overloading of local drainage systems.

7.5.2 PFRA – Identification of Potentially Significant Flood Sources

According to the Preliminary Flood Risk Assessment (Dec 2011) the town of Dundonald, in terms of the severity of the potential adverse consequences of flooding, is ranked lowest of the twenty SFRA within Northern Ireland (see Figure 4.1). Although there have been very few records of historical flooding in Dundonald it is important to recognise that the identification of potentially significant flood risk areas, is

largely based on predictive flood models as it would be inappropriate to presume that significant flooding will not occur in future because it hasn't occurred in the relatively recent past. The strategic flood model used for the PFRA indicates that within Dundonald there may up to 470 properties located within the floodplains of the River Enler and its tributaries and as a consequence the town was considered to be at potential significant risk from fluvial flooding.

Although the strategic flood maps are suitable for indicating general areas that may be prone to flooding their accuracy is not sufficient is to identify the flood risk to individual properties or as the basis for capital investment decisions for flood alleviation works. Therefore, to facilitate a more robust assessment of the flood risk to Dundonald a detailed flood model was developed for the River Enler and its tributaries. Details of the model and the assessment of the flood risk based on its findings are described below.

7.5.3 Catchment Description

Dundonald is a large settlement in County Down. Located east of Belfast, it is often deemed to be a suburb of the city and includes the large Ballybeen housing estate and many new housing developments which have emerged in the past twenty years. Drainage systems within Dundonald are dominated by the River Enler which rises in the Hollywood and Castlereagh Hills and flows in a south easterly direction for approximately 8km to its tidal outfall at Comber. The catchment of the watercourse extends to an area of around 63km^2. Apart from the urban areas within Dundonald and Comber, which have a combined area less than the 8km^2, the catchment is largely rural in nature. The main channel of the Enler River appears to have been artificially straightened and within the development limits of the town it has a number of tributaries, most of which are substantially culverted and have small heavily urbanised catchments.

7.5.4 Fluvial Flood Risk Assessment

Flood Model

The hydrodynamic model used for the assessment of fluvial flood risk was developed using Infoworks ICM. An existing HEC – RAS model and new survey data were combined to form one composite 1D/2D model of the rural and urban watercourses within the study reach. The study reach for the Enler River model commences from its outlet at Strangford Lough (approx. 1km east of Comber) and extends a distance of around 13km upstream to above the Upper Newtownards Road Culvert in Dundonald. It was necessary to model the entire length of the river from Dundonald to the sea because the town of Comber is also assessed to be at risk of flooding from the Enler River. The modelled extents of the Enler River and the associated tributaries that may impact on the Dundonald settlement are illustrated in Figure 7.5.6.1 below.

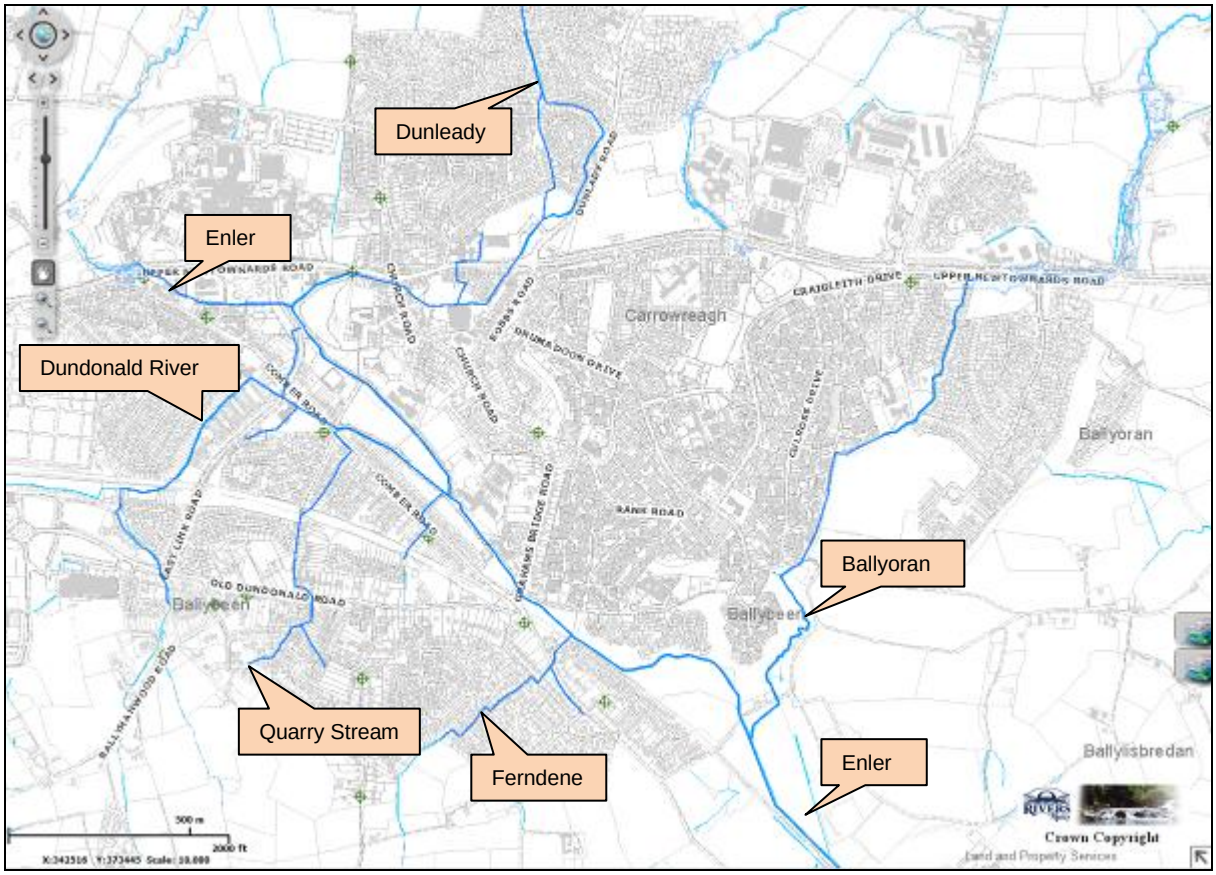


Figure 7.5.6.1 - Dundonald SFRA – Modelled Watercourses (Enler River and tributaries)

As the model predicts that there is virtually no flooding to property from the Dundonald River and no records of historical flooding associated with it, there is no further consideration of this watercourse within the Plan.

Fluvial Flooding Mechanisms

River Enler

The model predicts that the Enler River begins to overspill its right bank in the vicinity of Moat Park at the relatively frequent 50% AEP (1 in 2 year) event. Although at this return period the floodwater does not reach the line of terrace properties at the east side of the Comber Road (between Motte Lodge and Grahams' Bridge road junction) which are some 100m remote from the watercourse. Figure 7.5.6.2 below illustrates the predicted flood extents at the 1 in 10 year (10% AEP) and 1 in 100 year (1% AEP) events. The model indicates that at the 10% AEP event, floodwater skirts the line of properties, mainly causing flooding to gardens, detached garages and possibly shallow depth internal flooding to a few homes. The general ground levels at the property line are such that the extent of the property flooding does not increase markedly at the 1 in 50 year (2% AEP) event.

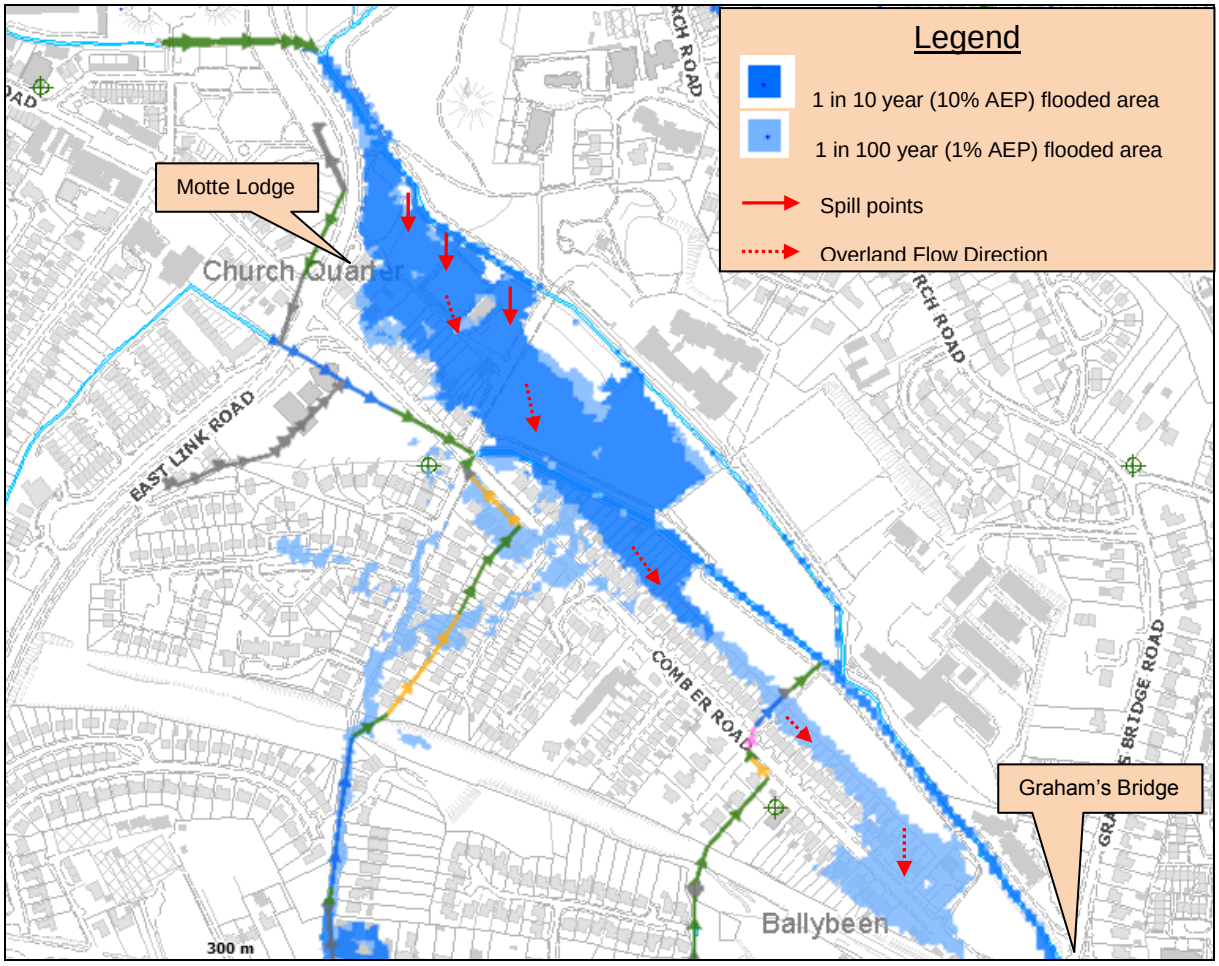


Figure 7.5.6.2 - Dundonald SFRA – Flooding Mechanism at River Enler (main channel)

Even at the at the 1 in 100 year (1% AEP) event the floodwater continues to skirt the majority of the properties along the Comber Road, although in this scenario there are at least 16 properties at Grahams' Bridge which are estimated to fall within the increased area inundation area. In addition, floodwater also flows across the Comber Road and inundates a few properties on the south side of the road near Mawhinney Park.

Ballyoran Stream

The model predicts that during a 1 in 100 year flood event on the Ballyoran Stream floodwater overtops the right bank of a section of open watercourse upstream of the Ballyoran Nursing Home. The floodwater inundates the Nursing Home, Community Centre and around ten residential properties in the adjacent housing development. The overland flow continues southwards via Ardmore Avenue, flooding a couple of properties at Beauly Drive, before returning to the watercourse at the next open section which begins at Millmount Road.

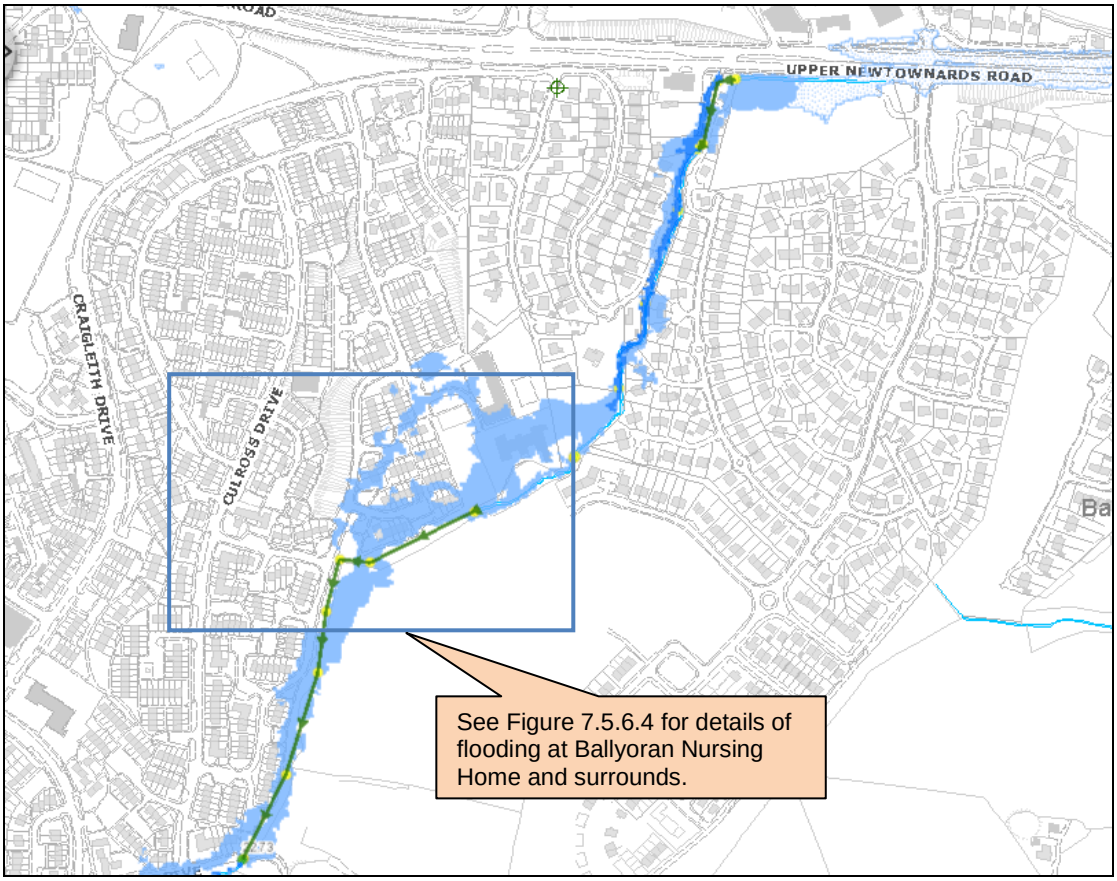


Figure 7.5.6.3 - Dundonald SFRA – Ballyoran Stream, 1% AEP Floodplain

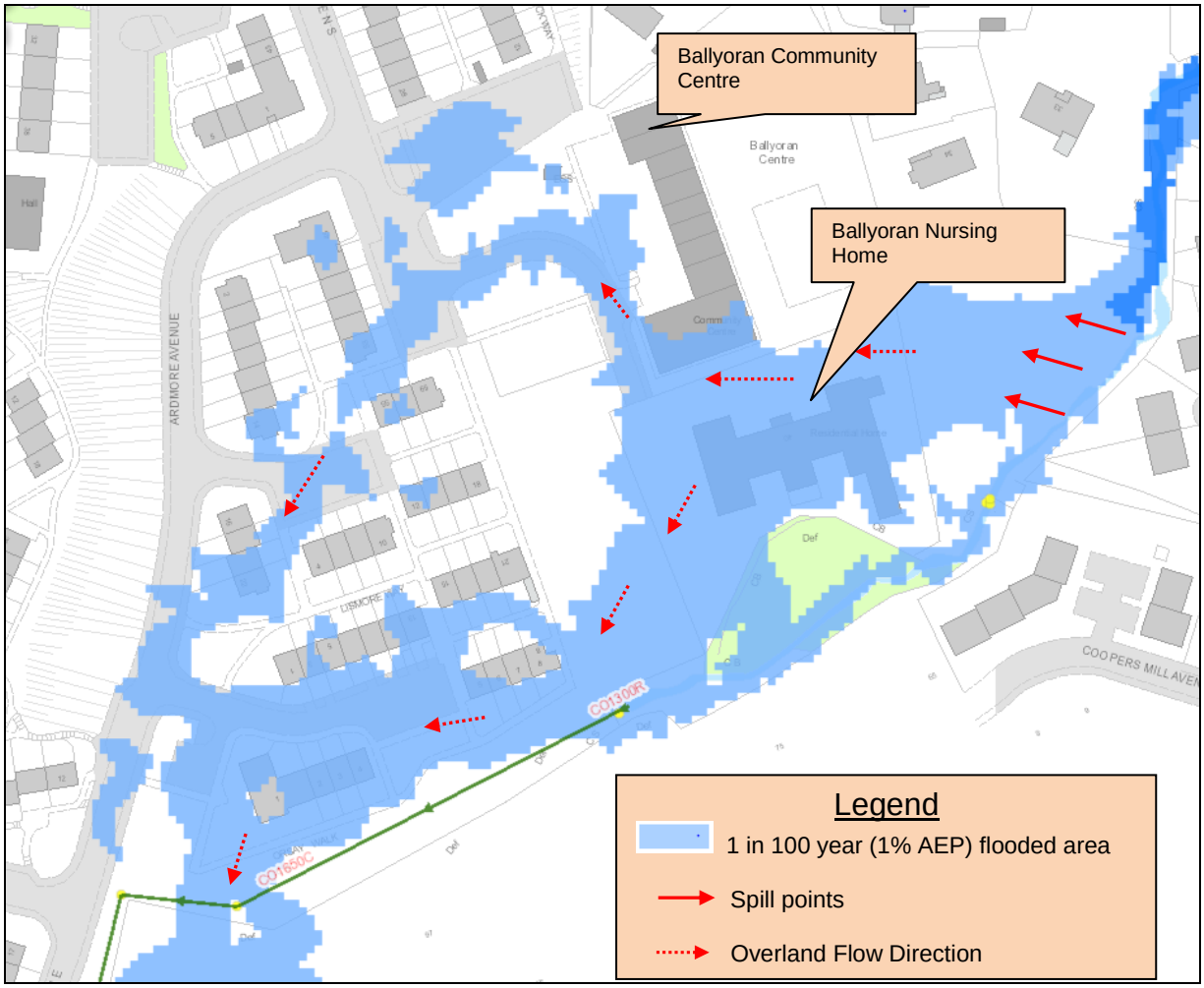


Figure 7.5.6.4 - Dundonald SFRA - Flooding mechanism at Ballyoran Stream (1% AEP)

Quarry Stream

The model indicates that flooding from the Quarry Stream originates from the reach marked A-B on Figure 7.5.6.5 and commences at the frequent 1 in 2 year event as floodwater overspills the banks of a short open section and discharges through a number of surcharged culvert manholes. In this scenario the very shallow flooding is contained within a narrow band following the route of the watercourse from Forthill Close to the Old Dundonald Road and is unlikely to cause internal flooding to property. At the 1 in 10 year (10% AEP) event the flooding is still contained within the same area although it begins to spread and deepen and could result in flooding to around 12 properties. At the 1 in 50 year (2% AEP) event the floodwater is routed beyond the Old Dundonald Road, as it flows steeply downhill via. Quarry Lane, then Grand Prix Park until it finds its way into the open section of the Dundonald River at the Comber Road. The extent of the flooding increases at the 1 in 100 year (1% AEP) event and although it is contained within a fairly narrow band by the steepness of the topography, it estimated to cause internal flooding to in excess of 30 properties. It should be noted that there is very limited historical flood information available for this area and no evidence of actual flooding arising from this watercourse since the introduction of the Flooding Hardship Payment scheme in 2007.

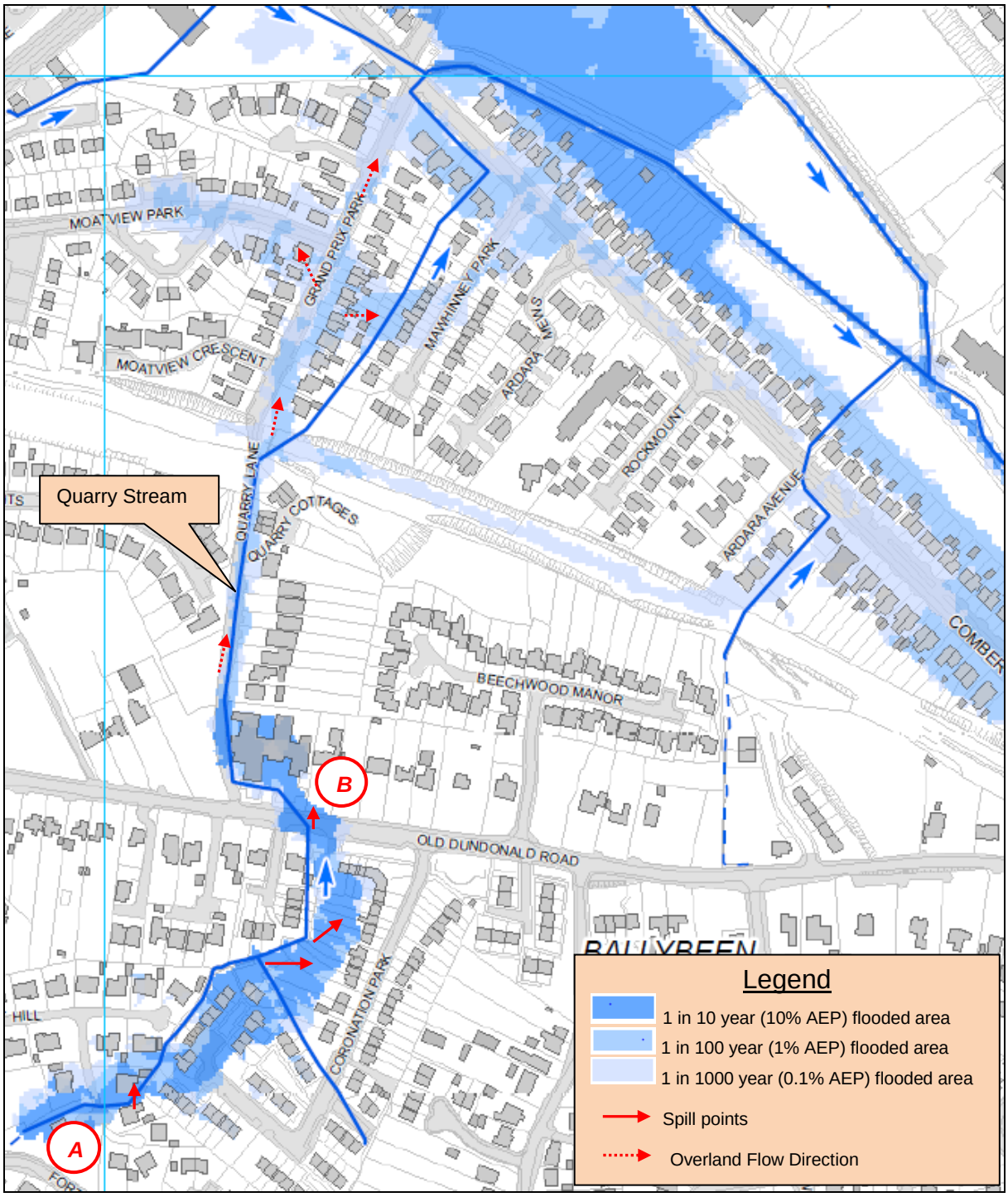


Figure 7.5.6.5 - Dundonald SFRA – Flooding Mechanism at Quarry Stream

Dunleady Stream

The model indicates that there is unlikely to be any out of channel flooding from the Dunleady Stream until the occurrence of 1 in 50 year (2% AEP) event or greater. In this scenario floodwater rises to the surface from surcharged culvert manholes in the gardens of properties at Canberra Park/ Dunleady Park. The floodwater travels overland and is predicted to cause shallow depth flooding to around six properties at Canberra Park. The extent of the flood inundation area increases to include 22 residential properties at the 1 in 100 year event

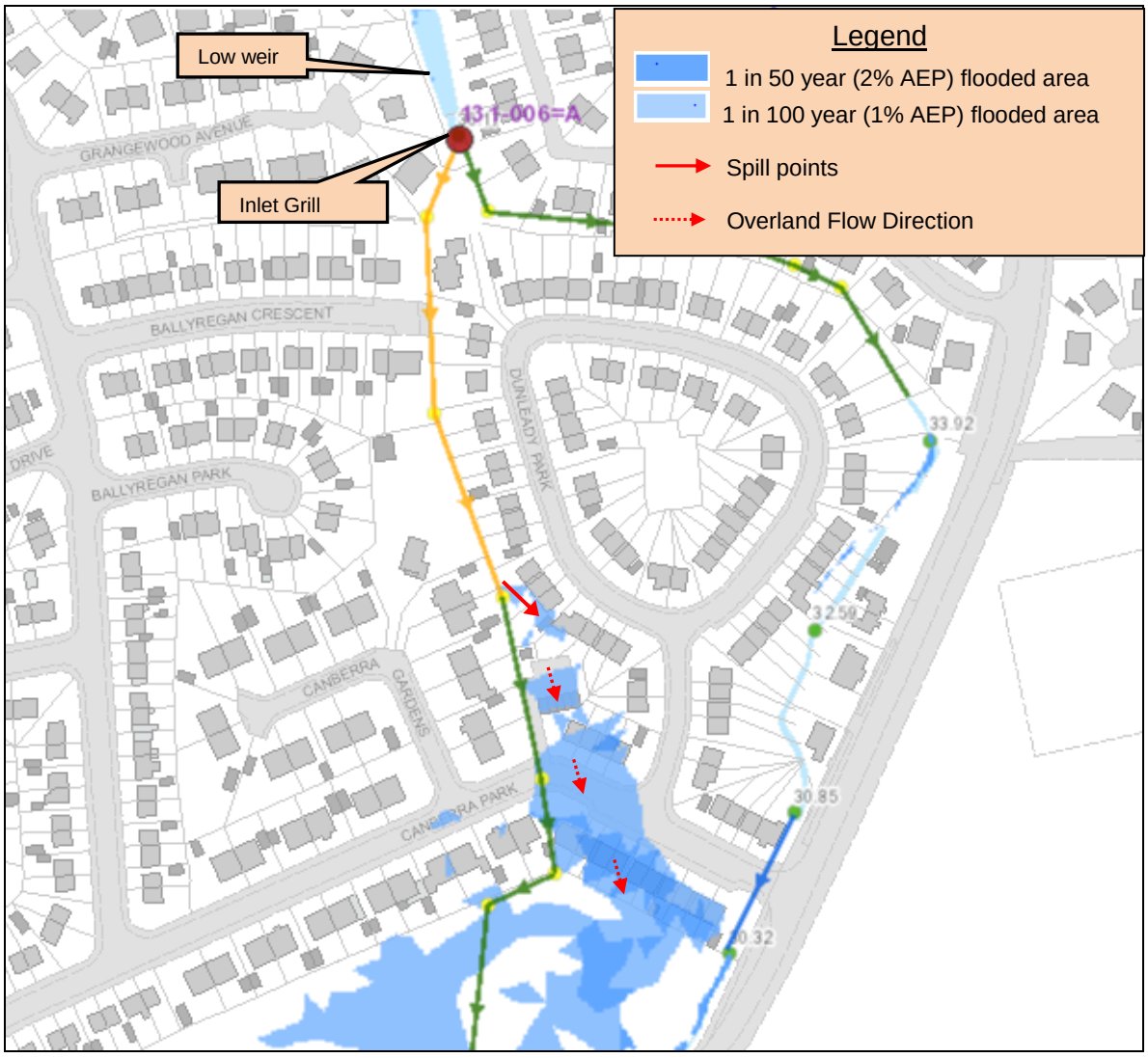


Figure 7.5.6.6 - Dundonald SFRA – Flooding Mechanism at Dunleady Stream

It is known that 18 properties in the vicinity of Dunleady Park and Canberra Park flooded during an extreme flood event in June 2012. A flood investigation report that was carried out by the Rivers Agency's Area Office in the immediate aftermath of this flood, concluded that the actual peak flow in the river during this event was far in excess of that which was estimated for 1 in 100 year event. On this occasion, the floodwater overtopped the bank of an open section of the watercourse immediately upstream of a culvert inlet structure (see Figure 7.5.6.6), flowed over the surface around the inlet structure and into the Dunleady estate. The Area Report recommended that consideration should be given to the lowering of a small weir which is located approximately 10m upstream of the inlet structure to increase the surcharge capacity and reduce the potential for overtopping at this location in the future. However, based on the findings of the predictive model, if would seem likely that if the watercourse had not overtopped the inlet structure it would have spilled from the manhole a short distance downstream as highlighted in Figure 7.5.6.6.

Ferndene Stream

The model indicates that there is likely to be no out of channel flooding from the Ferndene Stream at the 1 in 100 year (1% AEP) flood event. Although the model shows that this largely culverted watercourse is considered to be capable of satisfactorily venting the flow from a 1 in 100 year event and it is known to be in good structural condition throughout its length, it did cause flooding to at least 5 properties during the widespread flood event in June 2012. A post flood investigation report that was produced by the Rivers Agency's Area Office concluded that the culverted Ferndene Stream is fit for purpose and does not present a flood risk to property at the 1 in 100 year event. The investigation revealed that the flooding mechanism in this instance was overtopping of the inlet grille at the rear of 17 Ferndene Gardens and was probably caused by a reduction in the capacity at the culvert due to an accumulation of gravel. There is a history of gravel accumulation at this inlet structure (see Photograph 7.5.6.1) and it has been difficult to secure vehicular access to the grille for maintenance as it involves travelling across the lawns of adjacent properties. Consequently, the removal of gravel is an onerous undertaking as it has to be carried out by hand. It is recommended in the Area Report that the Agency should consider the installation of at least three separate gravel traps in a more accessible section of the watercourse, 200m to 300m upstream of the offending grille.

Photograph 7.5.6.1 - Ongoing problem with gravel accumulation at Ferndene Stream

Table 7.5.6.1 Dundonald SFRA – Enler River & tributaries			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	37	72	191
Non Residential (Nr)	3	4	10
Economic Damage (£)	58k	88k	599k
Annual Average Damage (£)	40k		
Present Value (£)	**1.2 million**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)	**0**	**1**	**2**
Care Homes		1	2
GP Surgery's			
Fire stations			
Hospitals			
Police Stations			
Schools			
Key Infrastructure (Nr)	**0**	**1**	**8**
NIW Wastewater Treatment Works			
NIW Sewage Pumping Stations			2
NIW Water Treatment Work			
NIW Treated Water Pumping Stations			
NIE Substation 6to11kV			2
NIE Substation 33kV			
NIE Substation 275kV			
NIE Substation 110kV			
Road Service - Trunk Road		1	4
Environmental Designated sites (Nr)	**0**	**1**	**1**
AONB			
ASSI			
Environmentally Sensitive Areas			
Maritime Nature Reserve			
Nature Reserve			
RAMSAR			
SAC			
Sites of Local Nature Conservation Importance		1	1
SPA			
RSPB Reserve			
UWT Nature Reserve			
Built Heritage sites (Nr)	**0**	**0**	**0**
National Trust			
Listed Buildings			
Sites and Monuments Records			
Buildings of Special Architectural or Historical Interest			
Areas of Significant Archaeological Interest			
Historic Gardens			

7.5.5 Proposed Fluvial Flood Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Dundonald it is important the flood risk is not increased by allowing new development in areas of known flood risk. Planning Policy Statement, PPS 15, Planning and Flood Risk, adopts a precautionary approach to development with the primary aim *'to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere'*.

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the 'Exception' rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to 'Greenfield' built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new Development Plans for Dundonald, Rivers Agency will advise against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 100 year fluvial floodplain, reservoir inundation area or is susceptible elsewhere to surface water flooding.

Rivers Agency shall also review the existing Development Plan for Dundonald (Belfast Metropolitan Area Plan 2015) with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

The main (undeveloped) flooded areas within Dundonald are:

- Both sides of the Dunleady Stream & Canberra Park Stream to the north of the Upper Newtownards Road.
- South of the Enler River and behind property along the Comber Road and opposite Mawhinney Park
- West of the Ballyoran Stream at Beauly Drive
- Along the Quarry Stream to the immediate north of the old Dundonald Road in the vicinity of Coronation Park.
- Along the Quarry Stream between Grand Prix Park and Mahwinney Park
- East of Canberra Park Stream alongside Canberra Park.

Planning Applications

Fluvial Areas at risk

Rivers Agency shall advise against the development of all sites that are located within the 1 in 100 year fluvial floodplain, irrespective of whether they are located within a current development plan or as a single site application outside the plan area.

For those sites within the 1 in 100 year fluvial floodplain where the principle of development has been accepted by Planning NI as meeting the 'Exception Test', Rivers Agency will further consider the application through the appraisal of an accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The main existing developed areas, amongst others, at flood risk within Dundonald were re-development may be likely to take place are located to the:

- South of the Enler River along the Comber Road between East Link Road and Graham's Bridge Road.
- North of the Ballyronan Steam at Lismore Way and Ballyoran Nursing Home.

Areas at Risk of Surface Water flooding

For those sites outside the 1 in 100 year fluvial floodplain that are located in an area where there is evidence of a history of surface water flooding (identified by flood hardship payments) Rivers Agency will further consider the application through the appraisal of the accompanying Drainage Assessment that will need to demonstrate suitable flood mitigation measures.

Where there is potential for surface water flooding as indicated in the predicted areas on the Surface Water Maps (highlighted purple) we will advise that the applicant should assess the flood risk and drainage impact to the site and construct in an appropriate manner.

The main areas with a flood history, identified in Dundonald as being at surface water flood risk are at:

- Dunleady Park and Canberra Park Area
- Old Dundonald Road near Hanwood Farm
- Ferndene Gardens and Wanstead Road.

Areas at Risk of Flood Inundation from Reservoirs

For all development proposals that are located within the potential flood inundation area of a controlled reservoir we will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures. If it is a new development proposal, Rivers Agency will also need the applicant to demonstrate that the condition, management and maintenance regime of the reservoir is appropriate to provide sufficient assurance regarding reservoir safety.

The controlled reservoirs identified in the Dundonald area are as follows:-

- NONE

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is therefore important that we continue to target investment by providing flood defences, culvert alleviation schemes and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. **The Flood Investment and Planning Group**, FIPG, provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a Flood Risk Metric Tool' (FRISM) is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total 'damage avoidance benefits' that the scheme will provide to property over the scheme's design life. If the benefit/cost ratio is greater than 1, then the potential scheme will be referred to Rivers Agency's Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely Rivers Agency's responsibility, or is the responsibility of NI Water or Transport NI such as a local drainage or road infrastructure issue, then it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a cost benefit analysis identifies a viable scheme, it will be placed on a prioritisation list and progressed alongside other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take anything from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Having conducted a detailed assessment of the fluvial flood risk to the Dundonald SFRA, Rivers Agency has determined that a potential flood alleviation scheme may be justified for the River Enler and that localised improvement works should be considered for the Dunleady Stream and Ferndene Stream. For details of the proposed measures see below.

River Enler (and tributaries) Flood Study

Based on the detailed fluvial model, there are predicted to be substantial clusters of properties at risk of flooding from the 'main channel' of the Enler River and all of its tributaries except the Ferndene Stream and Dundonald River. In total there are estimated to be 72 homes and 4 non-residential properties at risk from the relatively frequent 1 in 25 year event, rising to 191 homes and 10 non-residential properties (which includes two care homes) at the more extreme 1 in 100 year event. It is calculated the present value of the total cost of flood damages from potential future floods is £1.2 million. As the flooding is of a disparate nature and not focused at a particular location from a single watercourse, it has been determined that a broad scale flood study of the River Enler and its tributaries is required to establish if structural flood alleviation solutions are likely to be economically viable. Accordingly, Rivers Agency shall undertake a feasibility study for a potential flood alleviation scheme on the River Enler and tributaries. The timing for the commencement of this flood study will depend on its priority with the Flood Study Programme and will subject to the future resources available to Rivers Agency.

Localised watercourse improvement works

Dunleady Stream – Remove low weir located approximately 10m upstream of the inlet grille at the rear of No. 22 Grangewood Avenue. On removal of the weir regrade the channel invert of the open channel for a distance of approx 30m.

Ferndene Stream – Reconstruct inlet grill at No.17 Ferndene Gardens to meet Rivers Agency's specification, install gravel traps upstream of inlet grille and, if possible, identify source of gravel and undertake works necessary to prevent its entry to watercourse.

Preparedness

In Dundonald it is not possible to prevent or protect against all flooding. Indeed even where flood defences exist it is possible in an extreme event that these could be over topped and flooding could still occur.

Having recognised this fact, considerable effort in recent years has been made by emergency planners in a Government Departments, Councils and the Emergency Services working together and sharing information to ensure a coordinated response.

However, despite these improvements during significant flood events the emergency response of Government Departments and the Emergency Services can become over stretched. This means that not all calls for assistance during a flood event may be responded to in a timely manner. With this in mind it is important that households and communities, subject to a known flood risk, are prepared. The detail of preparedness actions, including flood warning and informing activities planned from a regional perspective, are provided in Annex E.

This is not Government withdrawing from any undertaking to respond in emergencies but an additional layer of support to ensure Government Departments and the public work together to reduce the overall impacts of flooding.

From the flood risk assessment there are 4 main areas within Dundonald that have flooded in the recent past and which may benefit from the flood warning and informing proposals, outlined in Annex D.

A pilot project of community engagement to deliver flood warning and informing, held in 2014, identified basic assessment formulae to assess and score areas that could potentially be a focus for flood warning and informing actions. Based on this scoring the following area could be considered suitable for inclusion in a programme of community engagement to deliver flood warning and informing initiatives:-

- Dunleady Park / Canberra Park area.

Key activities that could be undertaken are:

- Explaining the potential and limitations of Community Resilience;
- Briefing communities on information available, particularly from the Met Office;
- The facilitation of self-help initiatives, including remote sandbag storage; and
- Reviewing and validating all elements of the Community Engagement Plan to help the community communicate effectively in an emergency and work together.

A table in Annex J shows how this community's rank in the overall context of the 20 SFRA's in this Plan. It should be noted that this is an indicative assessment which may change subject to further information on flood risk becoming available.

The rollout of this work is dependent on funding being available.

7.6 Bangor Significant Flood Risk Area

The core boundary of the Bangor SFRA, which has been determined through the PFRA, is located within the Belfast Lough and Tidal Lagan local Flood Management Area and is illustrated in Figure 7.6.1 below.

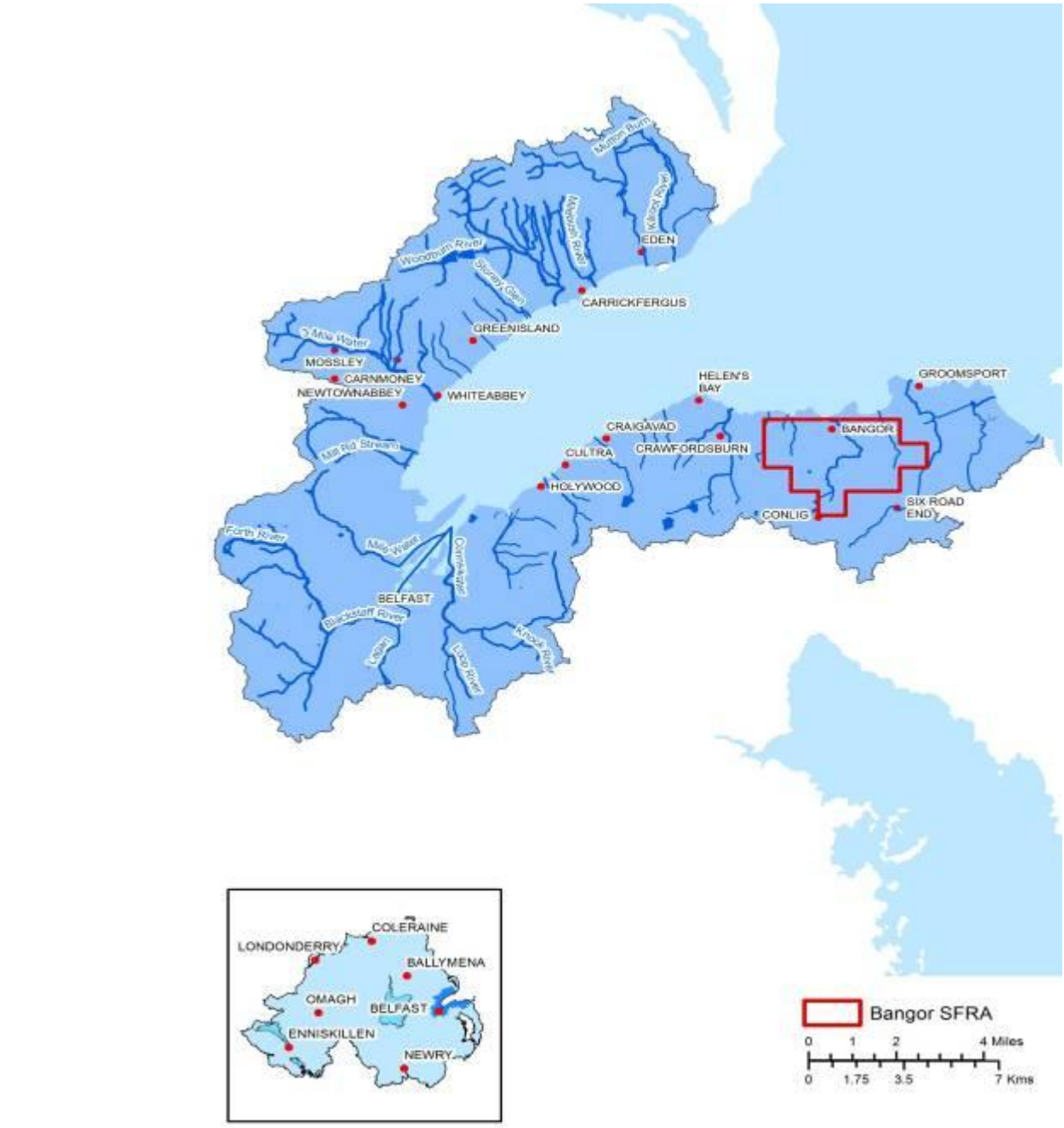


Figure 7.6.1 - Belfast Lough & Tidal Lagan Local Flood Management Area and Bangor SFRA

7.6.1 Flooding History

Information not available for the draft Flood Risk Management Plan but will be included in the final Flood Risk Management Plan

7.6.2 PFRA – Identification of Potentially Significant Flood Sources

According to the Preliminary Flood Risk Assessment (Dec 2011) the town of Bangor, in terms of the potential adverse consequences of flooding, is ranked seventh of the twenty SFRA within Northern Ireland (see Figure 4.1). On the basis of this initial assessment, which was undertaken using the Strategic Flood Maps, the town is considered to be at significant risk from fluvial flooding only. Although a coastal town, the coastal fringe is well elevated above sea level and therefore tidal inundation of the town is unlikely, even in the most extreme tidal events.

It should be noted that the PFRA was based on the Strategic Flood Map (NI) Rivers & Sea which, at the time of this assessment, was the best available information upon which to identify the general areas throughout Northern Ireland that may be prone to flooding from rivers and the sea. However, due to the onerous requirement to produce flood maps that cover the whole of the province, it was necessary to develop the strategic flood models using a broad-scale modelling methodology that had clear limitations. The extents of the floodplains predicted by the Strategic Flood Maps are illustrated in Figure 7.6.2.1 below.

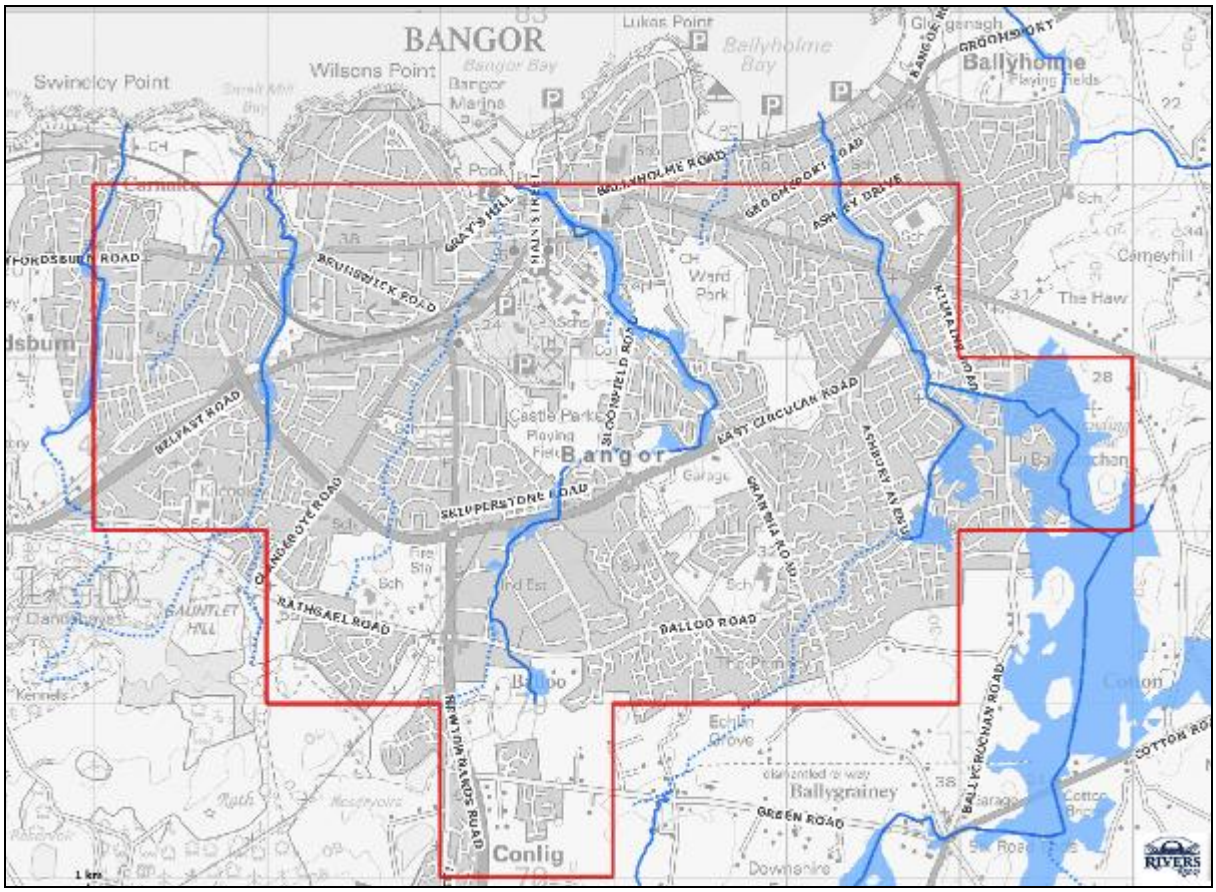


Figure 7.6.2.1 - Bangor SFRA – Undefended Fluvial Flood Plains, Strategic 1% AEP (1 in 100 yr) event

Although the PFRA established that there may be in excess of 900 properties in Bangor at risk of flooding from rivers, it was acknowledged that there was a high degree of uncertainty with this figure as it was based on the Strategic Flood Maps. To reduce this uncertainty and facilitate a more robust assessment of the level of fluvial flood risk to Bangor, Rivers Agency developed detailed predictive flood models for each of the watercourses within the town. The Flood Hazard Maps produced using the detailed flood models are more accurate than the strategic maps which may be over estimating or under estimating the number of properties at risk of flooding. Details of the models and their output are described in the following sections.

7.6.3 Catchment Description

Bangor is a coastal town which is located on the southern shore at the mouth of Belfast Lough. The coastline fringing the town is generally a steep rock face with the exception of a sandy bay to the east at Ballyholme. There are 6 substantial watercourses that flow through the urban footprint. The watercourses all flow in a northerly direction from the Gauntlet Hills to their individual sea outfalls at various locations along the shoreline from Swinely Point at the west side of town to Ballyholme Bay in the east. Four of the watercourses (Carnrea Stream, Rathmore Stream, Bryan's Burn and Clandeboye Stream) have small predominantly urban catchments with an area less than 5km^2. Ballyholme Stream has a catchment area in

excess of 19km^2 and is largely rural and the Ward Park Stream has the largest catchment, which exceeds 26km^2 and is about 50% rural.

7.6.4 Fluvial Flood Risk Assessment

Fluvial Model

Fundamental to the detailed fluvial risk assessment was the development of an Infoworks ICM 1D/2D hydrodynamic model for each of the six main watercourses (and tributaries) which have the potential to adversely impact the urbanised area of Bangor. The names, location and extents of the watercourses which were modelled in detail are indicated in Figure 7.6.4.1 below.

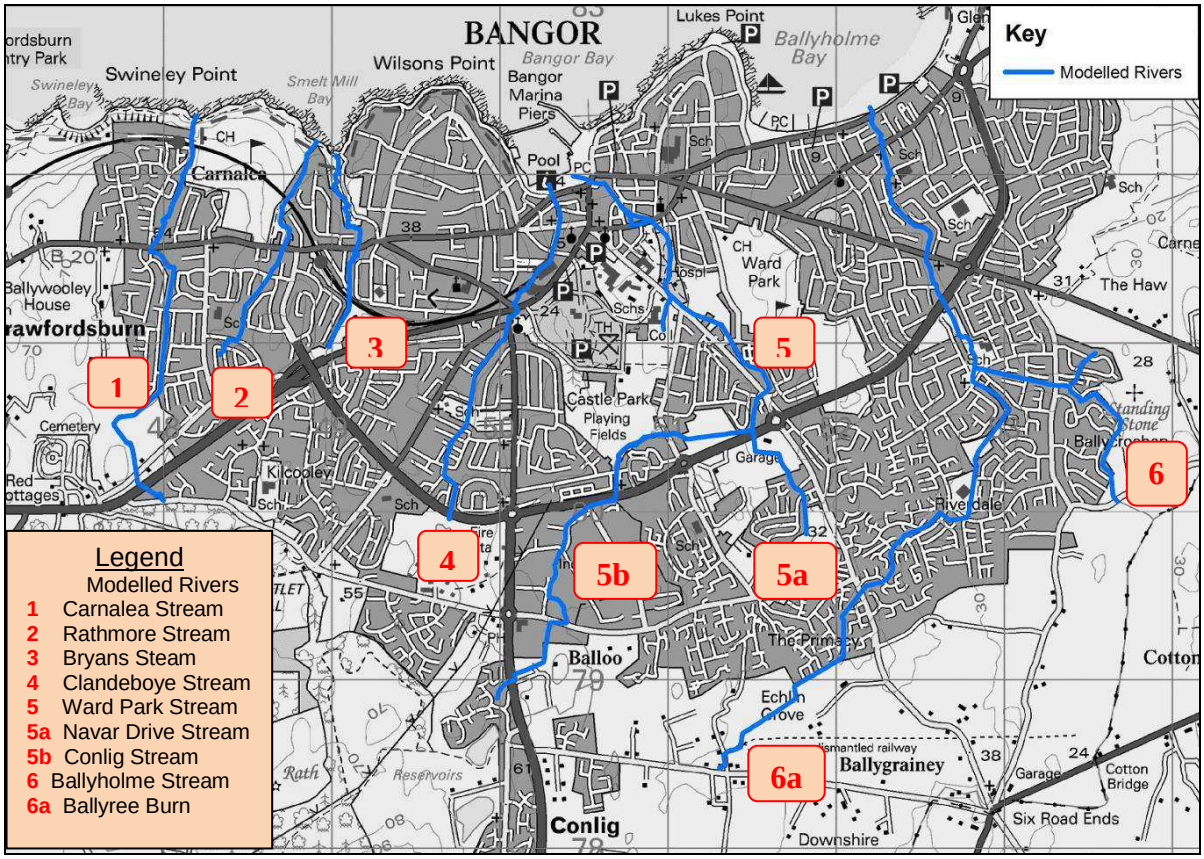


Figure 7.6.4.1 - Bangor SFRA – Modelled Watercourses

Fluvial Flooding Mechanisms

The 'Flood Hazard Maps' produced using the detailed flood maps (and available through Flood Maps NI) show that for two of the six watercourses within the urban footprint, the Clandeboye Stream and the Bryan's Burn, there is no risk to property from floods up to and including the 1% AEP (1 in 100 year) event. Consequently, the flooding from these watercourses is considered no further within the plan. The flood risk from the other four watercourses is assessed below.

Carnalea Stream

The modelled reach of designated Carnalea Stream (U3505) starts at the Rathgael Road, flows through the western side of town (usually within the confines of the rear gardens of residential properties) and skirts around the western edge of the Carnalea Golf Course before discharging to the sea near Swinely Point. The length of this modelled section is around 2.8km and flows within an open channel for most of its length with occasional short sections of culverts at road and railway crossings. The sizes of the culverts are generally around 1200mm diameter with an 1800mm X 1500mm concrete box culvert under the Belfast Road Dual Carriageway. All culverts are assessed to be in good structural condition.

The developed areas that are prone to flooding within the Carnalea Stream, together with a the flooding mechanisms are described below.

The model predicts that at the relatively frequent 10% AEP event, floodwater spills from a section of open watercourse at localised dips on its right bank to the rear of 48 Rathmore Crescent and at the inlet to the culvert located behind 13 Wandsworth Park (see Figure 7.6.4.2). However, in this scenario the impact is likely to be limited to shallow depth internal flooding of a couple of properties. The extent of the flooding is predicted to increase substantially at the more extreme (and less frequent) events, potentially inundating up to around 30 properties at the 1 in 100 year event. It is calculated that the present value of the total damages to properties from potential future floods is around £56k. Considering the number of properties affected, the value of the damage appears quite low, but this reflects the very shallow depth of the predicted flooding. There are flood records to indicate that at least two properties have flooded at this location in recent years. In addition, Rivers Agency has received dozens of calls for assistance from residents over the past twenty years who were fearful that rising floodwater in their gardens may reach their property.

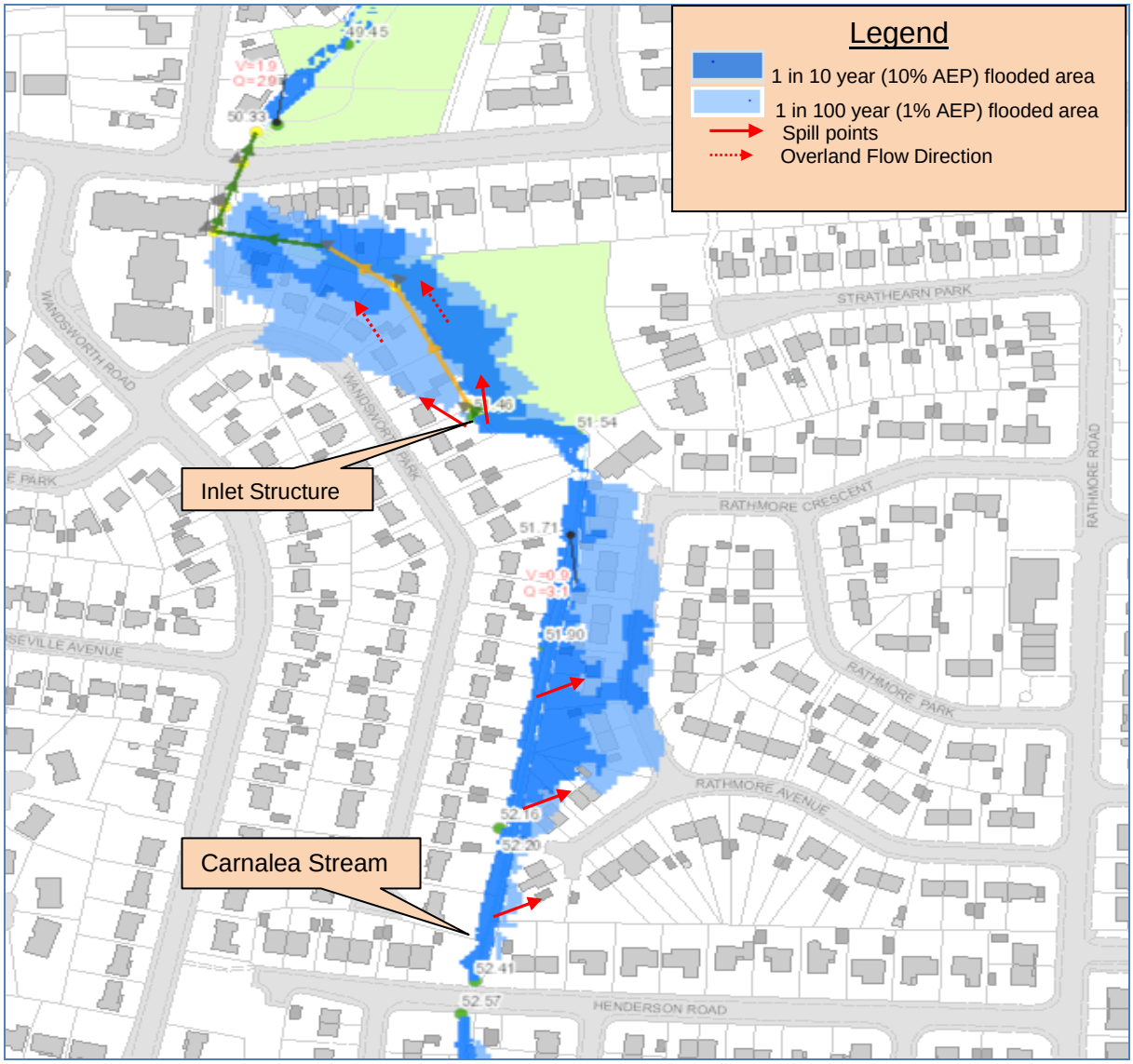


Figure 7.6.4.2 - Bangor SFRA – Carnalea Stream (1% AEP)

Figure 7.6.4.1 Bangor SFRA – Carnalea Stream			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	13	20	36
Non Residential (Nr)	1	1	1
Economic Damage (£)	10k	23k	1
Annual Average Damage (£)	£1.9k		
Present Value (£)	**56k**		
IPPC sites (Nr)	**0**		**0**
Community Assets (Nr)	**0**		**0**
Care Homes GP Surgery's Fire stations Hospitals Police Stations Schools			
Key Infrastructure (Nr)	**2**	**2**	**3**
NIW Wastewater Treatment Works NIW Sewage Pumping Stations NIW Water Treatment Work NIW Treated Water Pumping Stations NIE Substation 6to11kV NIE Substation 33kV NIE Substation 275kV NIE Substation 110kV Road Service - Trunk Road	1 1	1 1	1 2
Environmental Designated sites (Nr)			
AONB ASSI Environmentally Sensitive Areas Maritime Nature Reserve Nature Reserve RAMSAR SAC Sites of Local Nature Conservation Importance SPA RSPB Reserve UWT Nature Reserve	1	1	1
Built Heritage sites (Nr)			
National Trust Listed Buildings Sites and Monuments Records Buildings of Special Architectural or Historical Interest Areas of Significant Archaeological Interest Historic Gardens			

Rathmore Stream

The modelled reach of the Rathmore Stream (designated watercourse U3504) extends to a length of around 1.6km. It flows in a northerly direction, commencing in the heart of the Belmont housing development in Bangor West and is culverted through dense residential areas for a distance of around 850m until it crosses the Crawfordsburn Road. Downstream of the Crawfordsburn Road the watercourse flows within an open channel, forming a boundary between Carnalea Golf Course and Bryansglen housing development before discharging to the sea at Ballyvarnet. The diameter of the culverts are in the range 450mm to 1250mm and all of the culverts, except for a couple of shorts sections of small diameter pipes with a combined length of around 60m, are in good structural condition.

The developed areas that are prone to flooding within the Rathmore Stream, together with a description of the flooding mechanisms are as follows.

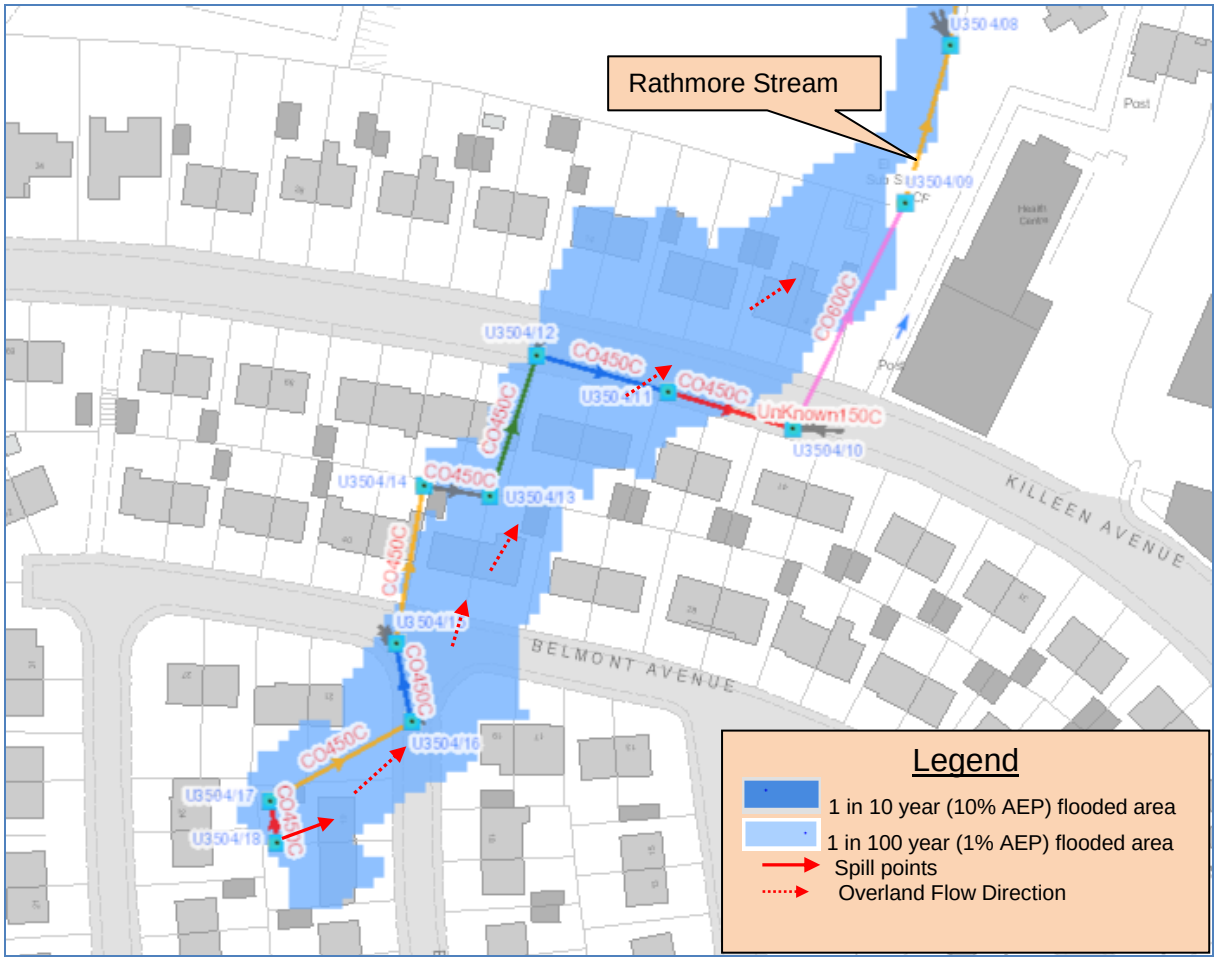


Figure 7.6.4.3 - Bangor SFRA – Rathmore Stream (1% AEP)

The model predicts that flooding to property from Rathmore Stream will be limited in scale and very infrequent as there is no indication of flooding to property until the very extreme 1 in 100 year event. In this scenario, the model shows that a 450mm diameter culvert, located in the rear garden of 19 Belmont Road, surcharges at the 1 in 100 year event and results in a spill from a manhole that could cause shallow (<

300mm) depth flooding to around 12 properties. However, there is no record of historical flooding at this location and Rivers Agency has received no phone calls to the emergency Floodline from members of the public to alert them of any concerns in relation to flows from manholes or flooding generally.

The level of flood risk from the Rathmore Stream has been determined to be so low that a 'Potential Adverse Consequences' table has not been prepared.

Ward Park Stream (and tributary Conlig Stream)

The modelled watercourse reach commenced at Rathgael House where a short section of culverted watercourse known as the Beechill Stream (U3G350) crosses the Newtownards Road. This watercourse continues within an open channel, through the Balloo Industrial Estate and crosses the South Circular Road at Lisbreen Presbyterian Church. At this point the name of the watercourse changes to the Conlig Stream. The Conlig Stream continues in an easterly direction as an open watercourse, through the Skipperstown Glen and Bloomfield Playing Fields, to the Gransha Road Roundabout where it meets the Navar Drive Stream and forms the Ward Park Stream (designated watercourse U3513). The Ward Park Stream turns to flow in a north westerly directly and runs in a culvert through the rear gardens of properties on the Gransha Road. Beyond this point it reverts to an open watercourse, which is impounded by a series of weirs to form ponds as it passes through Ward Park. Downstream of Ward Park the watercourse is culverted and runs under the Flagship Centre to its sea outfall at the Bangor Marina. All of the culverted sections of the watercourse are in a satisfactory structural condition, except for a short (20m) length of masonry arch culvert at the Flagship Centre under Mill Row which is assessed to be Grade 2 (poor).

The developed areas that are to prone flooding within the Ward Park Stream and its tributaries (Conlig Stream and Navar Drive Stream), together with a description of the flooding mechanisms are as follows.

Ward Park Stream and tributaries (see Figure 7.6.4.5 and Figure 7.6.4.6 for greater detail)

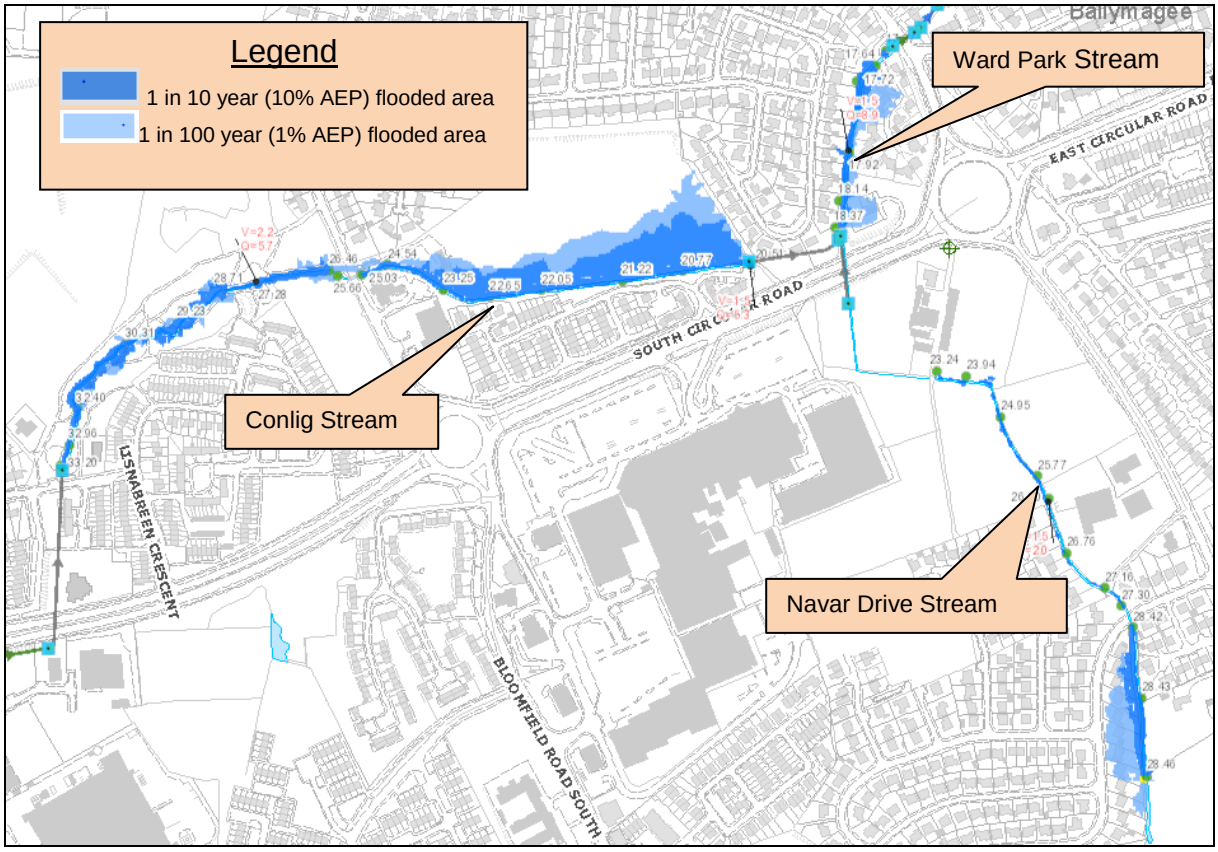


Figure 7.6.4.4 - Bangor SFRA – Ward Park Stream and tributaries (1% AEP)

The model predicts a relatively low risk of flooding to property from the Ward Park Stream and its tributaries the Conlig Stream and the Navar Drive Stream. In the case of the Conlig Stream there is one substantial flood inundation area at the South Circular Road. However, the land predicted to flood is grassland with only one non-residential property located on the fringe of the floodplain.

There are two predicted flood inundation zones arising from flooding related to the main channel of the Ward Park Stream. The larger of these is located within the confines of the Ward Park recreational area and presents no risk to property. The other flood inundation area, which does present a risk to a small number of properties, is situated near the Gransha Road Roundabout and the flood mechanism for this is described below and illustrated in Figure 7.6.4.5.

On the Navar Drive Stream, the only notable flood zone impacts a residential area at Navar Court and the flood mechanism for this is described below and illustrated at Figure 7.6.4.6.

The predicted adverse consequence arising from the whole of the Ward Park Stream (and its tributaries) are listed in Table 7.6.4.2. This shows that across the whole of this drainage system, there are estimated to be only 12 homes and 9 non-residential properties at risk of flooding from the 1% AEP (1 in 100 year) event. It

is calculated that the present day value of the property damage costs arising from potential future floods is £75k, which is not sufficiently high to justify any substantive structural works to mitigate the risk.

Ward Park Stream

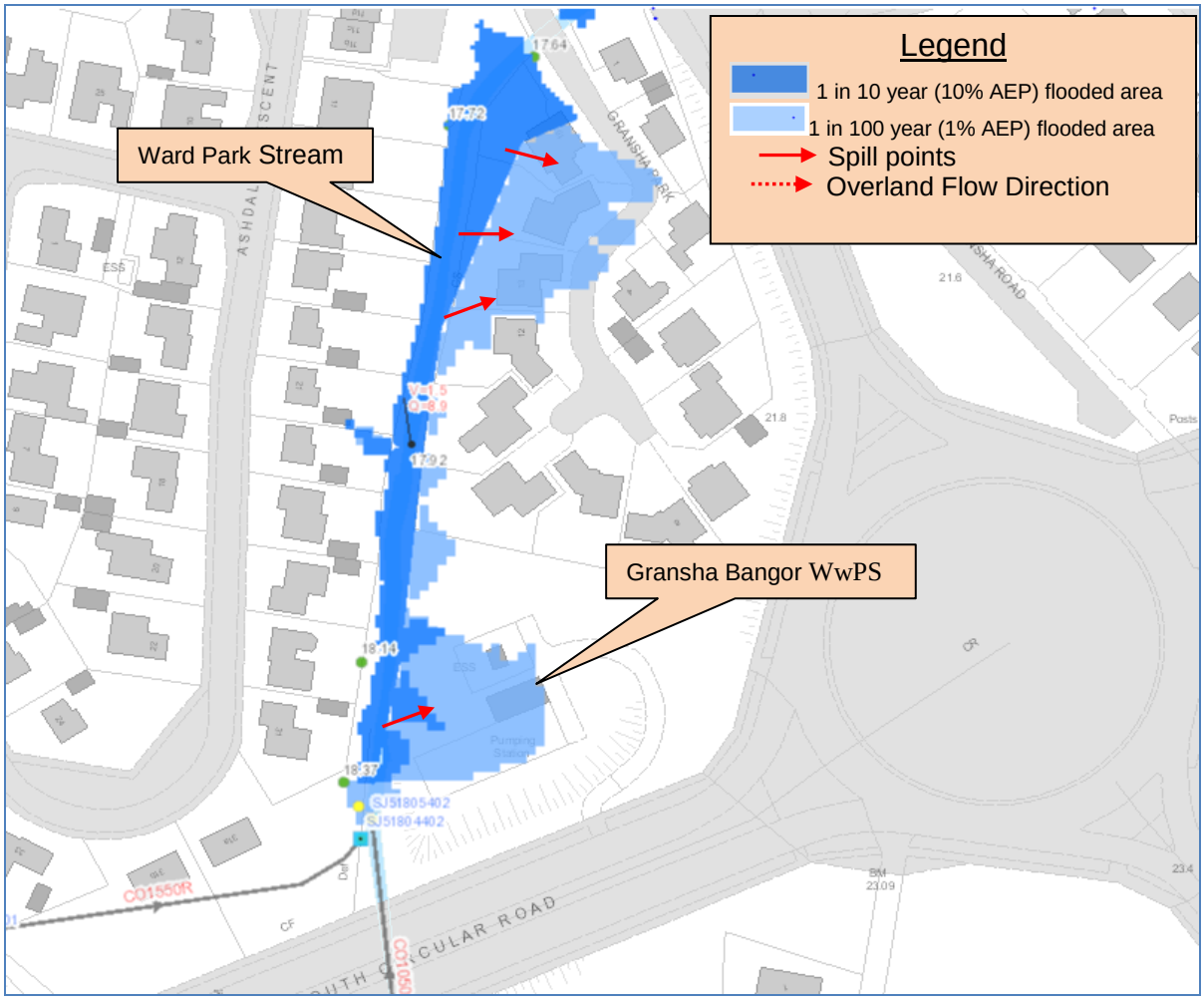


Figure 7.6.4.5 - Bangor SFRA – Ward Park Stream (1% AEP)

The model predicts flooding from a short section of open watercourse that is sandwiched between road culverts under the South Circular Road and Gransha Park access road. Although floodwater over spills the right bank at the relatively frequent 10% AEP (1 in 10 year) event, it is unlikely to present a risk to property in this scenario. Even at the 1% AEP (1 IN 100 year) event, damage is predicted to be restricted to shallow depth flooding (<300mm) to 4 large residential properties and the Gransha Bangor Wastewater Pumping Station. There is some evidence of past flooding at this location and it is recorded in Rivers Agency's Flood Reporting Database that three properties were flooded internally in June 2007 due to a badly blocked culvert inlet grill at a time of high flows in the watercourse. Two other flood calls are recorded (2005 & 2008) and both of these were from homeowners fearful that their properties may flood due to rising river levels and on both occasions this was attributable to partial blockage of the inlet grille.

Navar Drive Stream

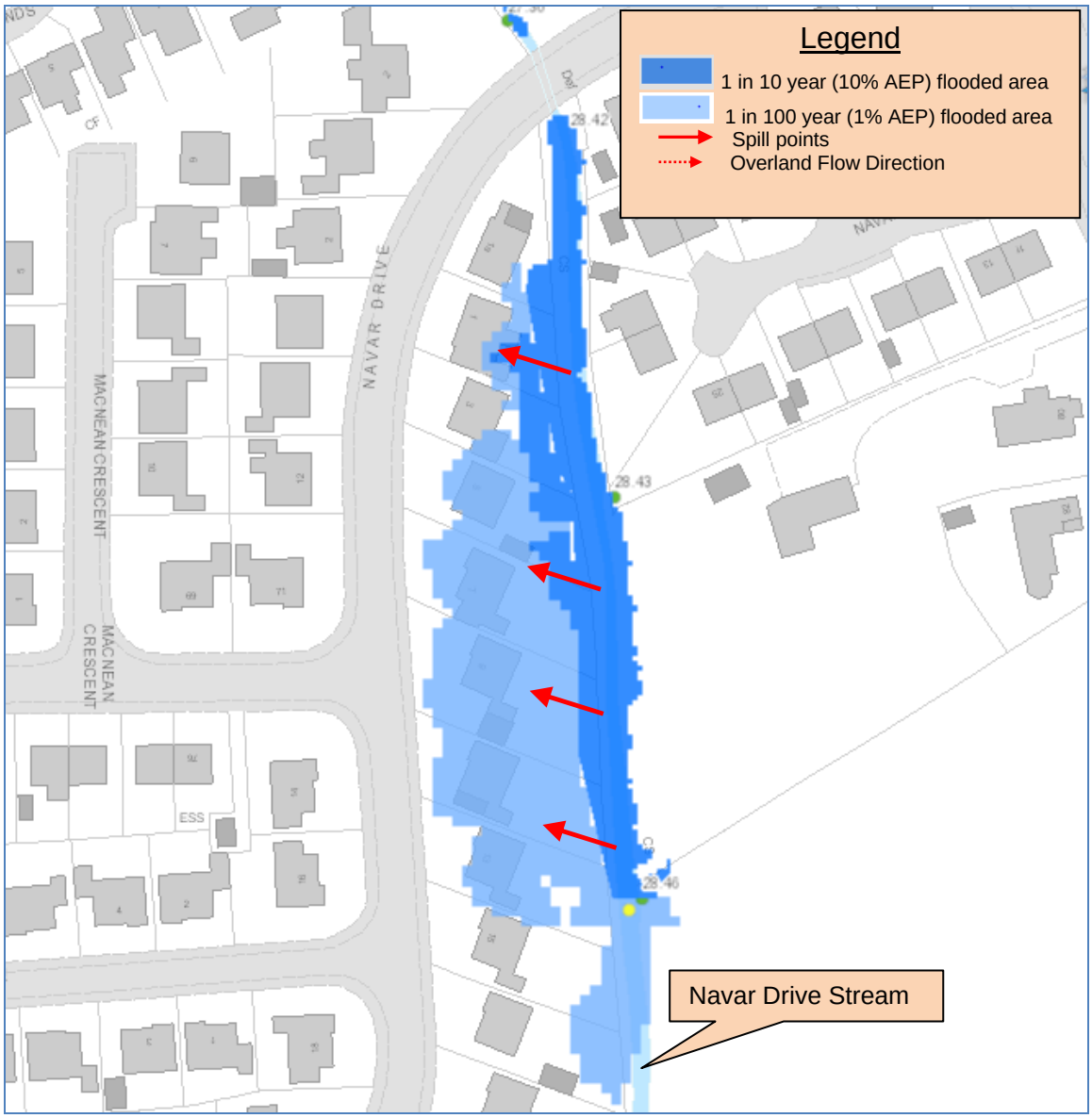


Figure 7.6.4.6 Bangor SFRA – Navar Drive Stream (1% AEP)

The model predicts flooding to property from an open section of watercourse which runs along the rear of residential properties at Navar Drive. It indicates that at the relatively frequent 10% AEP (1 in 10 year) event, floodwater can spill from the open channel at a localised dip in the left bank behind 5 Navar Drive. However, in this scenario there is unlikely to be internal flooding to any properties. At the 1% AEP (1 in 100 year) event, the predicted flooded area increases to include 7 residential properties, some of which may be inundated to a depth of 1m. Although there is no historical evidence of internal property flooding at this location, the Rivers Agency's Flooding Reports Database shows it responded to calls for assistance from homeowners in the area in 1986 and 1987. On both occasions properties were close to flooding from the watercourse, which at that time was undesignated and clearly in need of maintenance. Rivers Agency designated the watercourse in 1995 for the purposes of maintenance and there have been no flooding concerns since that time.

Table 7.6.4.2 **Bangor SFRA – Ward Park Stream (and tributaries)**			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	2	4	12
Non Residential (Nr)	6	6	9
Economic Damage (£)	9k	15k	84k
Annual Average Damage (£)	2.2k		
Present Value (£)	**66K**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)	**0**	**0**	**0**
Care Homes GP Surgery's Fire stations Hospitals Police Stations Schools			
Key Infrastructure (Nr)	**0**	**0**	**2**
NIW Wastewater Treatment Works NIW Sewage Pumping Stations NIW Water Treatment Work NIW Treated Water Pumping Stations NIE Substation 6to11kV NIE Substation 33kV NIE Substation 275kV NIE Substation 110kV Road Service - Trunk Road			1 1
Environmental Designated sites (Nr)			
AONB ASSI Environmentally Sensitive Areas Maritime Nature Reserve Nature Reserve RAMSAR SAC Sites of Local Nature Conservation Importance SPA RSPB Reserve UWT Nature Reserve			
Built Heritage sites (Nr)			
National Trust Listed Buildings Sites and Monuments Records Buildings of Special Architectural or Historical Interest Areas of Significant Archaeological Interest Historic Gardens			

Ballyholme Stream and Ballyree Burn

The modelled reach of the Ballyholme Stream (designated watercourse MW3604) extends to a length of around 3.2km. It starts at the Hawe Road and flows in a northerly direction, through a dense residential area at the east side of town, to its outlet to the sea at Ballyholme Bay. Apart from the occasional culverted section at road crossings, the watercourse flows within an open channel for the whole of its length. Around 800m of the watercourse is located within open spaces and park land, with the remainder running alongside the boundaries of the rear gardens of residential properties. The Ballyree Burn is a tributary of the Ballyholme Stream. The modelled reach of this watercourse commences outside of the town's urban area at the upstream side of the Green Road. It flows in a north easterly for around 3.6km to it confluence with the Ballyholme Stream at the Silverbirch Road near the Kilmaine Primary School. Apart from a couple of culverted road crossing, the upper 1.5km section of the watercourse (from the Green Road to the Gransha Road), flows within an open channel. After the Gransha Road, the watercourse alternates from culverted to open sections until it reaches Albany Road at Ballymagee Primary School, some 1km downstream. Thereafter, the watercourse reverts to an open watercourse, which runs through a linear park for most of its length, until it meets the Ballyholme Stream. The culverts in these watercourses are typically 1350mm diameter concrete pipes and have been assessed to be in a satisfactory structural condition.

The developed areas that are to prone flooding within the Ballyholme Stream and its tributaries the Ballyree Burn, together with a description of the flooding mechanisms are as follows

The model predicts substantial flooding at numerous discrete locations throughout the length of the Ballyholme Stream and its tributary the Ballyree Burn. However, at most locations the areas inundated are undeveloped (or lightly developed) and present no substantial risk to property.

Along the main channel of the Ballyholme Stream, the flooding to property is largely (although not exclusively) limited to the lower reaches of the watercourse between the Donaghadee Road and the tidal outfall at the Ballyholme Esplanade. The flooding mechanism at this section of the Ballyholme Stream and the potential adverse consequences are described below and illustrated in Figure 7.6.4.7.

Flooding to property from the Ballyree Burn is mainly restricted to two residential areas on either side of the Gransha Road. One on the east side of Gransha Road in proximity to Bexley Road and the other on the west side, near Rockfield Glen. The flood mechanisms at these sections are described below and illustrated on Figure 7.6.4.9 and Figure 7.6.4.8.

In addition to the main areas of flooding from the Ballyholme Stream and the Ballyree Burn that are described in detail, there are a number of small clusters of properties located at various locations including for example, Greenhill Road, Pinehill Road and Marlo Heights.

Ballyholme Stream (main channel)

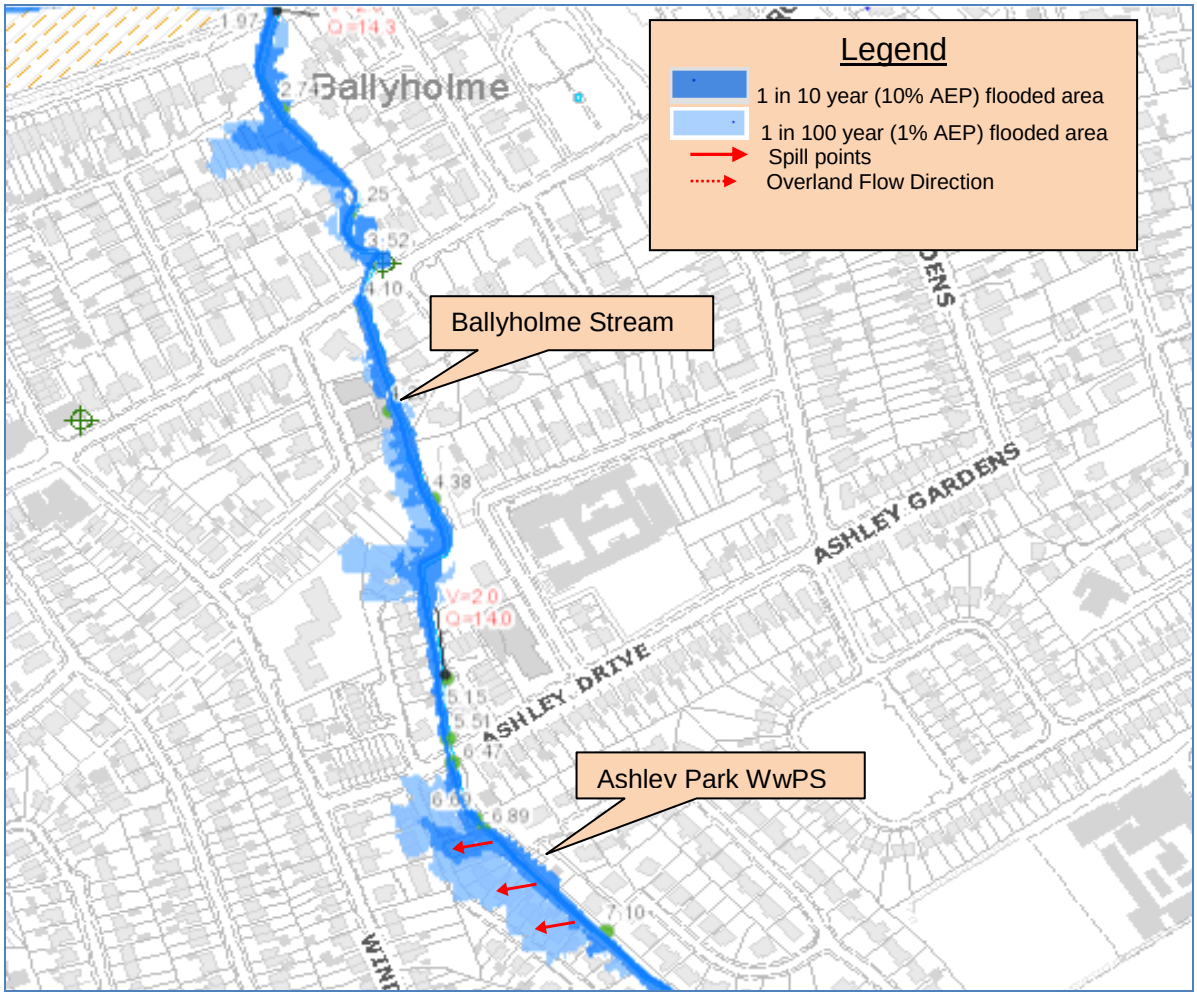


Figure 7.6.4.7 - Bangor SFRA –Ballyholme Stream (1% AEP)

The model predicts that floodwater overspills the left bank of a section of open watercourse which is immediately upstream of the culvert laid under the lane leading from Grandmere Park to the Ashley Park Sewerage Pumping Station. At the relatively frequent 10% AEP (1 in 10 year) event, floodwater is predicted to overspill at a localised dip in the bank to the rear of numbers 2 and 5 Grandmere Park. In this scenario, the extent of the flooding is largely limited to the grounds of around ten properties and as the depth of flooding is shallow (less than 300mm) substantial internal flood damage to many of these may not occur. At the more extreme 1 in 100 year event, the flood level in the watercourse exceeds the height of a substantial section of the left bank from the culvert inlet, upstream for a distance of around 140m, and in this case at least 20 properties are likely to be flooded to depths of around 0.5m. Further downstream, it is predicted that at the 1 in 100 year event, a small numbers of properties, around 14 in total, are predicted to flood at two separate location in the vicinity of Fruithill Park and at Sandhurst Drive. Although few, if any, of these properties are expected to flood at the more frequent 1 in 10 year event. Despite the findings of the detailed model, there is very little historical evidence of flooding to property at any of these locations. The only flood call which was made to the emergency Floodline was back in 1986 and this was to alert Rivers Agency that debris was blocking the grille on the culvert inlet at Grandmere Park.

Ballyree Burn (1)

Figure 7.6.4.8 - Bangor SFRA – Ballyree Burn (1% AEP)

The model predicts that there is a likelihood of flooding to property from an open section of the Ballyree Burn which starts at the point at which the watercourse enters the urban zone in the vicinity of Brookvale Avenue and ends some 180m downstream, when it flows into a third party culvert which was laid under the access road to the recently constructed Rockfield Close development. Although the model predicts that floodwater begins to overspill the banks of the open channel at the relatively frequent 1 in 10 year event, the flood inundation area produced is very narrow and is limited to the gardens of the many residential properties which line its banks. However, the height of the right bank throughout the whole of this section is substantially lower than the estimated water level for a 1 in 100 year event by between 0.4m to 1.0m. In this scenario the inundation area increases substantially and as many as 30 properties in vicinity of Brookvale Crescent and Rockfied Glen are estimated to flood. Also, as the floodwater rises in the open channel, it flows across the carriageway surface at Rockfield Road to rejoin the open watercourse downstream of the road culvert and contributes to the flooding of a further 6 properties at the Poplars. As the predicted depth of flooding in the immediate vicinity of most of the properties is predicted to be less than 300mm deep, some of the properties may escape internal flooding doe to the height of their thresholds. It is notable that there is no historical evidence of flooding to property at this location.

Ballyree Burn (2)

Figure 7.6.4.9 - Bangor SFRA – Ballyree Burn (1% AEP)

The model predicts flooding from an open reach of the Ballyree Burn which issues from a culvert section at Tadworth Road. This watercourse runs along the rear of properties in Irvine Crescent, before flowing into a 1350mm diameter culvert that starts at the rear boundary of 6 Irvine Park, some 150m downstream. Flooding is estimated to occur at the frequent 1 in 10 year event as flooding rises from the open channel into the gardens of the houses in Irvine Crescent and could cause shallow depth internal flooding to one or two of the properties. At the downstream limit, floodwater can flow around the culvert inlet structure, across the Irvine Park carriageway to the Shamrock Glen housing development and may cause shallow depth flooding to another property in Irvine Park. At the more extreme 1 in 100 year flood event, the area inundated by flood water increases substantially and is estimated to cause flooding up to 1m deep to as many as 30 homes located in and around Irvine Crescent, Irvine Park and Shamrock Glen. There is no historical evidence of flooding at this location. The only relevant flood call received by Rivers Agency from the public was in 1994 and this was to report a debris blockage at the culvert inlet grille.

Across the whole of this watercourse drainage system there are predicted to be 28 residential and 7 non-residential properties at risk from a 1 in 10 year flood event, increasing to 139 homes and 8 non-residential properties at the more extreme 1 in 100 year event. It is calculated that the present day value of the cost of the damages to property from potential future floods is £840k.

Table 7.6.4.3 Bangor SFRA – Ballyholme Stream and tributaries			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	28	60	139
Non Residential (Nr)	7	7	8
Economic Damage (£)	35k	268k	973k
Annual Average Damage (£)	28k		
Present Value (£)	**840k**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)	**0**	**0**	**0**
Care Homes GP Surgery's Fire stations Hospitals Police Stations Schools			
Key Infrastructure (Nr)	**4**	**4**	**6**
NIW Wastewater Treatment Works NIW Sewage Pumping Stations NIW Water Treatment Work NIW Treated Water Pumping Stations NIE Substation 6to11kV NIE Substation 33kV NIE Substation 275kV NIE Substation 110kV Road Service - Trunk Road	1 3	1 3	2 3 1
Environmental Designated sites (Nr)	**2**	**2**	**3**
AONB ASSI Environmentally Sensitive Areas Maritime Nature Reserve Nature Reserve RAMSAR SAC Sites of Local Nature Conservation Importance SPA RSPB Reserve UWT Nature Reserve	1 1	1 1	1 1 1
Built Heritage sites (Nr)	**0**	**0**	**0**
National Trust Listed Buildings Sites and Monuments Records Buildings of Special Architectural or Historical Interest Areas of Significant Archaeological Interest Historic Gardens			

7.6.5 Proposed Fluvial Flood Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Bangor it is important the flood risk is not increased by allowing new development in areas of known flood risk. Planning Policy Statement, PPS 15, Planning and Flood Risk, adopts a precautionary approach to development with the primary aim *'to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere'*.

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the 'Exception' rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to 'Greenfield' built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new Development Plans for Bangor, Rivers Agency will advise against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 100 year fluvial floodplain, reservoir inundation area or is susceptible elsewhere to surface water flooding.

Rivers Agency will also review the existing Development Plan for Bangor (Belfast Metropolitan Area Plan, 2015) with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

The main (undeveloped) flooded areas, amongst others, within the Bangor Significant Flood Risk Area are:

Conlig Stream

- North of the watercourse alongside Bloomfield Playing Pitches

Carnalea Stream

- East of the stream in field behind Wandsworth Park
- East of the stream and south of the Crawfordsburn Road at Rathmore Avenue.
- West of the stream and south of the Crawfordsburn Road along Wandsworth Avenue

Rathmore Stream

- West of the stream at Killen Avenue
- East of the stream at Belmont Avenue
- West of the stream to the north of Innisfoyle Drive

- Both sides of the river at the south of Innisfoyle Drive

Ward Park Stream

- West of the stream along Gransha Park

Navar Drive Stream

- West of the stream along Navar Drive

Ballyholme Stream / Ballyree Burn

- East of the stream at Brookvale Avenue
- West of the stream at the Poplars
- West of the Stream at Shamrock Glen, Irvine Park and Irvine Crescent
- West of the stream at Grandmere Park
- West of the stream at Sandhurst Drive

Planning Applications

Fluvial Areas at risk

Rivers Agency shall advise against the development of all sites that are located within the 1 in 100 year fluvial floodplain, irrespective of whether they are located within a current development plan or as a single site application outside the plan area.

For those sites within the 1 in 100 year fluvial floodplain where the principle of development has been accepted by Planning NI as meeting the 'Exception Test', Rivers Agency will further consider the application through the appraisal of an accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

Areas at Risk of Surface Water flooding

For those sites outside the 1 in 100 year fluvial floodplain that are located in an area where there is evidence of a history of surface water flooding (identified by flood hardship payments) we will further consider the application through the appraisal of the accompanying Drainage Assessment that will need to demonstrate suitable flood mitigation measures.

Where there is potential for surface water flooding as indicated in the 'purple' predicted areas on the Surface Water Maps we will advise that the applicant should assess the flood risk and drainage impact to the site and construct in an appropriate manner.

Areas at Risk of Flood Inundation from Reservoirs

For all development proposals that are located within the potential flood inundation area of a controlled reservoir we will further consider the application through the appraisal of the accompanying Flood Risk

Assessment that will need to demonstrate suitable flood mitigation measures. If it is a new development proposal we will also need the applicant to demonstrate that the condition, management and maintenance regime of the reservoir is appropriate to provide sufficient assurance regarding reservoir safety.

The “controlled” reservoirs identified in the Bangor area are:

- **Clandeboye Lake**
- **Conlig Upper & Conlig Lower**
- **Clandeboye Reservoir**

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is therefore important that we continue to target investment by providing flood defences, culvert alleviation schemes and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. **The Flood Investment and Planning Group**, FIPG, provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a Flood Risk Metric Tool’ (FRISM) is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total ‘damage avoidance benefits’ that the scheme will provide to property over the scheme’s design life. If the benefit/cost ratio is greater than 1, then the potential scheme will be referred to Rivers Agency’s Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely Rivers Agency’s responsibility, or is the responsibility of NI Water or Transport NI such as a local drainage or road infrastructure issue, then it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a cost benefit analysis identifies a viable scheme, it will be placed on a prioritisation list and progressed alongside other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take anything from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Having conducted a detailed assessment of the fluvial flood risk to the Bangor SFRA, Rivers Agency has determined that within the national context, only the flooding from one of the of the six main watercourses which drain the urban area could be described as potentially significant. See below for details.

The detailed fluvial flood models predict that two of the six watercourses, which include the Bryan's Burn and the Clandeboye Stream, present no tangible flood risk to property. The models also show that for three of the others, the Ward Park Stream, Rathmore Stream and Carnalea Stream, the numbers of properties that are estimated to be at risk are relatively low.

There is however, considered to be a substantial risk of flooding to property from the Ballyholme Stream and its tributaries where it is estimated that up to 139 homes and 8 non-residential properties are at risk from the 1 in 100 year event. It is calculated that the present day value of the cost of property damages from potential future floods is around £1 million and therefore a potential flood alleviation scheme to mitigate the flood risk may be economically viable. Accordingly, Rivers Agency shall undertake a feasibility study for a potential flood alleviation scheme on the Ballyholme Stream. The timing for the commencement of this flood study will depend on its priority within the Flood Study Programme and will subject to the future resources available to Rivers Agency.

It should also be noted that the available historical records would indicate that the watercourses have caused nothing other than minor flooding to very small numbers of properties in the recent past and on each occasion debris blockage of a culvert inlet grille was a contributing factor. The lack of flooding in recent year may be attributable to the fact that in the early 1990s Rivers Agency undertook studies to identify deficiencies in the urban watercourse systems within the Bangor area and carried out major improvement schemes to address the deficiencies and alleviate potential future flood risk, most notably on sections of the Ward Park Stream and Carnalea Stream.

Preparedness

In Bangor it is not possible to prevent or protect against all flooding. Indeed even where flood defences exist it is possible in an extreme event that these could be over topped and flooding could still occur.

Having recognised this fact, considerable effort in recent years has been made by emergency planners in a Government Departments, Councils and the Emergency Services working together and sharing information to ensure a coordinated response.

However, despite these improvements during significant flood events the emergency response of Government Departments and the Emergency Services can become over stretched. This means that not all calls for assistance during a flood event may be responded to in a timely manner. With this in mind it is important that households and communities, subject to a known flood risk, are prepared. The detail of preparedness actions including flood warning and informing activities planned from a regional perspective are notes in Annex E.

This is not Government withdrawing from any undertaking to respond in emergencies but an additional layer of support to ensure Government Departments and the public work together to reduce the overall impacts of flooding.

From the flood risk assessment it would appear that there are 8 main areas within Bangor that have flooded in the recent past and may benefit from the flood warning and informing proposals, outlined in Annex D.

A pilot project of community engagement to deliver flood warning and informing, held in 2014, identified basic assessment formulae to assess and score areas that could potentially be a focus for flood warning and informing actions. Based on this scoring these areas did not score high enough to be placed within the top 20 communities to be offered a programme of community engagement during the period of this plan. However, if communities want to become more resilient, the Department is committed to providing assistance were possible to develop the consistent approach to resilience. The NI Direct website www.nidirect.gov.uk/ will host further information and advice on what to do in advance of flooding, what to do during flooding and how to recover after flooding. The website will also contain templates for communities wishing to develop their own plan.

7.7 Newcastle Significant Flood Risk Area

The core boundary of the Newcastle SFRA, which has been determined through the PFRA, is located within the South Down Local Flood Management Area and is illustrated in Figure 7.7.1 below.

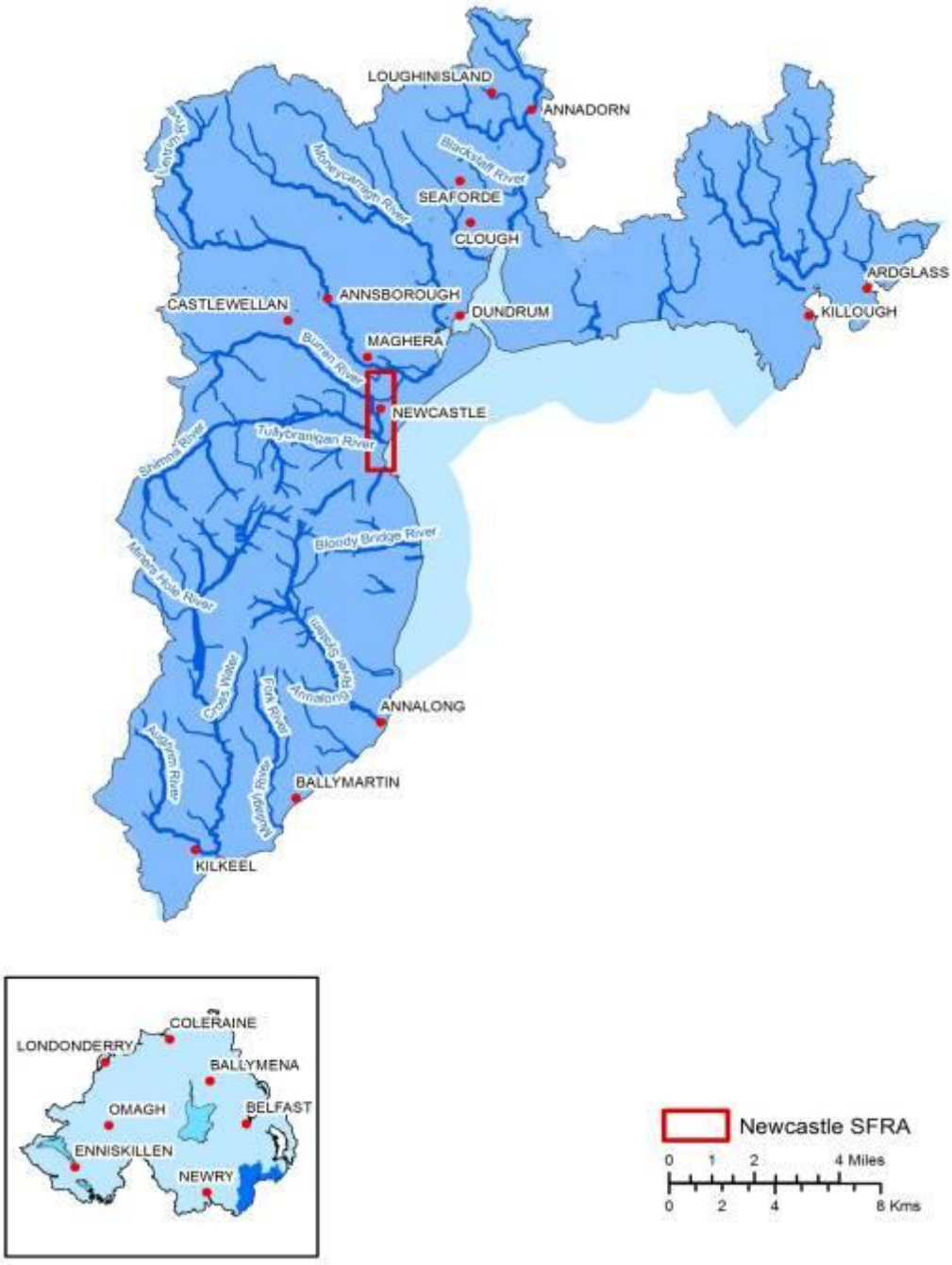


Figure 7.7.1 - South Down Local Flood Management Area and Newcastle SFRA

7.7.1 Flooding History

Flooding to Newcastle from both the Shimna River and Burren River has happened on many occasions in the past. A report produced by Rivers Agency in 2003 titled *Newcastle Urban Area Assessment of the Flood Levels* contains references to newspaper reports of flood events in 1968, 1978, 1978, 1987, 1988 and 1994 and other significant events are known to have occurred in 1982, 1986, 1990 and 1997. Much of this historical flooding has emanated from the Burren River and, as consequence, Rivers Agency undertook the Burren flood alleviation scheme in 2007. The scheme involved the construction of flood walls along both sides of the lower reach of the river which extend from its confluence with the Shimna River for a distance 2km upstream (see Photograph 7.7.1.1).

Photograph 7.7.1.1 - Newcastle, Burren River flood defences.

Following completion of the Burren Flood Alleviation Scheme, another major flood event occurred in Newcastle on 16th August 2008. On this occasion, the flooding largely emanated from the Shimna River and caused flood damage to around 40 properties mostly located in and around Bryansford Avenue and Shimna Road. Unfortunately, on this occasion floodwater from the Shimna River 'jumped its catchment' and spilled into an area behind the recently constructed flood defences on the Burren River. This was a particular disappointment to the owners of flooded properties in Shimna Road and Shimna Vale who, understandably, believed that they would be protected from flooding by the Burren River defences.

Since the introduction of the flooding hardship payment scheme in 2007, there have been in excess of 70 payments issued to homeowners in the Newcastle SFRA. The majority of the payments relate to properties that flooded during the August 2008 event described above. However, 13 of the payments relate to an extreme rainfall flood event in June 2012 which overwhelmed the urban drainage systems and mainly affected properties in and around Mourneview housing development. Many similar flood events have occurred in this area prior to the introduction of the 2007 scheme and this area is listed in the inter-agency Flood Liaison Group's 'Flooding Hotspots' register. The cause of this repeated flooding is due to the ineffectiveness of the existing sewerage systems that were laid by the developer of the housing estates in the 1970s. Measures to address the significant surface water flooding at Mourneview are outlined in the protection section.

Photograph 7.7.1.2 - Flooding at Mourneview and Burrendale housing developments – 5 July 2012

7.7.2 PFRA – Identification of Potentially Significant Flood Sources

According to the Preliminary Flood Risk Assessment (Dec 2011) the town of Newcastle, in terms of the potential adverse consequences of flooding, is ranked eighth of the twenty SFRA within Northern Ireland (see Figure 4.1). On the basis of this initial assessment, which was undertaken using the strategic flood maps, the flood risk to the town was considered to arise almost exclusively from fluvial flooding with in excess of 1300 properties estimated to fall within the predicted 1 in 100 year strategic flood plain outline. Although Newcastle is a seaside town, it is not considered to be at significant risk from tidal inundation as there is nothing more than the toilet block in Castle Park exposed to flooding at a 1 in 200 yr event.

To facilitate a more robust assessment of the fluvial flood risk to Newcastle, Rivers Agency developed detailed predictive flood models for the Shimna River and its tributaries, the Leitrim River and its tributaries and the Glen River. The Flood Hazard Maps, produced using the detailed flood models, are more accurate than the strategic maps which may be over estimating or under estimating the number of properties at risk of flooding. Details of the models and their output are described in the following sections.

7.7.3 Catchment Description

The Shimna River rises in the Mourne Mountains and flows for approximately 11km in an easterly direction through the Tullymore Forest Park to the sea at Newcastle. Within the town of Newcastle the Shimna River is joined by the Burren River at Islands Park and, less than 100m downstream, it is joined by the Tullybranigan River (in the vicinity of the Castle Park boating lake) before discharging to the sea at the Castle Bridge. The upper catchment of the Shimna falls quite steeply from the mountains through a narrow valley which flattens abruptly in the vicinity of Island Park before being joined by its main tributaries. The lower sections of the rivers are tidally influenced which adds to the risk by damping the capacity of the river to discharge to the sea during high tides.

7.7.4 Fluvial Flood Risk Assessment

Fluvial Model

Following the August 2008 flood event, Rivers Agency has undertaken a number of flood studies for Newcastle. The Newcastle Modelling & Flood Mapping Study was completed in October 2013 and the output from this modelling study has been used to produce the detailed Flood Hazard Maps and Flood Risk Maps required by the Directive and which are available through Rivers Agency's website in Flood Maps NI. Fundamental to this study was the development of a single Infoworks ICM model which is capable of simulating the flood mechanisms, taking account of the interactions between the various watercourses located within the urban area. This combined hydrodynamic model includes the Shimna River, Burren River, Tullybranigan River, Glen River and Shanslieve Drive Stream. In addition, a separate Infoworks RS 1D/2D hydrodynamic model was developed for the Leitrim River and its tributary the Murlough Drain which skirt the north side of the town.

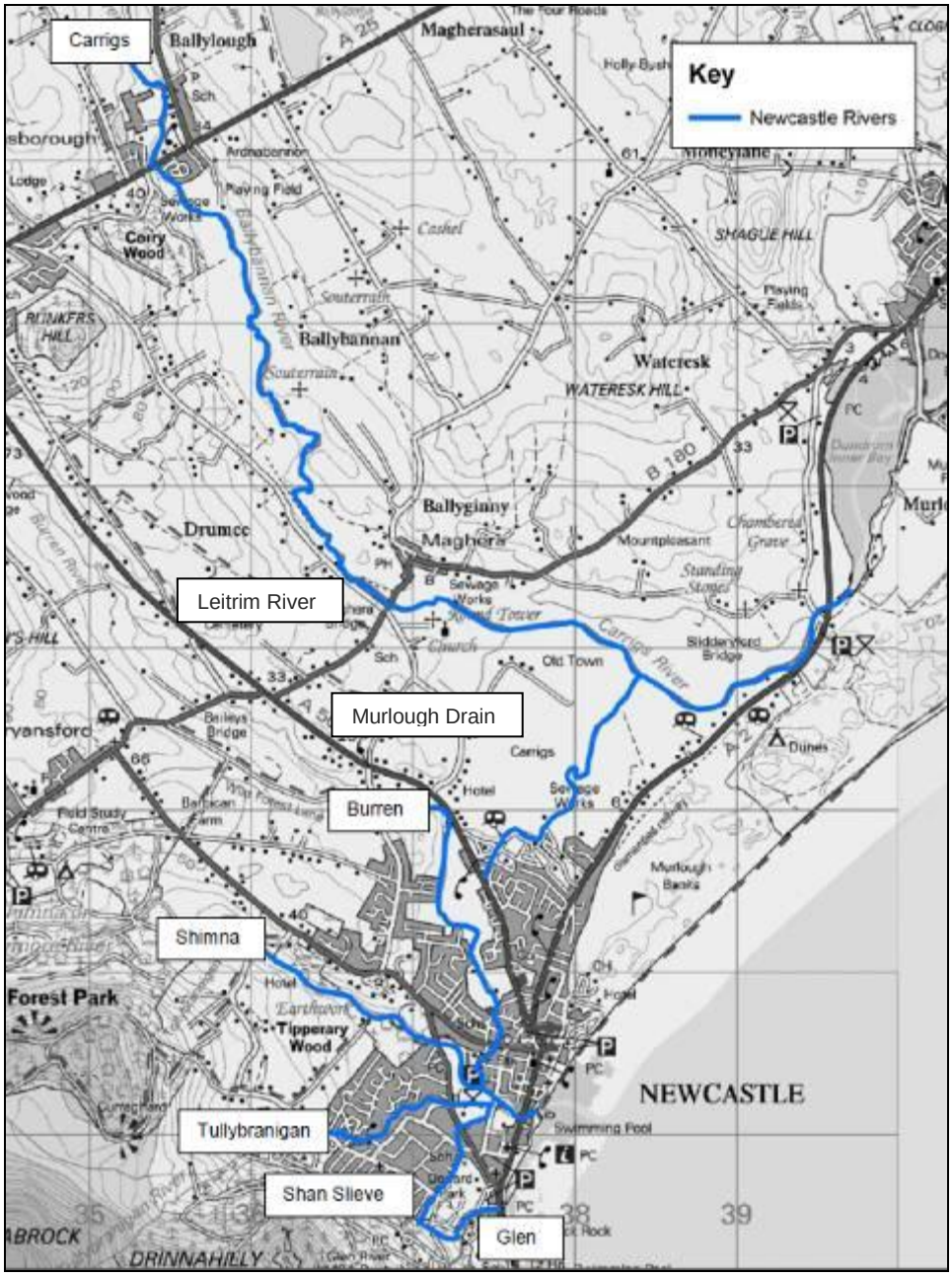


Figure 7.7.4.1 - Newcastle SFRA – Modelled Watercourses

Flooding Mechanisms

Shimna River (and tributaries)

The upper limit of the modelled reach of the Shimna River is at the outskirts of the Newcastle urban limits. Above this point the upstream catchment is mountainous in nature and predominantly rural with no properties located in areas that likely to be affected by flooding. The Shimna discharges to the Irish Sea at Castle Bridge. The lower section of the Shimna River is tidally influenced and therefore, for purposes of modelling this scenario, the 1 in 2 year tidal level predicted by the Irish Surge and Tidal Model was used for the downstream boundary condition.

The modelled reach of the Burren River begins at the confluence with the Shimna River at the Islands Park and extends upstream to a location near the Burrendale Hotel (at Castlewellan Road). Upstream of this position the catchment is essentially rural with very few properties estimated to be located in or near the floodplain.

Flowing from the Tullybranigan Hill and Shan Slieve, the upstream catchment the Tullybranigan River is entirely mountainous. The Tullybranigan was modelled through the urban reach which flows through the southwest of the town from Bonny's Caravan Park to its outlet at the boating pond in Castle Park. Immediately upstream of the boating pond, the Tullybranigan River is linked to the Shimna River by a channel that runs along the upstream face of the Shimna Bridge.

The upper catchment of the Shan Slieve Drive Stream which flows through Donard Wood is entirely mountainous. The upstream limit of the model begins at the outskirts of the town to the rear of houses at Slieve Shannagh Park and extends to its convergence with the Tullybranigan River at the Shimna Bridge. A 200m section of the watercourse is culverted from the bottom of Shan Slieve Drive to the Bryansford Road with pipes (typically 450mm to 600mm in diameter) and a short 60m section of the pipeline has been assessed as Grade 4 defective. Historically, the majority of the flow from the Shan Slieve has been diverted to the Glen River via the Shan Slieve Diversion Channel and consequently, the channel of the Shan Slieve Drive Stream is dry except in times of heavy rainfall, when some local drainage discharges to it. For the purposes of the model, the flows from the Shan Slieve are included in the Glen River.

The developed areas that are prone flooding within the Shimna River and its tributaries (Burren River and Tullybranigan River), together with a description of the flooding mechanisms are as follows.

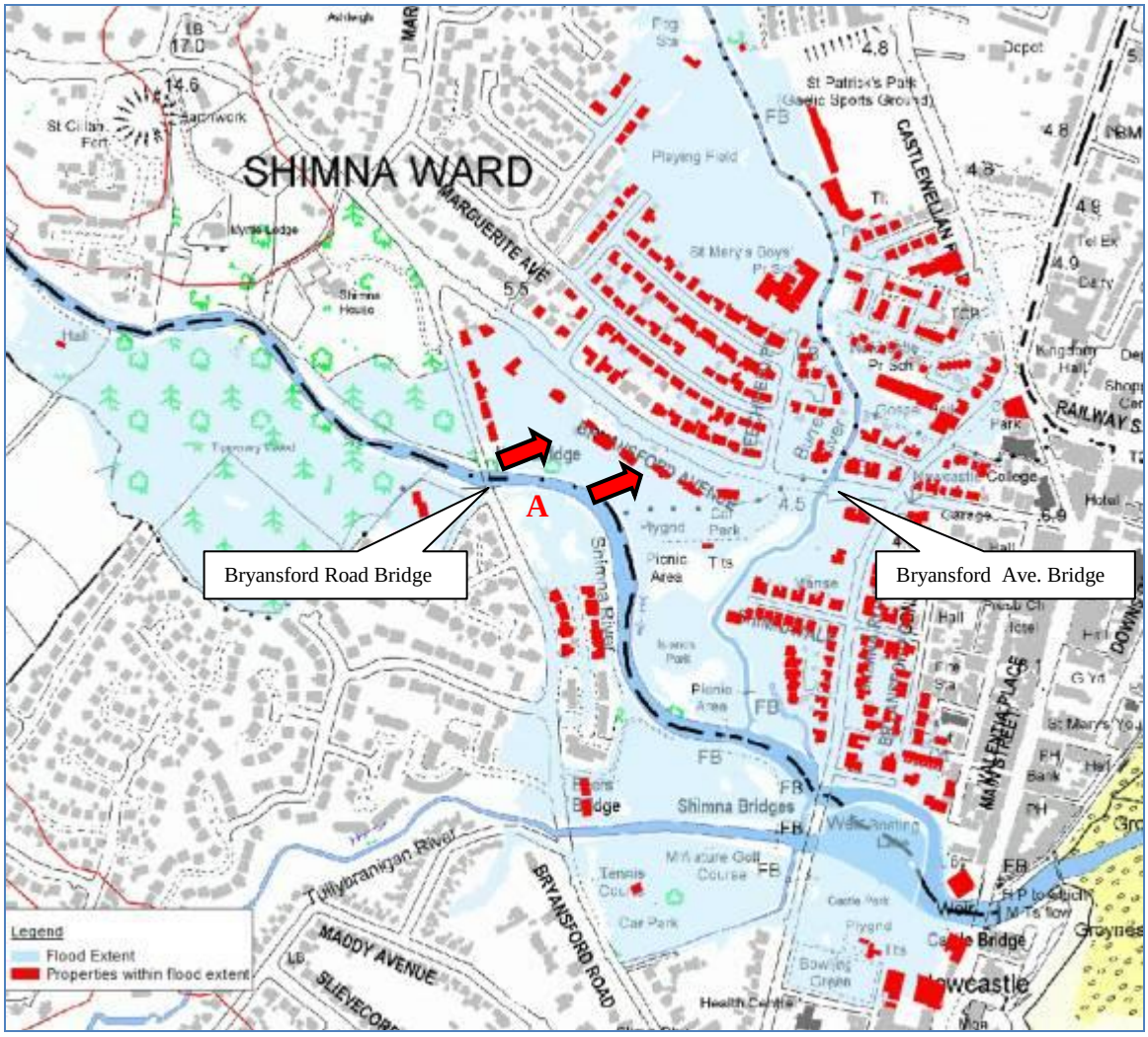


Figure 7.7.4.2 - Newcastle SFRA, Shimna River (and tributaries) - 1% AEP Floodplain

Figure 7.7.4.2 illustrates the predicted geographical extents of the potential fluvial flooding at Newcastle for a 1% AEP flood event in the Shimna River and its tributaries. The details of the potential impacts of the flooding on property and key infrastructure is summarised in Table 7.7.4.1. The model shows that at the 1% AEP (1 in 100 year) flood event, floodwater begins to overspill the banks in the vicinity of the Bryansford Road Bridge (marked as point A on Figure 7.7.4.2). The floodwater then flows across Bryansford Avenue into Beechfield Park and on towards the Bryansford Avenue Bridge. The Bryansford Avenue Bridge then acts as an aqueduct and conveys the floodwater over the Burren River to the eastern side of the town, causing flooding to properties in and around Shimna Road and Shimna Vale. This flooding mechanism, predicted by the model, corresponds with the actual flood routing observed during the severe flood event in August 2008.

Importantly, the model shows that the Burren Flood Defences, recently constructed by Rivers Agency to protect the town from repeated flooding from the Burren River, do not get overtopped by a 1% AEP (1 in 100 year) event. Therefore, although properties in the town are adequately protected from flooding by the Burren River, around 300 remain at risk from the Shimna River. The majority of the properties at risk are located

within the wedge shaped residential area that is sandwiched between the left bank of the Shimna River and the Burren River (near their confluence) and also behind the flood defences on the left bank of the Burren River. However, there is a small number of properties located on the right bank of the Shimna River at Shimna Mile, Riversdale Park and Bryansford Road which are exposed to shallow depth flooding (typically <300mm). The flooding mechanism at the more frequent 10% AEP (1 in 10 year) event is similar to that described above except that the area of inundation is substantially reduced and, as a consequence, there is lesser number of properties (around 80) estimated to be affected by flooding. The present value of the total property damages from potential future floods is calculated to be in excess of £5.5 million. This figure has been abstracted from the recent *Shimna River, Newcastle Flood Risk Assessment Economic Appraisal* report (RPS 2014) which is considered to be more accurate than the calculation of damages through the automated FRISM tool that is used generally for the assessments carried out for the plans.

Table 7.7.4.1 Newcastle SFRA – Shimna River and tributaries			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	77	N.A.	274
Non Residential (Nr)	5	N.A.	14
Economic Damage (£)	£99k	N.A.	£6.2m
Annual Average Damage (£)	*£312k		
Present Value (£)	***£**5.5m		
IPPC sites (Nr)	**0**		**0**
Community Assets (Nr)	**0**		**0**
Care Homes	**0**		**0**
GP Surgery's	**0**		**0**
Fire stations	**0**		**0**
Hospitals	**0**		**0**
Police Stations	**0**		**0**
Schools	**0**		**1**
Key Infrastructure (Nr)	**3**		**10**
NIW Wastewater Treatment Works	**0**		**0**
NIW Sewage Pumping Stations	**3**		**5**
NIW Water Treatment Work	**0**		**0**
NIW Treated Water Pumping Stations	**0**		**0**
NIE Substation 6to11kV	**0**		**5**
NIE Substation 33kV	**0**		**0**
NIE Substation 275kV	**0**		**0**
NIE Substation 110kV	**0**		**0**
Road Service - Trunk Road	**0**		**0**
Environmental Designated sites (Nr)	**6**		**6**
AONB	**1**		**1**
ASSI	**2**		**2**
Environmentally Sensitive Areas	**0**		**0**
Maritime Nature Reserve	**0**		**0**
Nature Reserve	**0**		**0**
RAMSAR	**0**		**0**
SAC	**1**		**1**
Sites of Local Nature Conservation Importance	**2**		**2**
SPA	**0**		**0**
RSPB Reserve	**0**		**0**
UWT Nature Reserve	**0**		**0**
Built Heritage sites (Nr)			**2**
National Trust	**0**		**0**
Listed Buildings	**0**		**1**
Sites and Monuments Records	**0**		**1**
Buildings of Special Architectural or Historical Interest	**0**		**0**
Areas of Significant Archaeological Interest	**0**		**0**
Historic Gardens	**0**		**0**

Leitrim River and Murlough Drain

The modelled reach of the Leitrim River extends from just upstream of Annsborough to its outlet to the sea at Dundrum Bay. Within this 9.5km reach there are 9 bridges and a number of weirs that affect flows in the channel and the hydrodynamic affects of these structures are included within the model. The modelled section of the Murlough Drain extends from the Castlewellan Road to its confluence with the Leitrim River a distance of around 2km.

The developed areas that are prone flooding within the Leitrim River and its tributary the Murlough Drain, together with a description of the flooding mechanisms are as follows.

Figure 7.7.4.3 illustrates the predicted geographical extents of the fluvial floodplains at Newcastle for a 1% AEP (1 in 100 year) flood event on the Leitrim River and its tributary the Murlough Drain.

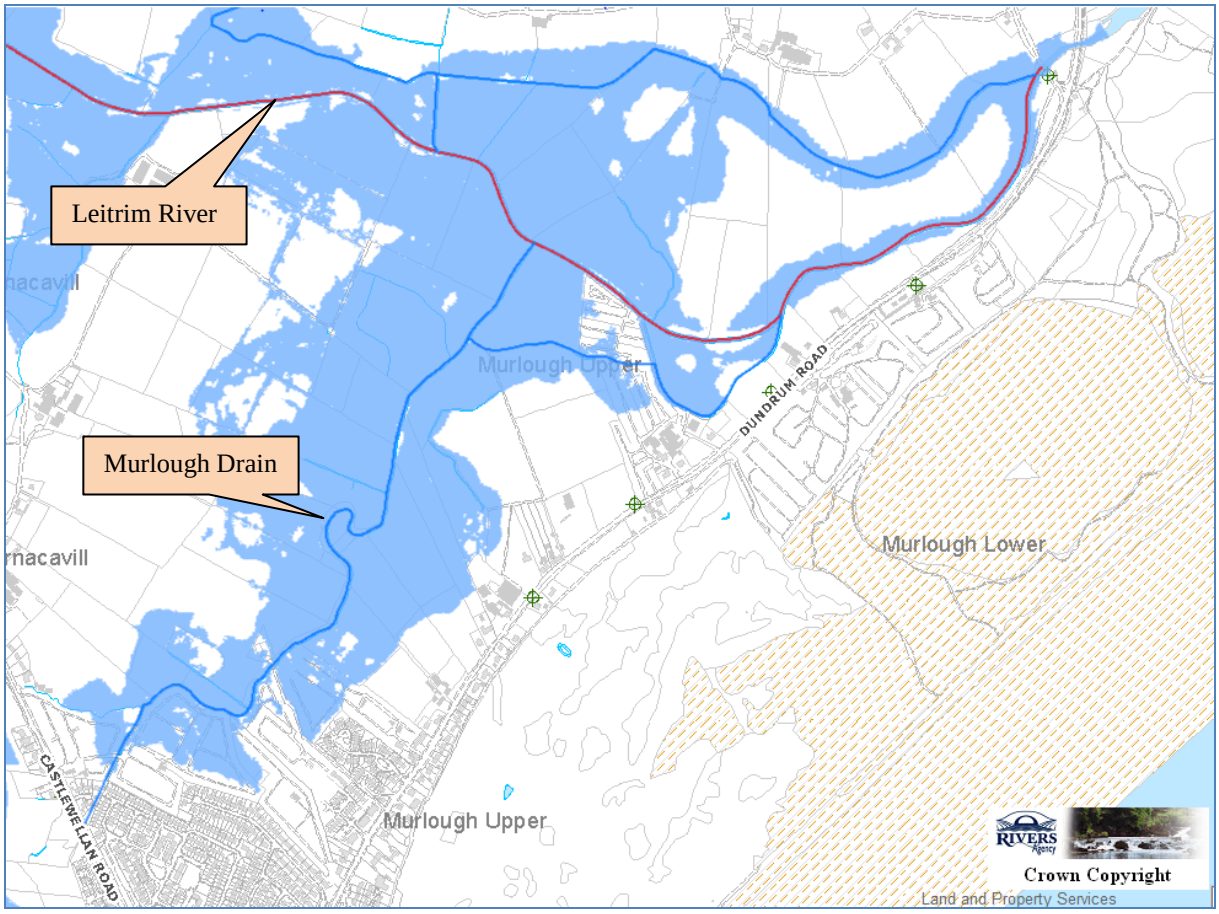


Figure 7.7.4.3 - Newcastle SFRA, Leitrim River and Murlough Drain - 1% AEP Floodplain

The floodplain for the Leitrim River and its tributary the Murlough Drain are essentially flat. Therefore, when river levels rise above bank height in either of these watercourses, the area that floods is extensive and causes the inundation of large areas of agricultural land and partial flooding to three caravan park sites with entrances off the Dundrum Road. The depth of flooding across the areas occupied by the caravan parks is very shallow and typically less than 150mm. Therefore, it is likely that most of the caravans within the flood

plain would avoid internal flood damage. The location of the vulnerable caravan parks are illustrated in the aerial view below.

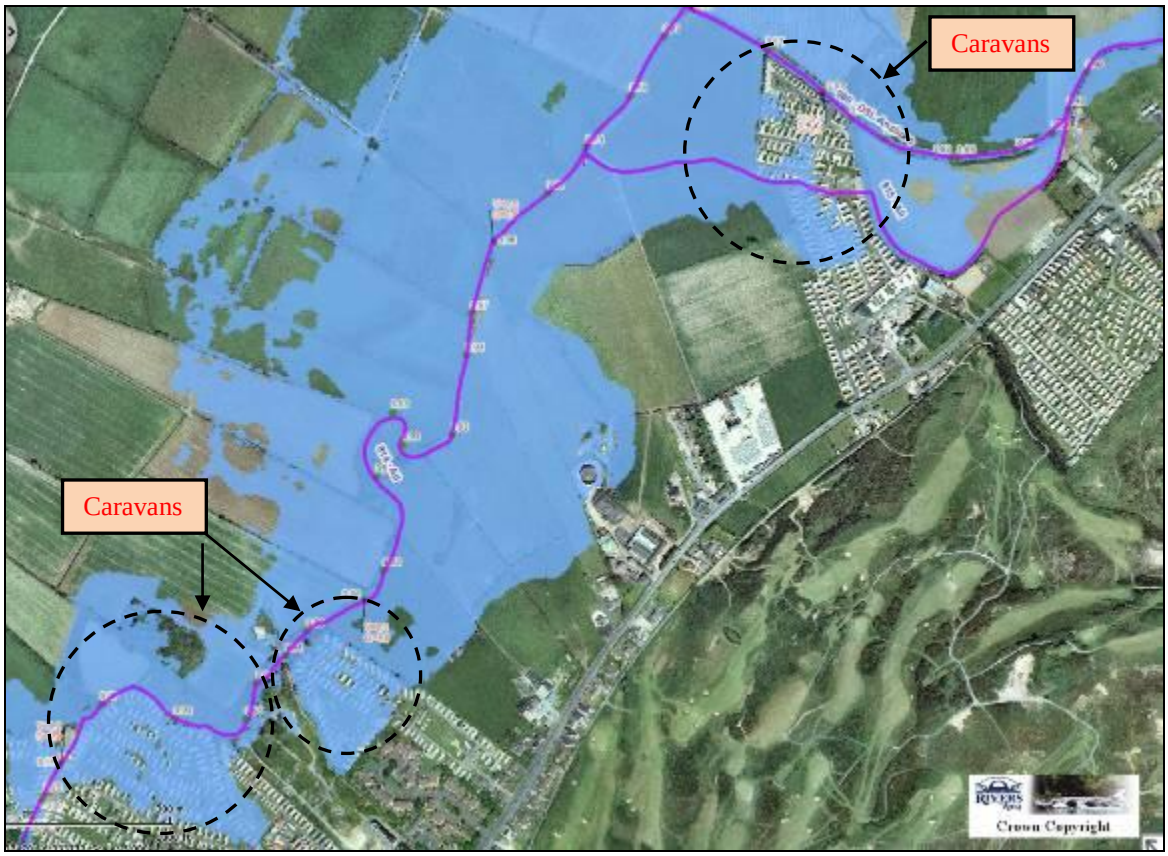


Figure 7.7.4.4 - Newcastle SFRA, Leitrim River and Murlough Drain
Location of caravan parks with 1 % AEP Floodplain

A feasibility study was undertaken by Rivers Agency in 2003 to establish if a flood alleviation scheme to mitigate the flood risk from the Leitrim River/Murlough Drain was likely to be economically viable. The conclusion of this feasibility study report was that the estimated cost of providing flood defences was around £7m and that the benefits in terms of the potential cost of the flood damage avoided was negligible. The main reason that calculated benefits were very low is that government guidance on economic appraisal does not allow the cost of damages to flooded caravans to be taken into consideration. However, even in the event that the cost of the caravan damages could be taken into account, a flood alleviation scheme would not be economically viable. Consequently, there will be no structural flood mitigation measures specific to these watercourses included within the plan.

The Glen River

The Glen River flows around the southern end of the town. Its upper catchment is entirely mountainous and dominated by Slieve Donard and Slieve Commedagh. It flows to the sea at Patton's Bridge on the Central Promenade and the modelled reach extends from the outlet to the foot of the hill at Donard Wood some 400m upstream.

The model shows that even at the 1% AEP event the flow in the Glen River remains within the confines of its channel and, as there is no potential significant risk to property, there will be no flood mitigation measures specific to this watercourse included in the plan.

7.7.5 Proposed Fluvial Flood Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Newcastle it is important the flood risk is not increased by allowing new development in areas of known flood risk. Planning Policy Statement, PPS 15, Planning and Flood Risk, adopts a precautionary approach to development with the primary aim *'to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere'*.

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the 'Exception' rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to 'Greenfield' built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new Development Plans for Newcastle, Rivers Agency will advise against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 100 year fluvial floodplain, reservoir inundation area or is susceptible elsewhere to surface water flooding.

Rivers Agency will also review the existing development plan for Newcastle (Ards and Down Area Plan) with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

The main (undeveloped) flooded areas, amongst others, within the Newcastle Significant Flood Risk Area are:

Burren River

- East of the river to the Castlewellan Road and to the north of Ardkeel Park
- West of the river in the playing fields area at St May's Primary School
- To the east of the river on both sides of the Castlewellan Road
- To the west of the river in Marguerite and Elmgrove Park Areas

Shimna River

- To the south of the river at Shimna Mile and Riverside Park
- To the North of the river along Bryansford Avenue

Shanslieve Drive Stream

- To the south of the river along the Shimna Road and Bryansford Road

Murlough Drain

- To the east of the drain at the caravan parks.

Planning Applications

Fluvial Areas at risk

Rivers Agency shall advise against the development of all sites that are located within the 1 in 100 year fluvial floodplain, irrespective of whether they are located within a current development plan or as a single site application outside the plan area.

For those sites within the 1 in 100 year fluvial floodplain where the principle of development has been accepted by Planning NI as meeting the 'Exception Test', Rivers Agency will further consider the application through the appraisal of an accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The main existing developed areas, amongst others, at flood risk within Newcastle were re-development may be likely to take place are:

- An area sandwiched between the Shimna River and the Burren River which includes existing developments in the vicinity of Bryansford, Elmgrove and Larchfield Park.
- An area to the east of the Burren River which includes developments in the vicinity of Shimnavale, Shimna Road, Shimana Park, Dunwellan Park and Burren Park.

Areas at Risk of Surface Water flooding

For those sites outside the 1 in 100 year fluvial floodplain that are located in an area where there is evidence of a history of surface water flooding (identified by flood hardship payments) Rivers Agency will further consider the application through the appraisal of the accompanying Drainage Assessment that will need to demonstrate suitable flood mitigation measures.

Where there is potential for surface water flooding as predicted by the Surface Water Maps (areas highlighted purple) Rivers Agency will advise that the applicant should assess the flood risk and drainage impact to the site and construct in an appropriate manner.

The main areas within Newcastle that have a history of surface water flooding area at:

- Tullybranigan Road
- Shimnavale
- Burren Park
- Marguerite Avenue

Areas at Risk of Flood Inundation from Reservoirs

For all development proposals that are located within the potential flood inundation area of a Controlled reservoir we will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures. If it is a new development proposal, Rivers Agency will also need the applicant to demonstrate that the condition, management and maintenance regime of the reservoir is appropriate to provide sufficient assurance regarding reservoir safety.

Controlled reservoirs identified in the Newcastle area are:

- Lough Island Reavy

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is therefore important that we continue to target investment by providing flood defences, culvert alleviation schemes and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. **The Flood Investment and Planning Group**, FIPG, provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a Flood Risk Metric tool (FRISM) is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total 'damage avoidance benefits' that the scheme will provide to property over the scheme's design life. If the benefit/cost ratio is greater than 1, then the potential scheme will be referred to Rivers Agency's Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely Rivers Agency's responsibility, or is the responsibility of NI Water or Transport NI such as a local drainage or road infrastructure issue, then it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a cost benefit analysis identifies a viable scheme, it will be placed on a prioritisation list and progressed alongside other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take anything from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Fluvial mitigation

Having conducted a detailed assessment of the fluvial flood risk from all of the rivers in the Newcastle SFRA, Rivers Agency has determined that the level of flood risk from the Shimna River may be sufficient to justify investment in a flood alleviation scheme.

Rivers Agency is currently undertaking a detailed feasibility study to more accurately determine the level of flood risk to Newcastle from the Shimna River and to assess the options to mitigate the risk from potential future floods (including their economic viability). This feasibility study is due to be completed by February 2015 and it is likely that the recommended option will be for the provision of hard defences (flood walls and embankments) along both banks of the river upstream and downstream of Bryansford Road Bridge. At the time of the publication of this Draft Plan it is not known if a flood alleviation scheme will be cost beneficial and,

if so, whether its priority relative to all others under consideration will be sufficiently high to progress to the design stage. However, this information will be available before publication of the Final Plan in December 2015 and therefore the plan will indicate if and when, the detailed design of the scheme will be undertaken.

Surface Water/Sewerage Flooding Mitigation Measures

The ongoing flooding at the Mourneview housing development was referred to the recently formed cross-departmental Flood Investment Policy Group (FIPG) for a resolution. FIPG agreed to coordinate a government wide investigation and solution (if appropriate) as the flooding appeared to be related to an 'unadopted' sewerage system, for which NI Water has no statutory responsibility and also because road drainage may be a contributing factor, a potential solution could involve more than one of the drainage authorities. On the basis of FIPG recommendations, NI Water has taken a lead on this issue now received a feasibility study from its consultants on the drainage situation within Mourneview and the investigation has outlined a complex drainage arrangement which has interdependencies between infrastructure owned by NI Water, Transport NI and some soakaway systems where ownership is unclear.

NI Water is currently developing the detail design of a project to reduce the risk of flooding in the Mourneview area of Newcastle. The project concept is being developed based on the installation of a new road drainage outfall and the enlargement of the combined sewer. Once the technical development and statutory approvals are completed, the project will be tendered with the aim of a construction start in summer 2015. The project will be jointly funded by NI Water and Transport NI.

Preparedness

In Newcastle it is not possible to prevent or protect against all flooding. Indeed even where flood defences exist it is possible in an extreme event that these could be over topped and flooding could still occur.

Having recognised this fact, considerable effort in recent years has been made by emergency planners in a Government Departments, Councils and the Emergency Services working together and sharing information to ensure a coordinated response.

However, despite these improvements, during significant flood events the emergency response of Government Departments and the Emergency Services can become over stretched. This means that not all calls for assistance during a flood event may be responded to in a timely manner. With this in mind it is important that households and communities, subject to a known flood risk, are prepared. The detail of preparedness actions, including flood warning and informing activities planned from a regional perspective, are provided in Annex E.

This is not Government withdrawing from any undertaking to respond in emergencies but an additional layer of support to ensure Government Departments and the public work together to reduce the overall impacts of flooding.

From the flood risk assessment it would appear that 1 area in Newcastle has flooded in the recent past and may benefit from the flood warning and informing proposals, outlined in Annex D.

A pilot project of community engagement to deliver flood warning and informing, held in 2014, identified basic assessment formulae to assess and score areas that could potentially be a focus for flood warning and informing actions. Based on this scoring the following area could be considered suitable for being included in a programme of community engagement to deliver flood warning and informing initiatives:-

- Bryansford Avenue / Shimna Road area.

Key activities that could be undertaken are:

- Explaining the potential and limitations of Community Resilience;
- Briefing communities on information available, particularly from the Met Office;
- The facilitation of self-help initiatives, including remote sandbag storage; and
- Reviewing and validating all elements of the Community Engagement Plan to help the community communicate effectively in an emergency and work together.

A table in Annex J shows how this community rank in the overall context of the 20 FRA's in this Plan. It should be noted that this is an indicative assessment which may change subject to further information on flood risk becoming available.

The rollout of this work is dependent on funding being available.

7.8 Newtownards Significant Flood Risk Area

The core boundary of the Newtownards SFRA, which has been determined through the PFRA, is located within the Strangford local Flood Management Area and is illustrated in Figure 7.8.1 below.

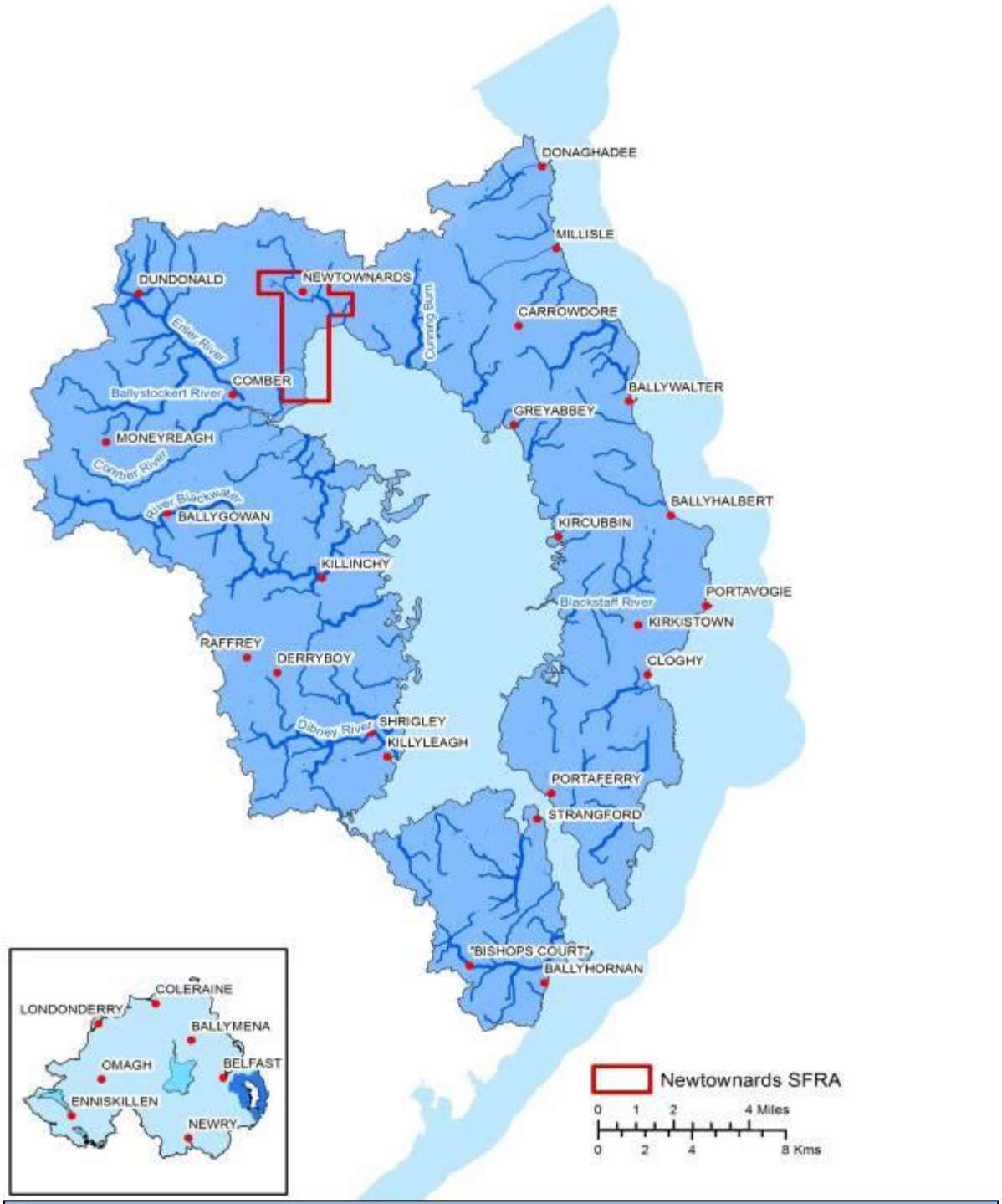


Figure 7.8.1 - Strangford Local Flood Management Area and Newtownards SFRA

7.8.1 Flooding History

Sea defences at the northern end of Strangford Lough were initially constructed as part of a land reclamation scheme by Lord Londonderry in 1810. In 1859 the original embankment was extended southwards to Ballyrickard and, in the 1950s, the construction of a waste water pumping station required further extensions. Significant improvement works to the defences were carried out in the 1970s when the banks were raised and widened and rock armouring was placed on the seaward face.

In December 1981 there was a significant breach of the sea defence near the Newtownards Airfield which caused flooding as far back as the Castle Gardens Primary School on the Portaferry Road (see photograph below). This breach was immediately repaired and to reduce the likelihood of future failures, a programme of major refurbishment works were undertaken between 1983 and 1987.

Photograph 7.8.1.1 - Flooding at Portaferry Road (Dec 1981)

Despite this work the defences continued to deteriorate due to damaging winter storms and a project to replace the most vulnerable section at the foreshore adjacent to the Airfield was completed in March 2001. This project involved the reconstruction of existing earth embankments with rock armour protected steel core embankments at a cost of around £4m. In addition to the work to improve the sea defences at the foreshore, another project was undertaken at the same time to improve the defences on the Ards Canal, which flows through the centre of the town to discharge through the structure known locally as the 'Floodgates' at the Portaferry Road. The Ards Canal defences form an integral part of the sea defence systems as the water levels in the lower canal rises and falls in sympathy with the tide in Strangford Lough and, during extreme tidal events prevents sea water overspilling the banks and causing flooding to the town. The scheme on the

Ards Canal involved the reconstruction of approximately 2.4km of the existing canal banks and was completed in 2000 at a cost of around £1m.

Photograph 7.8.1.2 - Newtownards SFRA – Sea Defences

Since the works to enhance the Newtownards Flood Defences in 2000/2001 there have been at least two extreme tidal events at Strangford Lough, most notably in February 2002 and latterly in January 2014. On both occasions the defences performed as intended and there was no significant flooding from the sea. The only minor flooding recorded during these events was to roads in the vicinity of South Street due to seepage through joints in the floodwalls and backflow through road gullies, which are connected to sewerage systems that discharge to the canal without a non-return valve.

Photograph 7.8.1.3 - Newtownards SFRA – Extreme Coastal Storm Surge (Jan 2014)

7.8.2 PFRA – Identification of Potentially Significant Flood Sources

According to the Preliminary Flood Risk Assessment (Dec 2011) the town of Newtownards, in terms of the potential adverse consequences of flooding, is ranked third of the twenty SFRA within Northern Ireland (see Figure 4.1). On the basis of this initial assessment, which was undertaken using the Strategic Flood Maps, the town is considered to at significant risk from both tidal and fluvial flooding with up 2700 properties estimated to be located within the 1 in 100 year fluvial and/or 1 in 200 year coastal floodplain.

A large proportion of the town is located within the 'undefended' 1 in 200 year coastal floodplain, the extent of which are is illustrated in Figure 7.8.2.1 below. It should be noted that the PFRA flagged up the potential for significant tidal inundation at Newtownards because this national assessment is based on strategic 'undefended' flood models which ignore the presence of existing flood defence systems such as those Newtownards Sea Defences. Therefore, the assessment is in effect based on the worst case scenario, as it assumes there is no benefit from the existing defences. This precautionary approach has been taken because at the time of the assessment there was a degree of uncertainty about the level of protection that each of the existing flood defence systems provides. By adopting this approach, the urban areas that are located behind existing flood defence structures were determined to be SFRA by default and as a consequence detailed Flood Hazard/Risk Maps had to be prepared in compliance with the requirements of the Directive. This provided the opportunity to undertake the detailed structural assessments and flood modelling necessary to remove the uncertainty and establish the actual level of protection offered by these defences.

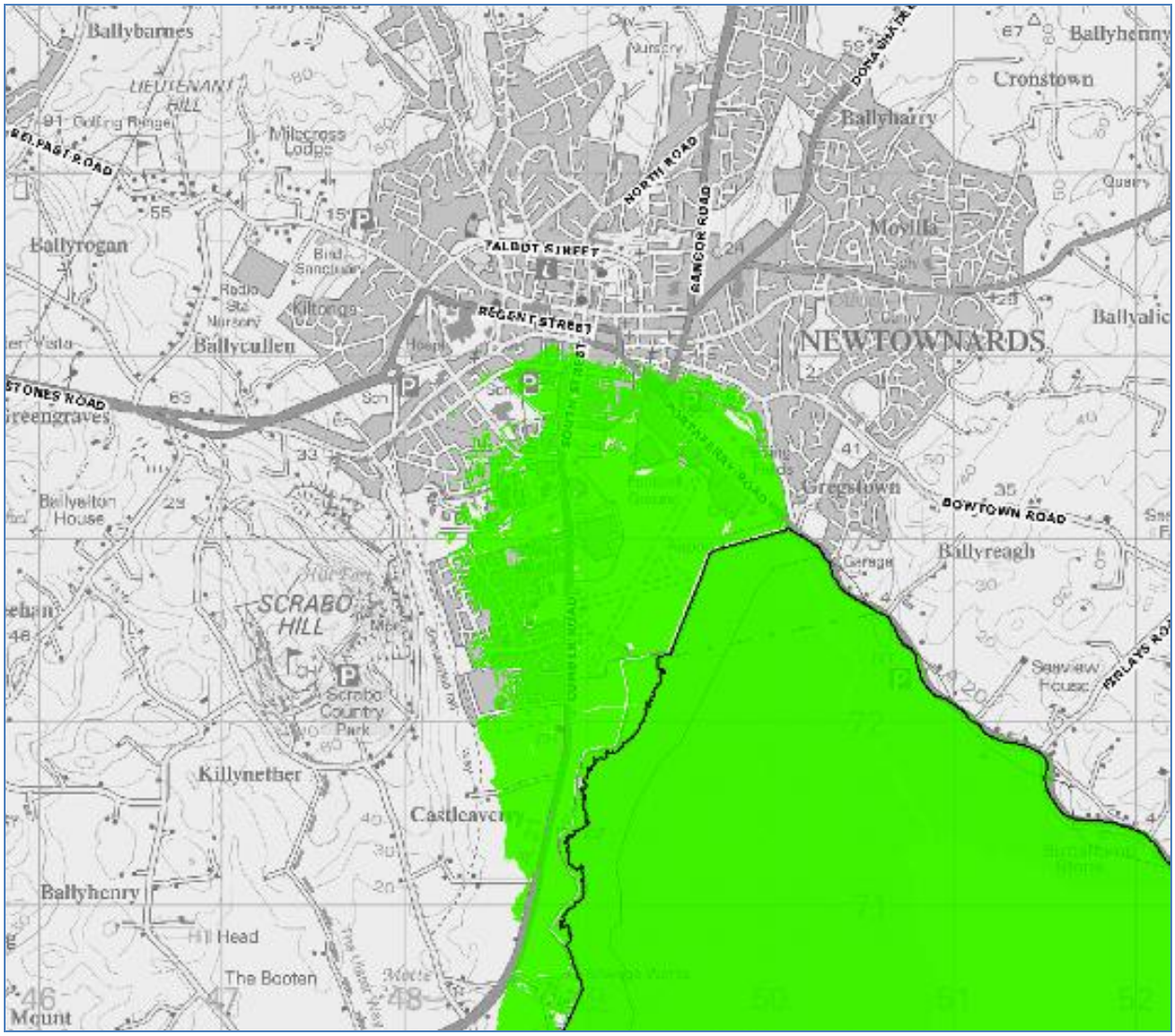


Figure 7.8.2.1 - Newtownards SFRA – Undefended Coastal Flood Plain, Strategic (0.5% AEP) 1 in 200 year event**.**

Newtownards is also considered to be at risk from significant fluvial flooding and the strategic fluvial map used for the PFRA indicates that the extent of the fluvial floodplain for the 1% AEP (1 in 100 year) event (see Figure 7.8.2.2) is almost identical to that illustrated above for the tidal flooding. The strategic flood model estimated that flooding could occur from the network of small rivers (many of which are culverted) which flow into the tidally influenced drainage channel known as the Ards Canal. As the water level in the canal rises and falls due to the influence of the tide in Strangford Lough, this can drown-out the culvert outlets and substantially reduce the discharge capacity of these culverted systems.

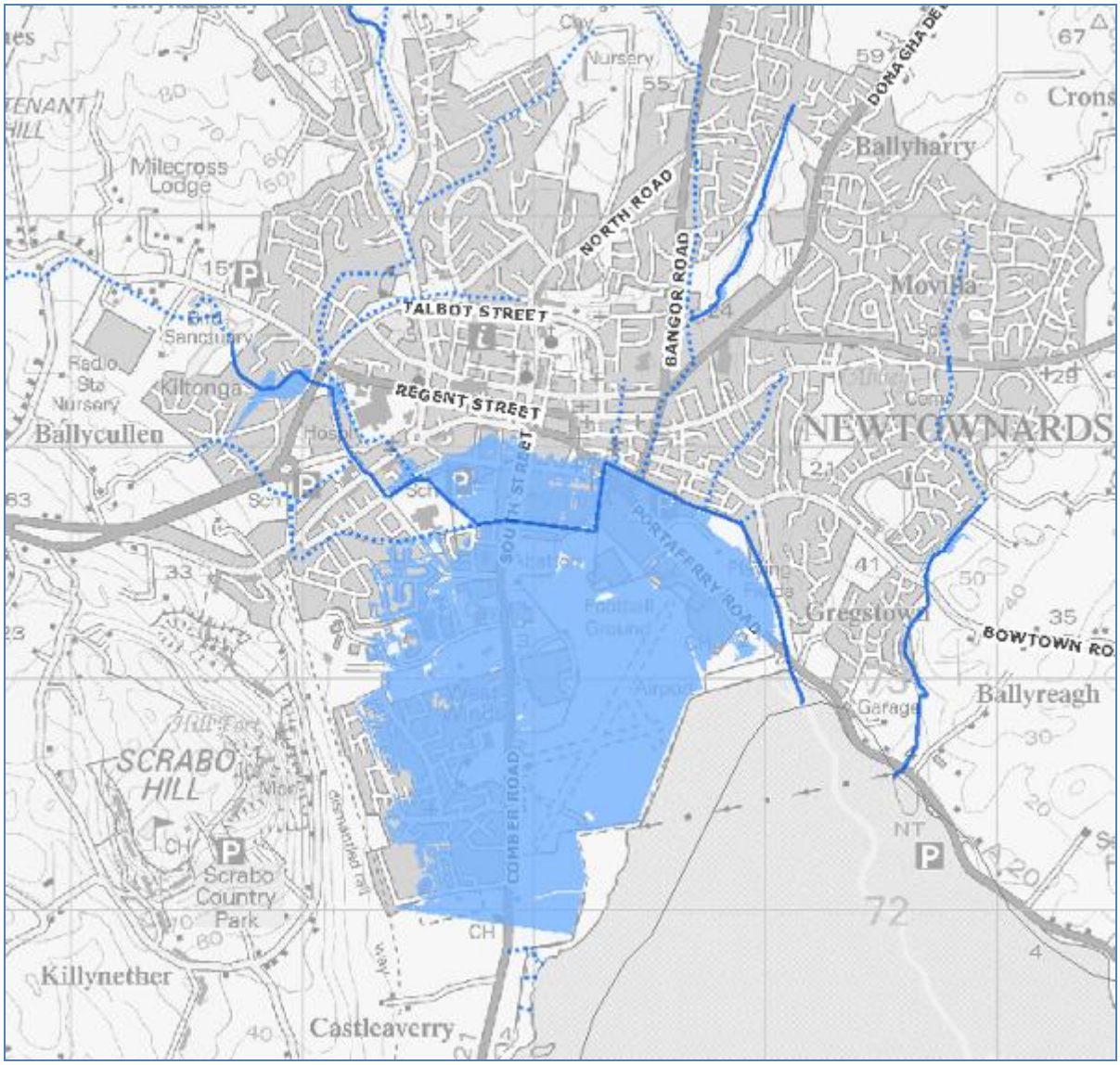


Figure 7.8.2.2 - Newtownards SFRA – Undefended Fluvial Flood Plain, Strategic (1% AEP) 1 in 100 year event.

To facilitate a more robust assessment of the level of flood risk to Newtownards from rivers and the sea, Rivers Agency developed detailed predictive flood models for each of these sources. The Flood Hazard Maps produced using the detailed flood models are more accurate than the strategic maps which may be over estimating or under estimating the number of properties at risk of flooding. Details of the flood models and their output are described in the following sections

7.8.3 Catchment Description

Newtownards town fringes the northern tip of Strangford Lough and relies on the sea defences (described in the 'Flooding History section above) to protect low lying areas of the town from coastal flooding. The town is drained via a network of small watercourses (largely culverted) which flow to the tidally influenced drainage channel known as the Ards Canal. The Ards Canal has a catchment area of around 20km^2 and its major

tributaries are the Glen River and Ballyharry Stream which flow to the canal from the north, and the Kiltronga Stream and Scrabo Stream from the west. The Bowstown Road Stream, which fringes the east side of the town, flows directly to the sea and not to the Canal. Cully's Stream, Glen River, Kiltonga Stream and Scrabo Steam are predominantly rural in their upper reaches while the Ballyharry and Bowtown Road catchments are entirely urban. Both the Kiltonga Stream and the Glen River has been impounded as they near the urban limits of the town. The impoundment of the Kiltonga Stream has created the fairly substantial Kiltonga Dams (upper and lower) which are an important feature of the Kiltonga Wildfowl Refuge on the Old Belfast Road. The Glen River impoundment has formed two ponds near Glen House on the Crawfordsburn Road. Although these impounded water bodies may present a flood risk to properties in Newtownards, the assessment and management of the risk from these dams will be managed through the proposed Reservoirs Bill which (as of the date of this Plan) is currently progressing through the NI Assembly legislative process.

A condition assessment of the culverted sections of the watercourses throughout the town, found that they are generally in a fair to good structural condition with a couple of notable exceptions. A 200m section of rectangular box culvert which links open sections of the Ards Canal at each end of John Street is assessed as Grade 4 (poor) condition. Likewise, on the Scrabo Stream, a couple of sections of 600mm diameter culvert with a combined length of 100m, located within the confines of the Movieland Cinema site at Blair Mayne Road South are assessed as Grade 4.

7.8.4 Coastal Flood Risk Assessment

Strangford Lough Flood Model and Levels

For the purposes of producing inundation flood mapping for the overtopping of the Newtownards Sea Defence system (which includes Ards Canal defences), the extreme sea water levels for a range of return periods were derived using the methodology described in the Rivers Agency's report Strangford and Belfast Extreme Tides Boundary Condition (August 2009). The tidal simulations for Strangford Lough were undertaken using a detailed MIKE 21 HD model which is a sub-model driven by the Irish Surge and Tidal Model that is used to determine extreme sea levels around the non-estuarine coastline of Ireland. Based on the Strangford tidal model the estimated extreme tidal levels at Newtownards are shown in Table 7.8.3.1 below.

	Strangford Lough – Newtownards Estimated Extreme Water levels	
	Annual Exceedance Probability - (Return Period)	**Extreme Water Level (m OD)**
Present Day	10% AEP - (1 in 10 year)	3.11
	0.5% AEP - (1 in 200 year)	3.36
	0.1% AEP - (1 in 1000 year)	3.60
Year 2030	10% AEP - (1 in 10 year)	3.18
	0.5% AEP - (1 in 200 year)	3.43
	0.1% AEP - (1 in 1000 year)	3.68
Year 2100	10% AEP - (1 in 10 year)	3.86
	0.5% AEP - (1 in 200 year)	4.11
	0.1% AEP - (1 in 1000 year)	4.35

Table 7.8.3.1 - Newtownards SFR – Extreme Tide levels

Tidal Flooding Mechanisms

A GPS survey of the primary defences at the foreshore between the Floodgates and the Ards Allotment established that the lowest crest level is around 4.3m OD. Therefore, based on the estimated extreme tidal levels obtained from the detailed model (see Table 7.8.3.1) there is no significant risk of the primary defences at the foreshore being overtopped by a tidal storm surge. With a minimum level of 4.3m OD, the primary sea defences have a substantial freeboard of around 1m at the predicted level of the 0.5% AEP (1 in 200 year) event. Although there is always the possibility of limited flooding behind the defences due to wave overtopping, this is likely to limited in scale and unlikely to present a significant risk to properties.

The design crest level of the defence structures along the Ards Canal is 3.40m OD and a recent survey confirmed that the heights of the various sections are consistently above this level except for one short section which is around 200mm lower. Despite this low spot in the canals defences, the dynamic model predicts that the defences will not overtop when water levels in the canal are raised due to the tidal backflow from a 1 in 200 year storm surge in Strangford Lough. Even if floodwater was to overspill the Canal defences at the identified low spot, the worst that would happen is that floodwater would pond on agricultural land between the edge of town and the primary sea defences. However, there is always likely to be some minor localised flooding in the vicinity of the canal during extreme tidal events. This will occur due to the backing up of drainage and sewerage systems and also from leakage through joints or cracks in the walls (see Photograph 7.8.1.3) and is likely to cause flooding of roads and possibly, very small numbers of properties.

On the basis of the foregoing, it is safe to assume that the Newtownards Sea Defences will not be overtopped by extreme tidal surges up to and including the 0.5% AEP (1 in 200 year) event. This is confirmed by the detailed tidal model and reflected in the Flood Hazard maps which are available through Flood Maps NI (see Figure 7.8.3.1 below for abstract).

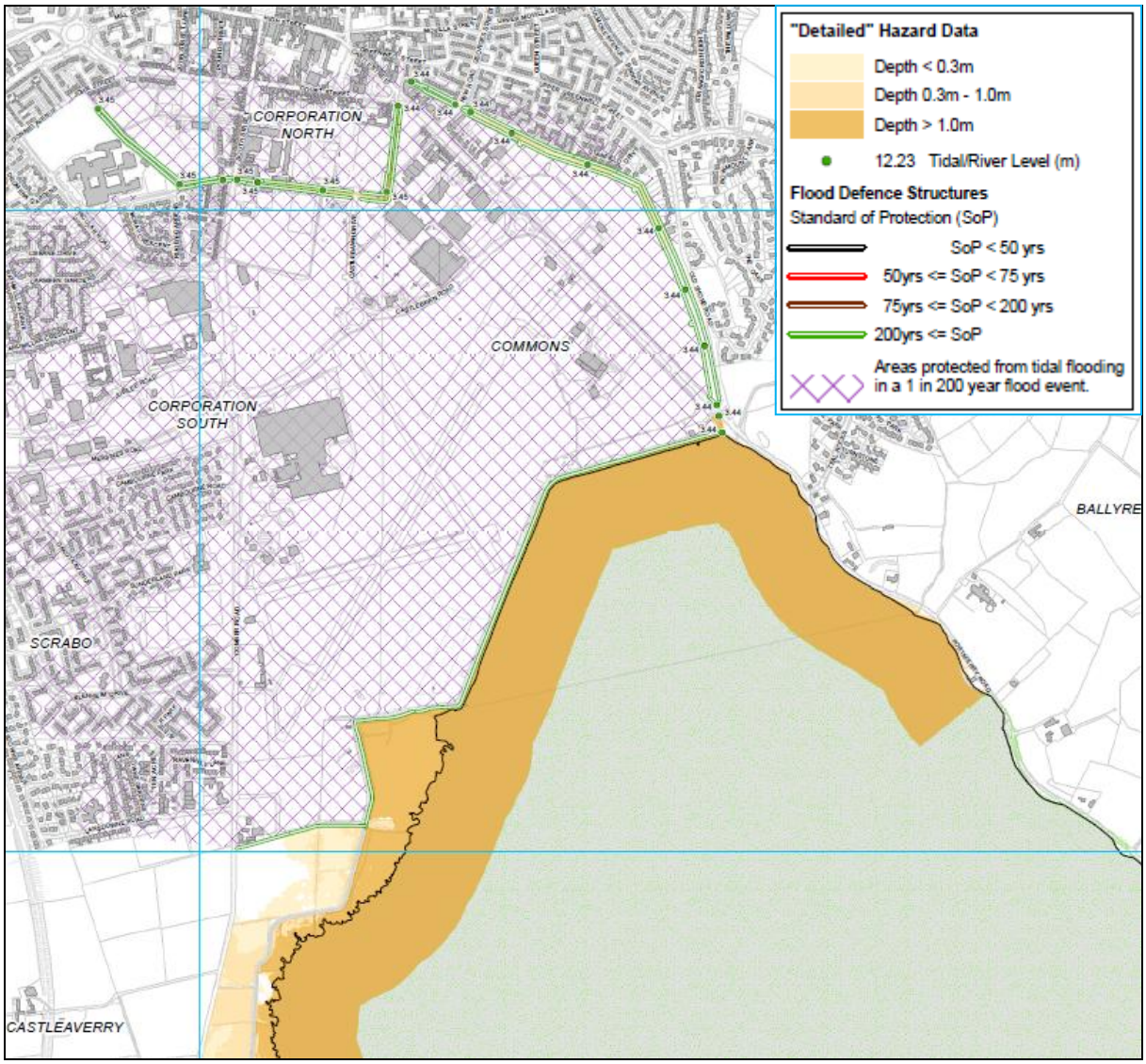


Figure 7.8.3.1 - Newtownards SFRA – Sea Defences and Area Benefitting (1 in 200 year event)

Whilst overtopping of the defences is not likely present a significant risk, there is always a possibility that a breach in the defences could occur during an extreme tidal event due to a structural defect and that this could result in flooding to property located behind the defences. However, the defences are currently considered to be in good structural condition and the potential for a breach failure mechanism is effectively mitigated through implementation of the Rivers Agency's Asset Management Plan (AMP).

Within the Agency's AMP the Newtownards Flood Defences are categorised as *'very high consequence'* which ensures that they are inspected by its Asset Management Unit (AMU) on an annual basis to assess

their structural condition and identify defects. All defects identified by AMU are referred to appropriate staff in the Lisburn Area Office who arrange for the necessary repairs to be undertaken. The Lisburn Area Office, which has operational responsibility for the defences, also undertakes routine inspections to identify and repair defects on an at least yearly basis. In addition, Rivers Agency's staff conduct post flood investigations after all major tidal events to identify leakage paths and were necessary, undertake remedial works to prevent their reoccurrence and to improve the future performance of the defences. All elements of the defence system are currently assessed as Grade 3 or better (fair to good condition) and there is every confidence that they will continue to provide an appropriate level of protection by continued application of the existing asset management procedures.

Potential Adverse Consequences

Due to the effectiveness of the sea defence systems, which were reconstructed at considerable public expense in the 2000/2001, there is predicted to be no significant risk to the town of Newtownards from tidal inundation. The sea defences protect an extensive area of around 3km^2 which includes the airfield and substantial residential/commercial property from tidal storm surges up to the 1 in 200 year event. The geographical extent of this protected area is shown using purple cross hatching in Figure 7.8.3.1.

As the Newtownards coastal defence system is in a good structural condition and provides an appropriate standard of flood protection to the town there are no additional measures required to mitigate the coastal flood risk.

7.8.5 Fluvial Flood Risk Assessment

Fluvial Model

Fundamental to the fluvial risk assessment was the development of a single Infoworks ICM model for the Ards Canal and its tributaries within the urban extents of the town. The model takes account of the tidal influence from Strangford Lough on the Ards Canal water level and is capable of simulating the flood mechanisms, taking account of the interactions between the various watercourses located within the urban area. The extent of the watercourse reaches (both open and culverted) which have been modelled in detail are illustrated in Figure 7.8.4.1 below.

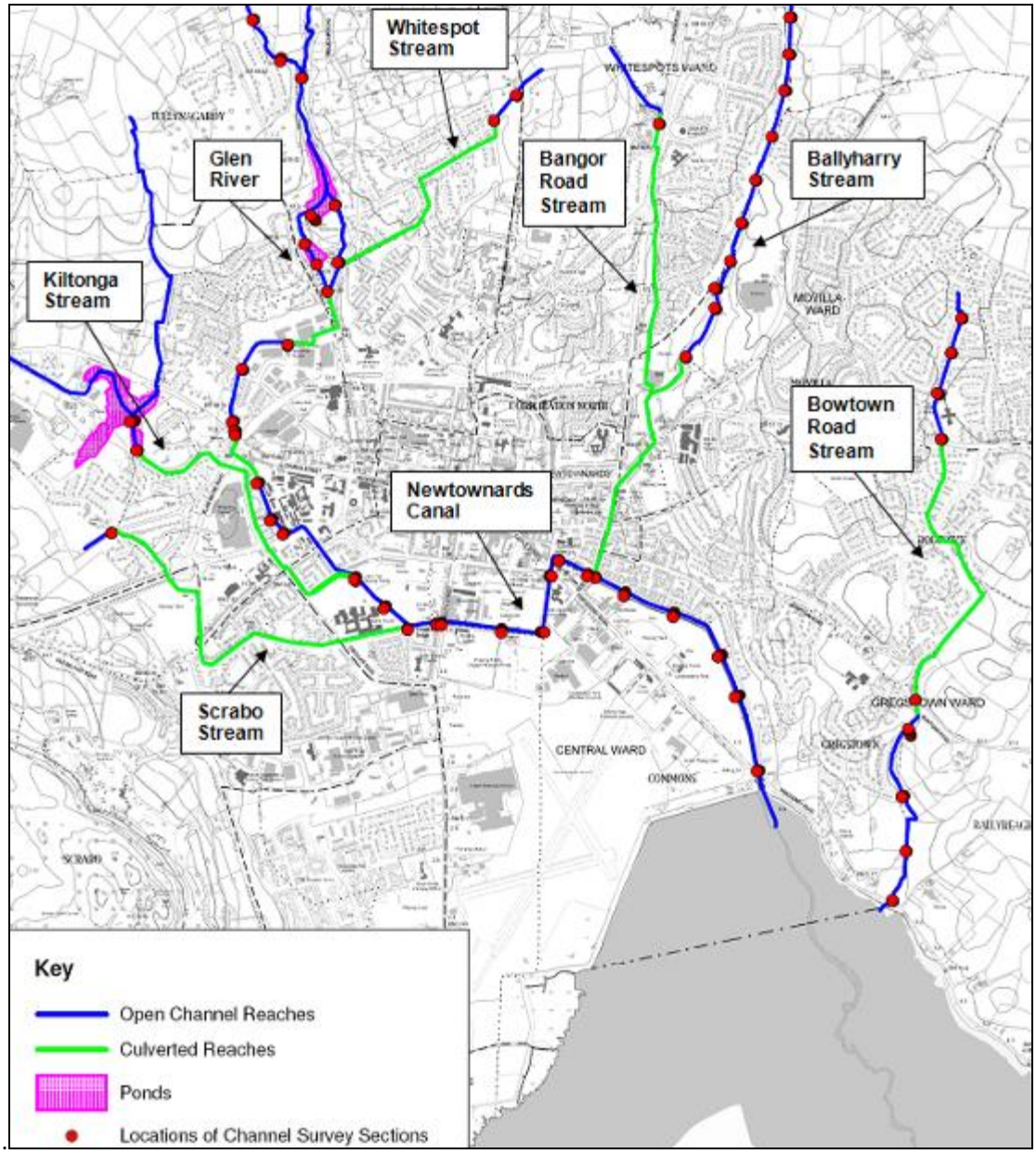


Figure 7.8.4.1 - Newtownards SFRA - Modelled Watercourses

Fluvial Flooding Mechanisms

The detailed fluvial models for the watercourses in Newtownards predict that the likelihood of the town flooding from rivers is generally very low. Of the many watercourses located within the urban footprint, Scrabo Stream is the only watercourse that is predicted to flood property at the 1% AEP (1 in 100 yr) event. The flood mechanism for this is described below and illustrated in Figure 7.8.4.2.

Scrabo Stream

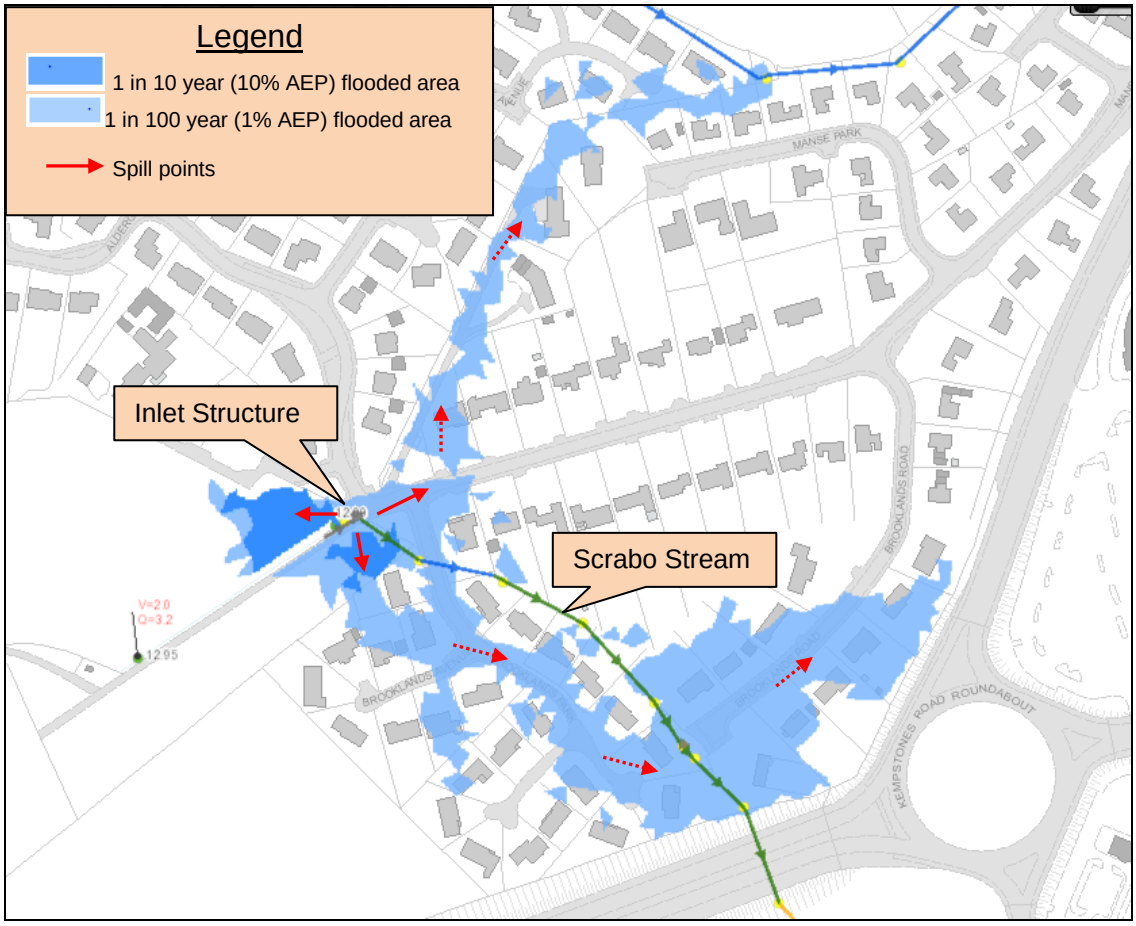


Figure 7.8.4.2 - Newtownards SFRA – Scrabo Stream flood inundation area, (1% AEP) event

The model predicts that at the relatively frequent 10% AEP event, floodwater overspills the banks of the open watercourse at the inlet to the culvert at Brooklands Park. However, in this scenario the flooding is limited to the corner of the fields either side of the watercourse. The extents of the flooding is predicted to increase at the more extreme (and less frequent) events with flooding mainly to the grounds of 15 properties in Brooklands Park and Brooklands Road predicted at the 4% AEP (1 in 25 year) and 33 properties at the 1 in 100 year event. It is calculated that the present value of the damages to property from potential future floods is around £270k. There are historical records to indicate that the watercourse overflowed in July 2010 in the manner predicted by the model.

Table 7.8.4.1 Newtownards SFRA – Scrabo Stream			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	0	15	33
Non Residential (Nr)	0	0	0
Economic Damage (£)	**0**	**£16,077**	**£238,344**
Annual Average Damage (£)	**£9,045**		
Present Value (£)	**£271k**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)	**0**	**0**	**0**
Care Homes	**0**	**0**	**0**
GP Surgery's	**0**	**0**	**0**
Fire stations	**0**	**0**	**0**
Hospitals	**0**	**0**	**0**
Police Stations	**0**	**0**	**0**
Schools	**0**	**0**	0
Key Infrastructure (Nr)	**0**	**1**	**1**
NIW Wastewater Treatment Works	0	0	0
NIW Sewage Pumping Stations	0	0	0
NIW Water Treatment Work	0	0	0
NIW Treated Water Pumping Stations	0	0	0
NIE Substation 6to11kV	0	1	1
NIE Substation 33kV	0	0	0
NIE Substation 275kV	0	0	0
NIE Substation 110kV	0	0	0
Road Service - Trunk Road	0	0	0
Environmental Designated sites (Nr)	**0**	**0**	**0**
AONB	0	0	0
ASSI	0	0	0
Environmentally Sensitive Areas	0	0	0
Maritime Nature Reserve	0	0	0
Nature Reserve	0	0	0
RAMSAR	0	0	0
SAC	0	0	0
Sites of Local Nature Conservation Importance	0	0	0
SPA	0	0	0
RSPB Reserve	0	0	0
UWT Nature Reserve	0	0	0
Built Heritage sites (Nr)	**0**	**0**	**0**
National Trust	0	0	0
Listed Buildings	0	0	0
Sites and Monuments Records	0	0	0
Buildings of Special Architectural or Historical Interest	0	0	0
Areas of Significant Archaeological Interest	0	0	0
Historic Gardens	0	0	0

Proposed Fluvial Flood Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Newtownards it is important the flood risk is not increased by allowing new development in areas of known flood risk. Planning Policy Statement, PPS 15, Planning and Flood Risk, adopts a precautionary approach to development with the primary aim *'to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere'*.

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the 'Exception' rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to 'Greenfield' built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new Development Plans for Newtownards, Rivers Agency will advise against bringing forward sites or the zoning of any land, particularly for built development that has been identified from the flood maps as being within the 1 in 100 year fluvial floodplain, reservoir inundation area or is susceptible elsewhere to surface water flooding.

Rivers Agency shall also review the existing Development Plan for Newtownards (Ards and Down Area Plan 2015) with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

The main (undeveloped) flooded areas, amongst others, within the Newtownards Significant Flood Risk Area are the:

- East side of Bowstown Road (adjacent to Burnreagh Drive)

Planning Applications

Fluvial Areas at risk

Rivers Agency shall advise against the development of all sites that are located within the 1 in 100 year fluvial floodplain, irrespective of whether they are located within a current development plan or as a single site application outside the plan area.

For those sites within the 1 in 100 year fluvial floodplain where the principle of development has been accepted by Planning NI as meeting the 'Exception Test', Rivers Agency will further consider the application through the appraisal of an accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The main existing developed areas, amongst others, at flood risk within Newtownards where re-development may be likely to take place are:

- In the vicinity of the Scrabo Stream at Brooklands Park/ Brooklands Avenue.

Areas at Risk of Surface Water flooding

For those sites outside the 1 in 100 year fluvial floodplain that are located in an area where there is evidence of a history of surface water flooding (identified by flood hardship payments) Rivers Agency will further consider the application through the appraisal of the accompanying Drainage Assessment that will need to demonstrate suitable flood mitigation measures.

Where there is potential for surface water flooding as indicated in Surface Water Map the Surface (areas highlighted purple), Rivers Agency will advise that the applicant should assess the flood risk and drainage impact to the site and construct in an appropriate manner.

The main areas identified in Newtownards as being at surface water flood risk are:

- East of Blair Mayne South Road to the Cinema.
- In the vicinity of Brooklands development
- Grounds of Victoria Primary School
- At the locus of Queen's Hall/Old Market Square
- East side of Bowtown Road Stream near the Cronstown Cottage development.

Areas at Risk of Flood Inundation from Reservoirs

For all development proposals that are located within the potential flood inundation area of a controlled reservoir we will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures. If it is a new development proposal, Rivers Agency will also need the applicant to demonstrate that the condition, management and maintenance regime of the reservoir is appropriate to provide sufficient assurance regarding reservoir safety.

Controlled reservoirs identified in the Newtownards area are as follows:

- **Strangford Lough Wildfowlers Pond**
- **Kiltonga Dams**

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is therefore important that we continue to target investment by providing flood defences, culvert alleviation schemes and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. **The Flood Investment and Planning Group**, FIPG, provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a Flood Risk Metric Tool' (FRISM) is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total 'damage avoidance benefits' that the scheme will provide to property over the scheme's design life. If the benefit/cost ratio is greater than 1, then the potential scheme will be referred to Rivers Agency's Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely Rivers Agency's responsibility, or is the responsibility of NI Water or Transport NI such as a local drainage or road infrastructure issue, then it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a cost benefit analysis identifies a viable scheme, it will be placed on a prioritisation list and progressed alongside other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take anything from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Having conducted a detailed assessment of the fluvial flood risk from all of the rivers in the Newtownards SFRA, Rivers Agency has determined that with the exception of Scrabo Stream all of the watercourses have the capacity to vent extreme floods up to and including the 1% AEP event and do not present a significant flood risk to property. The flood risk from the Scrabo Stream is determined to be moderate with in excess of 30 properties predicted to flood at the 1 in 100 year event. However, as the present value of the total damages to property from all potential future floods has been calculated to be in excess of £270k, it is possible that a flood alleviation scheme for the Scrabo Stream may be economically viable.

Accordingly, Rivers Agency shall undertake a feasibility study for a potential flood alleviation scheme on the Scrabo Stream. The timing for the commencement of this flood study will depend on its priority within the Flood Study Programme and will subject to the future resources available to Rivers Agency.

Preparedness

In Newtownards it is not possible to prevent or protect against all flooding. Indeed even where flood defences exist it is possible in an extreme event that these could be over topped and flooding could still occur.

Having recognised this fact, considerable effort in recent years has been made by emergency planners in a Government Departments, Councils and the Emergency Services working together and sharing information to ensure a coordinated response.

However, despite these improvements, during significant flood events the emergency response of Government Departments and the Emergency Services can become over stretched. This means that not all calls for assistance during a flood event may be responded to in a timely manner. With this in mind it is important that households and communities, subject to a known flood risk, are prepared. The detail of preparedness actions including flood warning and informing activities planned from a regional perspective are provided in Annex A.

This is not Government withdrawing from any undertaking to respond in emergencies but an additional layer of support to ensure Government Departments and the public work together to reduce the overall impacts of flooding.

From the flood risk assessment there at least 2 areas of Newtownards that have flooded in the recent past that may benefit from the flood warning and informing proposals, outlined in Annex D.

A pilot project of community engagement to deliver flood warning and informing, held in 2014, identified basic assessment formulae to assess and score areas that could potentially be a focus for flood warning and informing actions. Based on this scoring these areas did not score high enough to be placed within the top 20 communities to be offered a programme of community engagement during the period of this plan. However, if communities want to become more resilient, the Department is committed to providing assistance were possible to develop the consistent approach to resilience. The NI Direct website www.nidirect.gov.uk/ will host further information and advice on what to do in advance of flooding, what to do during flooding and how to recover after flooding. The website will also contain templates for communities wishing to develop their own plan.

7.9. Carrickfergus & Kilroot Power Station – Significant Flood Risk Area

The core boundary of the Carrickfergus & Kilroot Power Station SFRA, which has been determined through the PFRA, is located within the Belfast Lough and Tidal Lagan Local Flood Management Area and is illustrated in Figure 7.9.1 below.

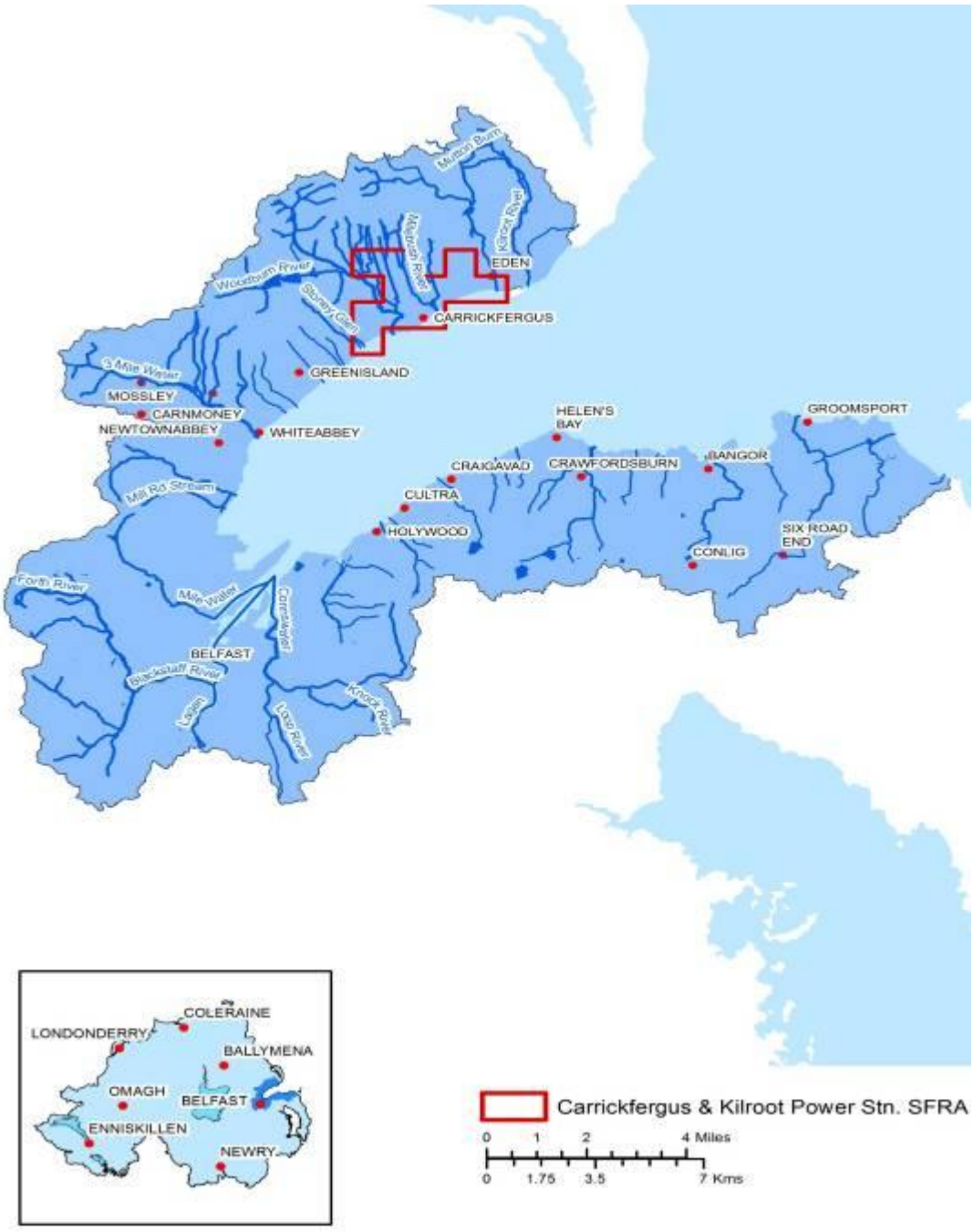


Figure 7.9.1 - Belfast Lough & Tidal Lagan Local Flood Management Area and Carrickfergus & Kilroot PS

7.9.1 Flooding History

There is evidence of localised flooding in Carrickfergus dating back to the 1980s and at some locations it is known to have occurred on a repeated basis. However, since the mid 1990s there has been a marked reduction in the instances of flooding following completion of two major flood alleviation schemes known as the North West Diversion and the North East Diversion (described below in 'Catchment Characteristics'). The most recent significant flooding occurred on 19 September 1999 and latterly on 21 June 2002 when at least 20 residential properties and one commercial property flooded within the town. However, it should be noted that the June 2002 event was assessed by the Meteorological Office as having a return period of 1 in 300 years, which is an extreme event that is well beyond the design standard for any drainage or sewerage system. Much of the property flooding pre 2002 occurred in the vicinity of the Sullatober Stream and a flood alleviation scheme, designed to protect properties from floods up the 1 in 100 year event, has been recently completed. Since the introduction of the Flood Relief Payment Scheme in 2007 there have been 6 payments issued to homeowners in Carrickfergus due to internal property flooding. Four of these payments relate to the recent extreme tidal event in January 2014 which caused flooding at Rhanbuoy Park (see Photograph 7.9.1.1). The other two payments relate to properties which flooded during the extreme weather event which occurred in August 2008 and affected large parts of the province. These properties are located sufficiently remote from a watercourse to conclude that they probably flooded due to surface water.

Photograph 7.9.1.1 - Carrickfergus Coastal Flooding – 3 January 2014

7.9.2 PFRA – Identification of Potentially Significant Flood Sources

According to the Preliminary Flood Risk Assessment (Dec 2011) the town of Carrickfergus, in terms of the potential adverse consequences of flooding, is ranked sixth of the twenty SFRA within Northern Ireland (see Figure 4.1). On the basis of this initial assessment, which was undertaken using the strategic flood maps, the predominant risk to the town was considered to arise almost exclusively from fluvial flooding. The

strategic fluvial models (see Figure 7.9.2.1) predict the potential inundation of large residential areas at the west side of town which may adversely affect up to 2300 individual properties at a 1 in 100 year event. There was also a concern that this number may be much greater as many of the minor watercourses flowing through the urban area had not been modelled at the time of the PFRA.

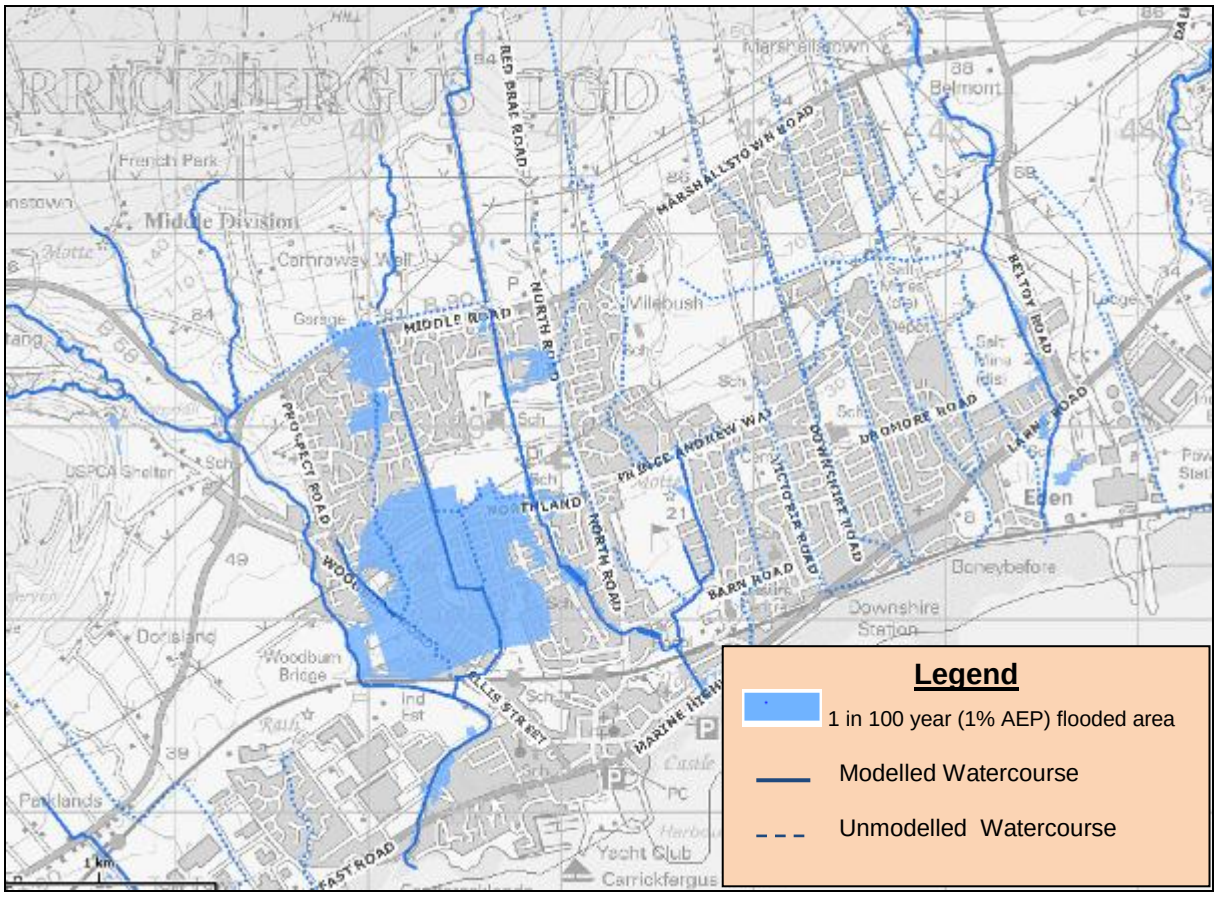


Figure 7.9.2.1 - Carrickfergus & Kilroot P.S. SFRA – Undefended Fluvial Flood Plains, Strategic 1% AEP (1 in 100 yr) event

Although situated on the coast, the town is not considered to be at significant risk from tidal inundation. The tidal model developed for Belfast Lough, which takes into account of the combined effects of tidal, surge and wind combinations, predicts that at the 1 in 200 year event flooding to property is likely to be confined to two main areas. At the western edge of the town's coastal fringe (near the outflow of the Woodburn River), it is estimated that in excess of 20 properties in the vicinity of Rhanbouy Park will be inundated to depths of up to 700mm. Tidal flooding is also predicted to occur to at least 30 properties which front the west and north sides of the Carrickfergus Marina. However, the predicted flooding around the Marina is estimated to be shallow (less than 300mm) and as a consequence, it is possible that the elevation of the property thresholds may be sufficient to prevent internal flooding to many of these properties.

To facilitate a more robust assessment of the fluvial flood risk to Carrickfergus, Rivers Agency developed detailed predictive flood models for all of the watercourses which flow through and have the capacity to

adversely affect the urbanised areas. The Flood Hazard Maps produced using the detailed flood models are more accurate than the strategic maps which may be over estimating or under estimating the number of properties at risk of flooding. Details of the models and their output are described in the following sections.

7.9.3 Catchment Description

The town of Carrickfergus is situated on the North Western shore of Belfast Lough approximately 11 miles from Belfast. The area is drained by a series of watercourse which run almost in parallel from their source in the Carrickfergus Hills north of the town to their outfalls with the sea. Although the natural watercourse catchments are typically narrow, and vary in size from around 5 to 10 km^2 these were deliberately modified by the Northwest Diversion and Northeast Diversion flood alleviation schemes which were undertaken in the 1980s and 1990s respectively. The Diversions were carried out by Rivers Agency in response to repeated occurrences of localised flooding throughout the town. They were also carried out to prevent the possibility of downstream worsening from increased flows arising from housing developments which at that time were proposed for the north east corner of the town near Marshallstown Road. Essentially the Diversions intercept the majority of the flow in most of the watercourses before they enter the urban zone, thereby reducing the risk that they will overspill during extreme events. The Diversions redirect flows to the Woodburn River on the west flank and to the Copeland Water on the east.

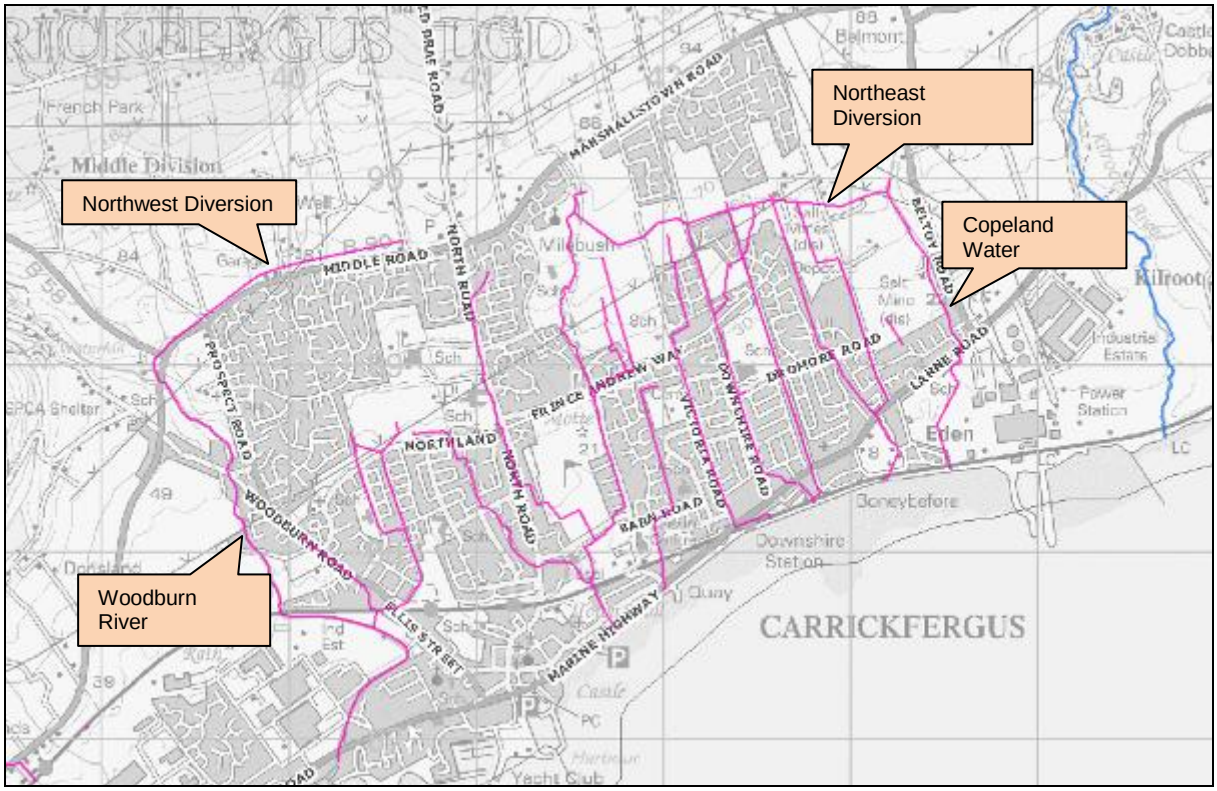
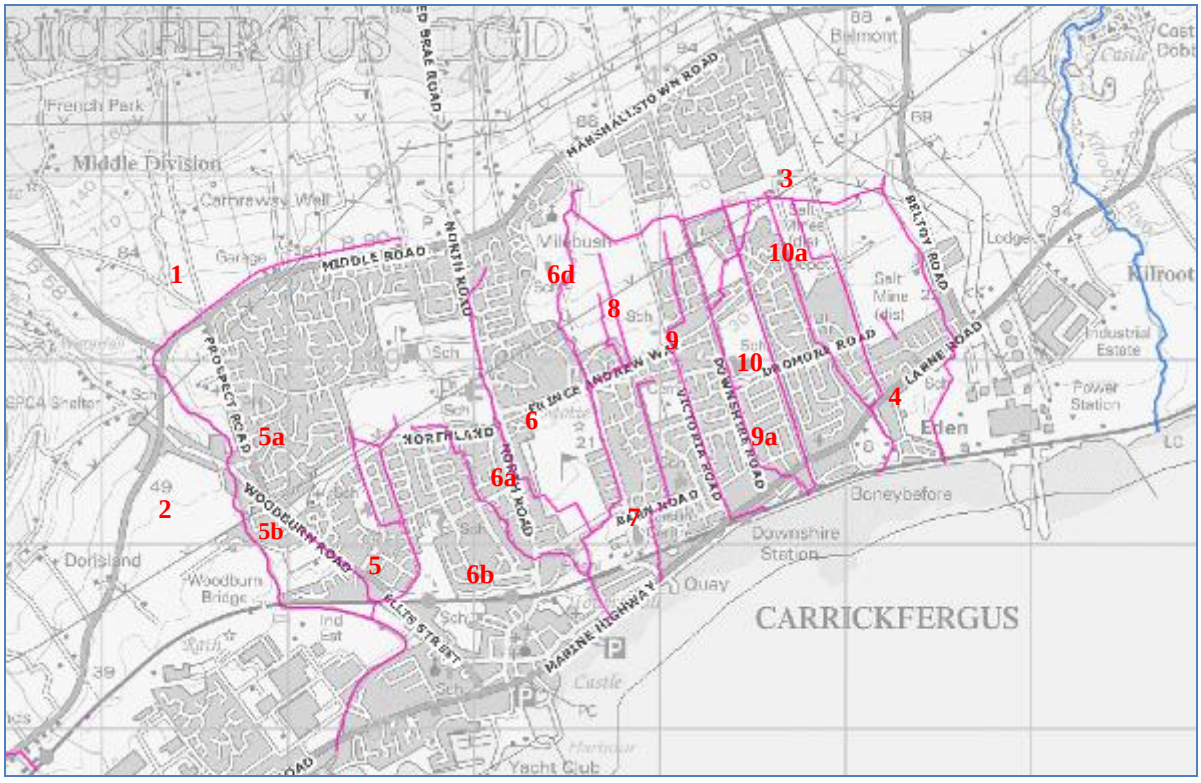


Figure 7.9.3.1 - Carrickfergus & Kilroot PS SFRA – North West and North East Diversions

7.9.4 Fluvial Flood Risk Assessment

Fluvial Modelling Methodology and Scope

Fundamental to the detailed fluvial risk assessment was the development of a hydrodynamic model for each of the main watercourses (and tributaries) which have the potential to adversely impact the urbanised areas within the Carrickfergus & Kilroot Power Station SFRA. The names, location and extents of the watercourses which were modelled in detail are indicated in Figure 7.9.4.1 below.



1	Northwest Diversion	5b	Carnraway Burn	8	Victoria Road Stream
2	Woodburn River	6	Sullatober Water	9	Downshire Road Stream
3	Northeast Diversion	6a	North Road Stream	9a	Bluefield Stream
4	Copeland Water	6b	Buskin Burn	10	Cloughlands Stream
5	Sunnylands Stream	6d	Prince William Stream	10a	Trailcock Lane
5a	Burleigh Stream	7	Barn Stream		

Figure 7.9.4.1 - Carrickfergus & Kilroot PS SFRA - Location and extents of modelled watercourses

Flooding Mechanisms

Northwest Diversion

The Northwest (NW) Diversion, constructed in the 1980s, is essentially a large (1350mm to 1800mm diameter) culvert which has been laid at the outskirts of the town to intercept a proportion of the flows from a number of the natural watercourses before they enter the western side of the urbanised zone. The NW Diversion takes a large proportion of the flows from the Buskin Burn, Sunnylands Stream, Carnraway Burn and a number of minor tributaries. The diverted flow from these watercourses is conducted around the northwest corner of the town and discharges to the Woodburn River which flanks the west side of the town and flows to its outlet with the sea at Rhanbuoy Park. The purpose of the Diversion is to substantially lower the flows in the natural watercourses during extreme rainfall events and thereby reduce the likelihood that they will cause flooding to property. The culverts in this watercourse have been assessed to be in a satisfactory structural condition.

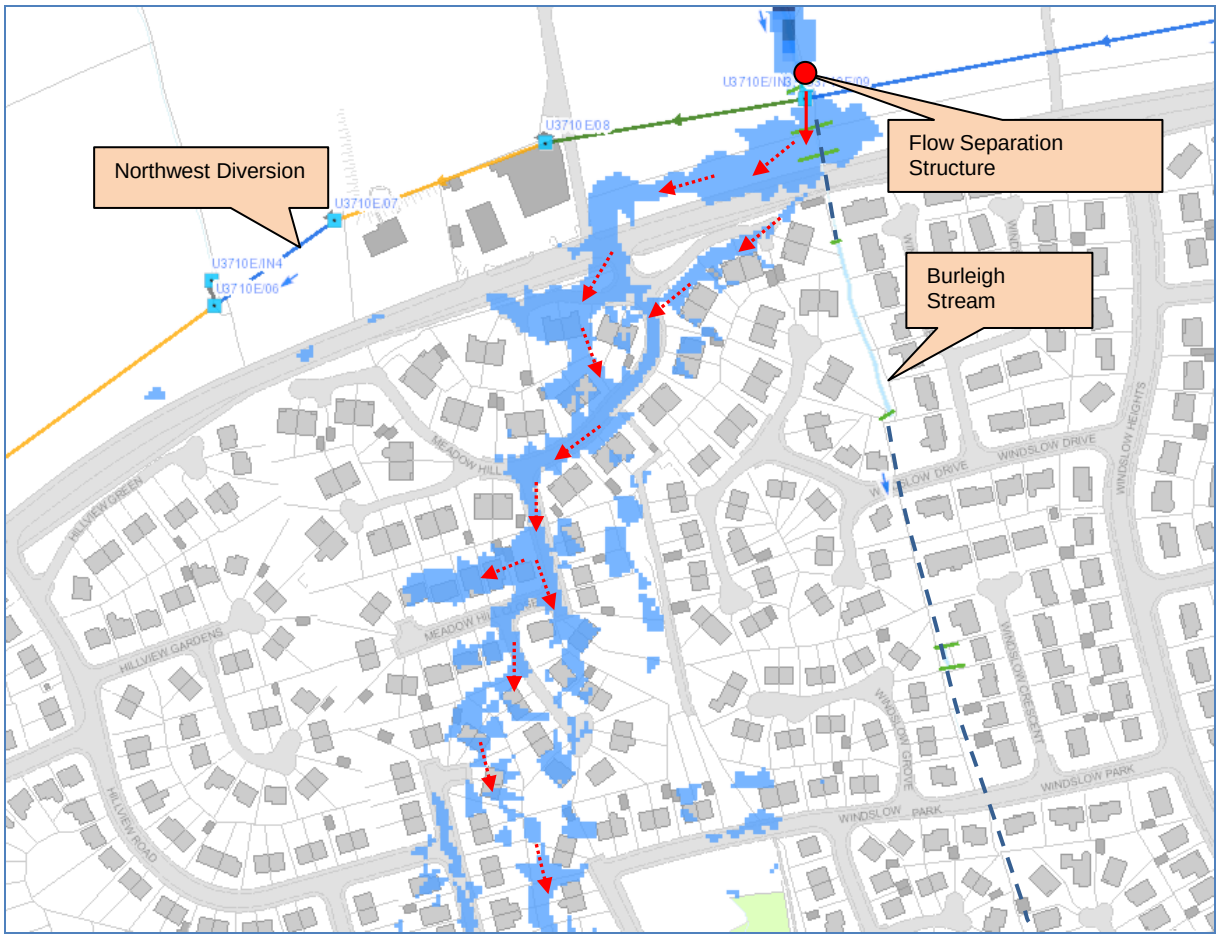


Figure 7.9.4.2 - Carrickfergus & Kilroot PS SFRA, Northwest Diversion - 1% AEP Floodplain

The developed areas that are prone flooding from the Northwest Diversion, together with a description of the flooding mechanisms are as follows.

The model predicts that the floodwater may overspill the headwalls of the flow separation structure that is designed to divert partial flows from the Burleigh stream to the culverted NW Diversion. It is estimated that flooding to property could begin to occur at the relatively infrequent 1 in 75 year event. It shows that when the floodwater overspills the structure headwalls, it flows across the Middle Road and rushes along steeply sloping carriageways within the Meadow Hill, Hillview and Rathlin Heights housing developments before spilling back into an open section undesignated of the Carnraway Stream near Mourneview Park. Although it estimated that up to 40 properties located within the flood inundation area for the 1 in 100 year event, it is important to note that the topography within the residential areas affected is very steep and, as a consequence, the depth of flooding is estimated to be shallow (less than 300mm). Therefore, many off the properties are likely to escape internal flooding due to the elevation of their thresholds above ground level. Since the installation of the NW Diversion in the 1980s there have been no instances of flooding in the manner predicted by the model and no records of flooding to any of the properties that are estimated to be at risk. The absence of any historical records of flooding would suggest that the watercourse is unlikely to present a flood risk to property except in the most extreme events (i.e. 1 in 75 year or greater).

Carnraway Burn

The Carnraway Burn is a very small urban tributary of the Sunnylands Stream. It has a highly urbanised catchment (less than 0.64 km_2) and is assumed to rise in the vicinity of Slemish Heights, and flows in a north easterly direction for around 1.2km to its confluence with the Sunnylands Stream at the railway cutting near the Clipperstown Shopping Centre. The lower reach of the watercourse in designated and extends from the confluence with the Sunnylands Stream and terminates at an inlet chamber located to the rear of Fairview Terrace some 600m upstream. This section is completely culverted with concrete pipes in the range 600mm to 1050mm diameter and these have been assessed to be in good structural condition except for a short (40m) length at the upstream end. A substantial undesignated tributary joins the Carnraway Burn approximately 100m downstream of the inlet chamber at Fairview Terrace. This undesignated tributary is culverted with concrete pipes up to 900mm diameter and it is known that these are in poor structural condition. Approximately half of the upper undesignated section of the Carnraway Burn is culverted with small diameter pipes and the open sections are heavily vegetated.

The developed areas that are prone flooding from the Carnraway Burn, together with a description of the flooding mechanisms are as follows.

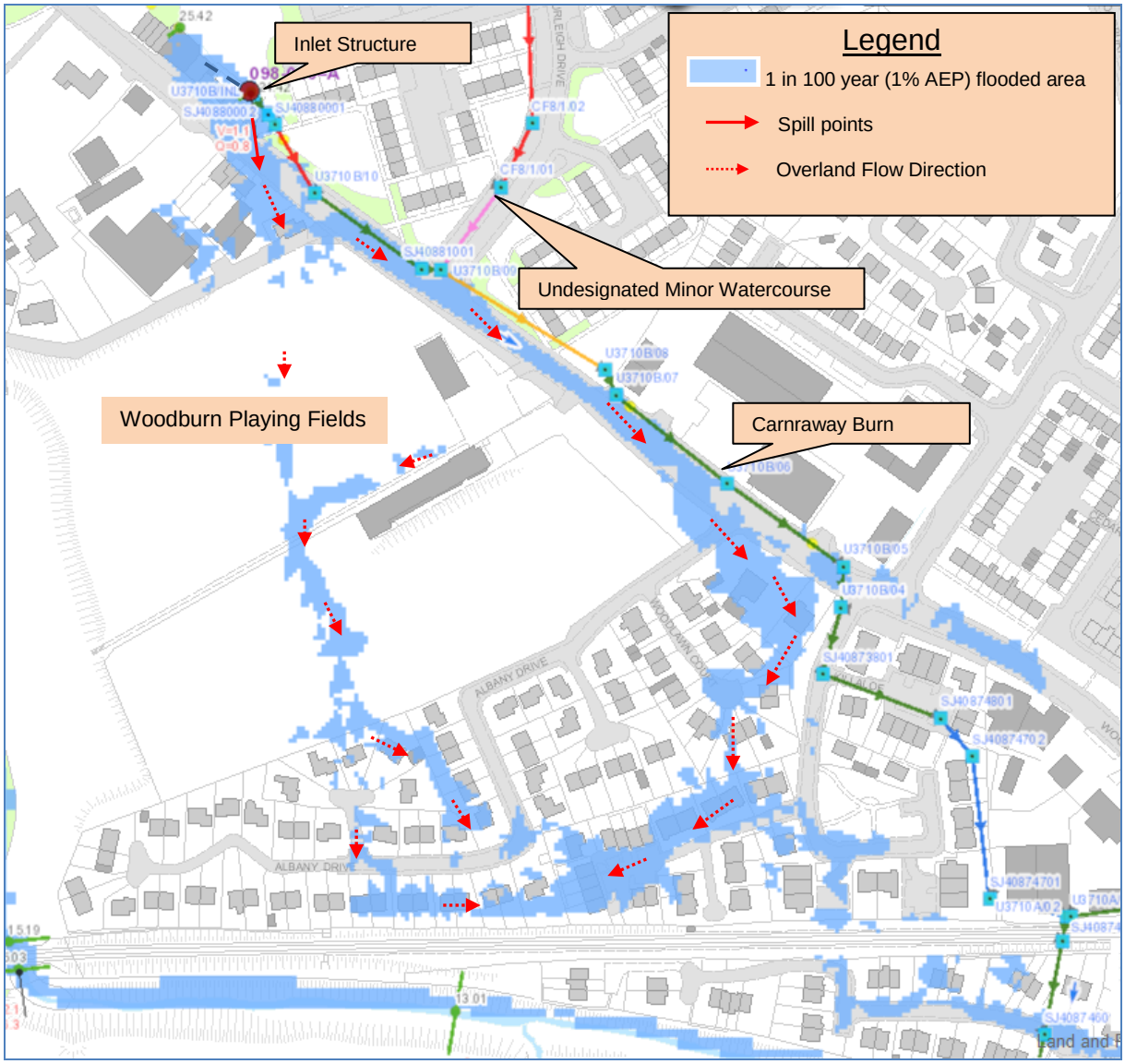


Figure 7.9.4.3 - Carrickfergus & Kilroot PS SFRA, Carnraway Burn - 1% AEP Floodplain

The model predicts that at the 1 in 25 year event, floodwater from the open section of Carnraway Burn at the rear of Fairview Terrace may jump the inlet structure and flow downhill via the Woodburn Road carriageway to cause minor flooding to the gardens of a couple of properties near the junction with Killaloe road. The likely cause of this failure is that the 600mm diameter pipe at the head of the culverted system does not have sufficient capacity to vent the flow at the inlet. At the more extreme events there is an additional flood pathway across the surface of the Woodburn Playing fields that conducts floodwater to the housing development at Albany Drive. The extent of the flooding to property increases for more extreme events and up to twenty properties are estimated to be located within the flood inundation areas predicted at the 1 in 100 year event.

The residential areas which are likely to be adversely affected by flooding are primarily in and around Albany Drive and Killaloe. However the model predicts that the depth of flooding across these areas is shallow (less than 300mm) and therefore, there is a likelihood that many of the properties will escape internal flooding due

to the height of their thresholds above ground level. The absence of any historical records of flooding at these locations would suggest that the watercourse is unlikely to present a significant flood risk to property except in the most extreme events (i.e. 1 in 75 year or greater).

Rivers Agency has received a small cluster of flood calls from the owners of properties at Fairview Terrace (dating from 1995 to 2005). However, these appear to be related to blockages at the culvert inlet and not as a consequence of overtopping from an extreme flood.

Buskin Burn

Flows from the rural catchment of the Buskin Burn are captured by the NW Diversion before the watercourse enters the town's urban boundary at the Middle Road. Beyond the Diversion the watercourse is culverted and flows in a southerly direction until it emerges from the Milebush housing development some 270m downstream. From here it flows in an open channel that fringes the eastern boundary of the Carrickfergus Grammar School and its playing fields to the Northland Road. Beyond the Northland Road the watercourse is designated and flows through a highly urbanised area to the Bird Sanctuary Pond at the Carrickfergus Leisure Centre and finally discharges via the pond outfall to the designated Sullatober Water. The designated reach of the watercourse, which extends to around 1.3km, is completely culverted with the exception of a short open section (approx 125m) in the vicinity of Rose Brook Grove. The culverts are a mix of rectangular box culverts (typically 750mm X 1500mm) and circular concrete pipes (900mm to 1050mm) with a short section of triple 600mm diameter pipes near Bridewell Drive. All of the culverts are assessed to be in a satisfactory structural condition.

The developed areas that are prone flooding from the Buskin Burn, together with a description of the flooding mechanisms are as follows.

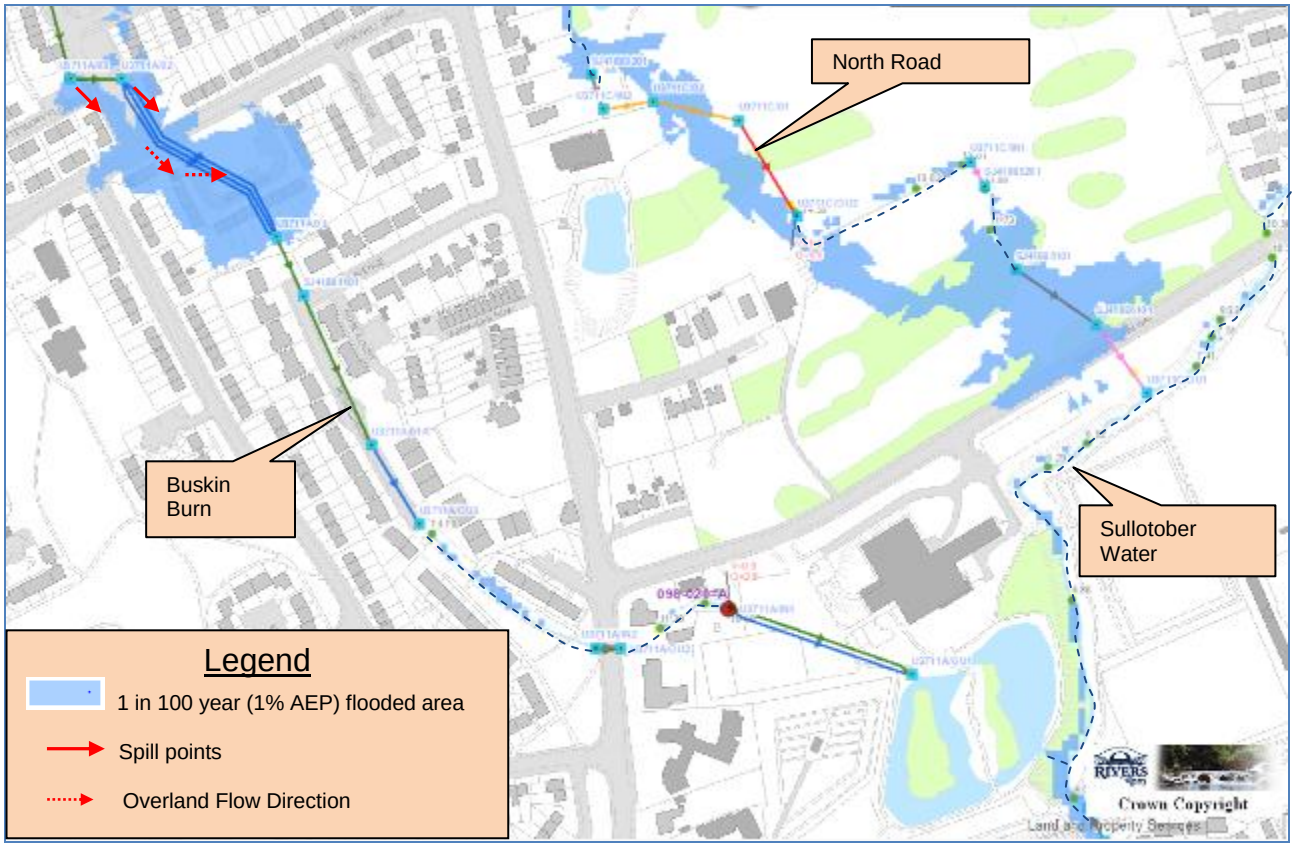


Figure 7.9.4.4 - Carrickfergus & Kilroot PS SFRA, Buskin Burn - 1% AEP Floodplain

The model predicts that the culverts at the junction of Bridewell Drive and Drumhoy Drive are incapable of venting the estimated flow for the frequently occurring 4% AEP (1 in 5 year) flood event. As the culverts surcharge, floodwater spills to the surface through two manholes located on grassed verges either side of the Drumhoy Driver near Shaftesbury Place. This floodwater is routed overland to the Green Park housing development where it collects in a depression in the landscape and floods around 20 properties. A similar flooding mechanism is predicted for each of the more extreme flood events except that the height of the water in the depression increases to the extent that properties in Green Park could be flooded internally up to 1m deep. There are no historical records of flooding in the vicinity of Green Park. Given that the model is predicting flooding on a very frequent basis (i.e. on average once every five years) the absence of a flood history would suggest that the model is overstating the likelihood of flooding. However, even though the model may be exaggerating the level of risk it cannot be assumed that the risk is not real and significant. It is notable that, at the location of the flooding, there is an unusual network configuration where a rectangular box culvert transitions to a triple 600mm diameter pipe combination within a chamber. This unusual network configuration may be causing a genuine hydraulic impediment which could result in flooding or, on the other hand, it could simply be presenting a glitch in the predictive model that is causing it to produce results that are unrepresentative of the real world situation.

North Road Stream

The North Road Stream is small tributary of the Sullatober Water. It has a narrow and steeply sloping catchment less than 1km^2 which is rural in nature above the Marshallstown Road and highly urbanised below. The watercourse flows in a southerly direction entering the urban zone as it crosses the Marshallstown Road and is culverted for around 0.7km as it passes through the Marlborough and Oakland housing developments to the playing fields at the junction of North Road and Oakland Drive. Beyond this the watercourse flows in an open channel for around 0.4 km as it flows along the eastern boundary of the Carrickfergus College campus. The watercourse is again culverted for a length of around 0.4km along the verges of the North Road. The final 0.6km reach of the watercourse runs through Carrickfergus Golf Course and alternates between open and culverted sections until it discharges to the Sullatober Water 100m east of the Carrickfergus Leisure Centre at Prince William Way.

The piped culverts are generally small in size with diameters ranging from 450mm to 650mm. A high proportion of the culverts in the upper reaches that run through the Marlborough and Oakland housing developments are assessed to be in poor structural condition.

The developed areas that are prone flooding from the North Road Stream, together with a description of the flooding mechanisms are as follows.

Within the upper reaches of the watercourse the model predicts flooding to property from two separate spill points due to insufficient hydraulic capacity of the culvert network. Flooding from the first of the spill points (see Figure 7.9.4.5) at the Marshallstown Road is estimated to commence at the 4% AEP (1 in 25 year) event when a 450mm surcharges causing a floodwater to rise to surface via a manhole on the carriageway. The floodwater flows across the surface for a short distance and ponds at the Marlborough housing development. However, flooding is slight and even at the more extreme 1 in 100 year event it is estimated that the depth of the flooding will be no more than 300mm and although 5 properties are shown to be located in the inundation area, it is possible that some of these may avoid internal flooding due to the height of their thresholds. Homeowners in this area have made at least seven phone calls to the emergency Floodline requesting assistance over the period 1998 to 2002. Although the majority of the calls appear to be related to road drainage issues, high flows in the watercourse may be a contributing factor. There have been no claims for flood relief payments arising from this location since the introduction of the scheme in June 2007.

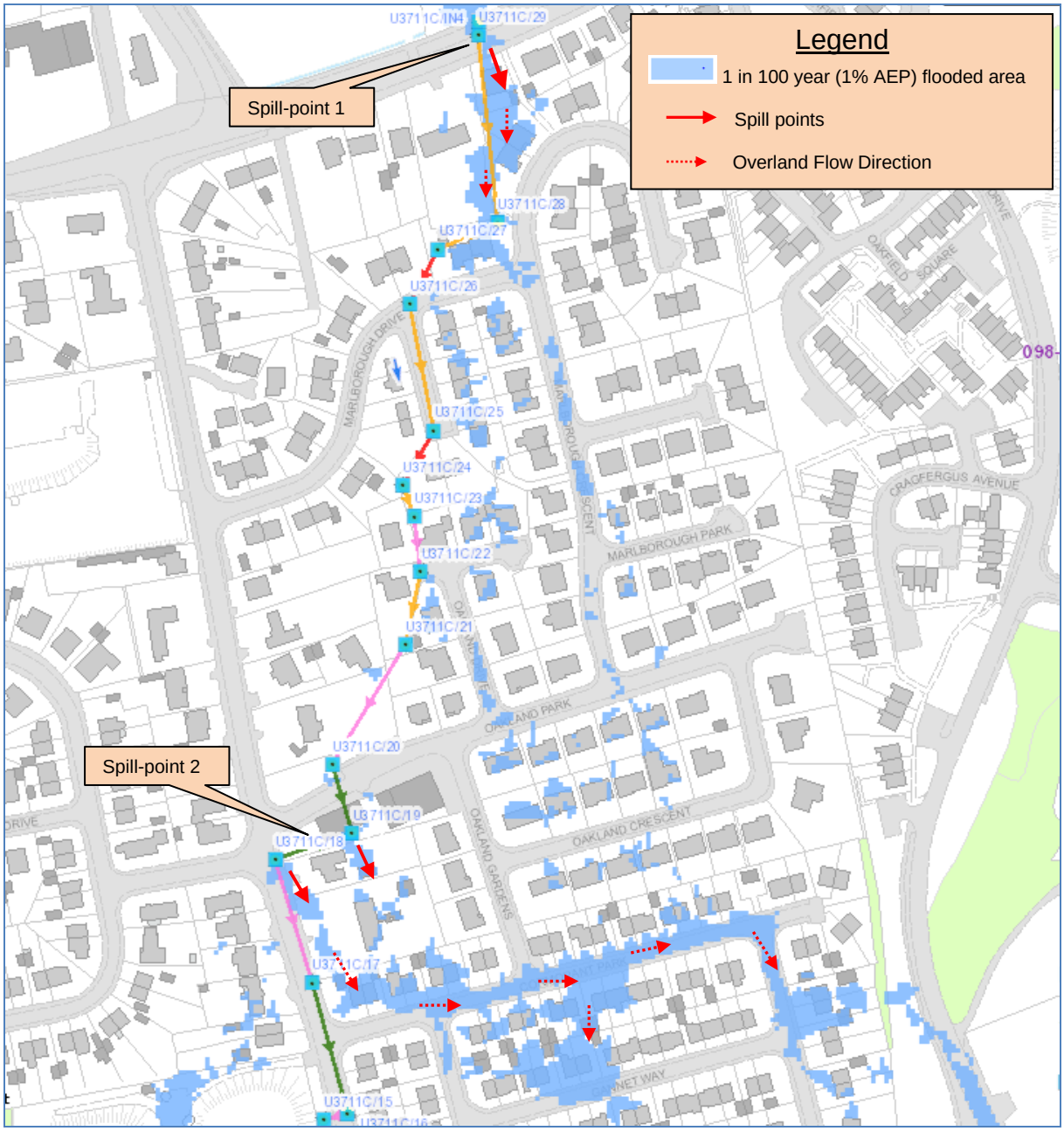


Figure 7.9.4.5 - Carrickfergus & Kilroot PS SFRA, North Road Stream - 1% AEP Floodplain

The model also predicts flooding from two manholes in the vicinity of Oakland Park which is illustrated at Spill-point 2. It is noticeable that there is a distinct dog-leg in the culverts at Oakland Park which may be causing a localised reduction in the flow carrying capacity of the culverted system. The culvert is estimated to surcharge at the frequent 10% AEP (1 in 10 year) event, causing floodwater to rise up in the manholes and spill to the surface. At this event flooding is limited to roads and gardens and no properties are likely to be flooded. Even at the 1 in 100 year event, the flooding is restricted to a relatively small area between Cormorant Park and Gannet Way and the depth of the flooding is shallow (less than 200mm). There are no more than eight properties located within the estimated 1 in 100 year flood inundation area and as the flooding is shallow it is a possibility that some of these may not flood internally due to the height of their

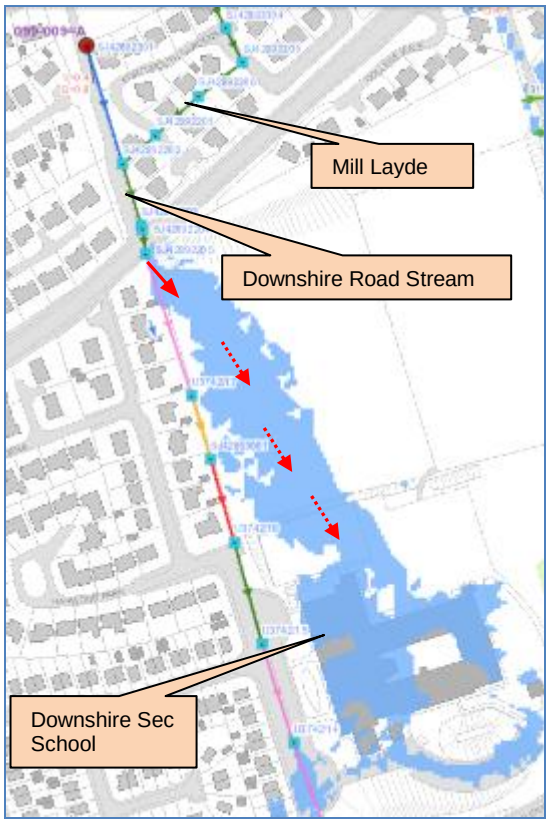
thresholds. Within the immediate area there have been only three phone calls from homeowners to the emergency Floodline to request assistance on two separate occasions (1987 and 2002). Two of these calls have been attributed to blocked road gullies. There have been no claims for flood relief payments arising from this location since the introduction of the scheme in June 2007.

Downshire Road Stream

Flows from the rural catchment of the Downshire Road Stream are captured by the Northeast Diversion before it approaches the Broadlands housing development. Beyond the Diversion the watercourse is designated, and starved of its natural flow, it essentially starts life as a dry open channel which runs in a southerly direction along the eastern side of Broadlands, then forms the boundary between a couple of fields and the Victoria housing development before entering a 450mm diameter culvert at Plymouth Gardens. A designated 450mm diameter culverted tributary, the Mill Layde, enters the Buskin Burn from the east around 70m downstream of the inlet structure at Plymouth Gardens. The watercourse is almost completely culverted from Plymouth Gardens, following the route of the Downshire Road to its tidal outfall at Boney Before, a distance of around 1.3km. There is a short (20m) section of open watercourse in a grassed verge on the Downshire Road near its junction with Churchill Drive. The piped culverts have diameters in the range 750mm to 900mm and numerous sections with a combined length in excess of 500m are considered to be in an unsatisfactory structural condition.

The developed areas that are prone flooding from the Downshire Road Stream, together with a description of the flooding mechanisms are as follows.

The model indicates that flooding to property can arise due to hydraulic under-capacity of the culvert network at two distinct locations, both of which are on the Downshire Road.



The model predicts that a culvert section at Prince Andrew Way will surcharge at the 1 in 25 year event and vent to the surface through a manhole in the grassed verge. The floodwater is routed downhill over playing fields to pond in shallow depressions within the grounds of the Downshire Secondary School. There is no risk of internal flooding to property at this event. At the more extreme 1 in 100 year event, the extent of the flooding around the school building is more extensive but, as it is unlikely to exceed 200mm in depth, there is a possibility that internal flooding to the building may be avoided.

There is no historical evidence of flooding to the school. There have been a number of phone calls to the emergency Floodline from homeowners in Plymouth Gardens which would suggest that the nearby inlet grilles to the Mill Layde and Downshire Road Stream are presenting a recurring problem due to blockages.

Figure 7.9.4.6 - Carrickfergus & Kilroot PS SFRA, Downshire Road Stream - 1% AEP Floodplain

A culvert section, located outside of the entrance to the Downshire Road School is predicted to be overwhelmed at the relatively frequent 1 in 10 year event. This causes floodwater to rise up in a manhole and spill onto the Downshire Road where it is conveyed downhill for 250m within the carriageway, and finally turns into and ponds in and around Castle Road. The extent of the very shallow depth ponding at this event is limited to the grounds of a few residential properties which is unlikely to result in internal flooding to property. At the more extreme 1 in 100 year event the flood mechanism remains the same, except that there are potentially up to 15 properties located within the predicted increased flood inundation area. However, even at this extreme event, flood depths are shallow (lower than 300mm) and it is possible that many of these houses may escape internal flooding due to the height of their thresholds.

It would appear that a potential reason for the flooding at this location is that the short length of 600mm diameter culvert located between pipes of larger diameters and is causing a hydraulic restriction.

Within the immediate area there has been only one phone call from a homeowner to the emergency Floodline to request assistance (2007) and this would appear to be related to the property's sewer. There have been no claims for flood relief payments arising from this location since the introduction of the scheme in June 2007.

Figure 7.9.4.7 - Carrickfergus & Kilroot PS SFRA, Downshire Road Stream - 1% AEP Floodplain

Copeland Water

The Copeland Water fringes the east side of town. It rises in Porg Hill and flows in a southerly direction for around 3.5km to its tidal outfall at the western edge of Kilroot Power Station site. Its natural catchment, which extends to around 2.5km^2 is largely rural. However, as it receives the outfall from the Northeast Diversion which captures the flows from numerous watercourses, it is effectively draining a much larger additional catchment in excess of 10km^2. The watercourse is designated from just above the point at which it receives the outfall from the Northeast Diversion. The designated watercourse initially flows within an open channel until it reaches the access road to Sunnybank Nursery. At this point there is a flow separation structure which diverts most of the flow into an 1850mm culvert, leaving the existing open channel with a residual compensatory flow. The culvert and open channel continue in parallel for around 500m to Copeland Avenue and come together at an inlet structure that conducts all of the flow into a large box culvert. This watercourse continues within a culvert (that changes in size and type) for a further 1.2km, passing under housing developments either side of the Larne Road, through the grounds of the Power Station, and reverts back to an open channel at the Loughview Village housing estate, and continues to its tidal outfall some 100m downstream. All of the large culverts, which are a mix of concrete pipes and box types, have been assessed to be in satisfactory condition.

The developed areas that are prone flooding from the Copeland Water, together with a description of the flooding mechanisms are as follows.

The model predicts that at the 1 in 25 year event floodwater overspills the inlet structure at Copeland Road which is designed to merge the parallel flows from the 1850mm diameter culvert and open watercourse into a box culvert. The floodwater spills across the surface, through gardens and along access roads in the Copeland and Beltoy housing developments, crossing the Larne Road and eventually ponding on the many access roads and hardstanding areas at the west side of the Power Station site. At this event there are no properties located within the estimated flood inundation area. At the more extreme 1 in 100 year event the flood mechanism is the same, and although the size of flood inundation is substantially larger the depth of flooding is generally shallow (less than 300mm). At least 10 residential properties are estimated to be located with the flood inundation area.

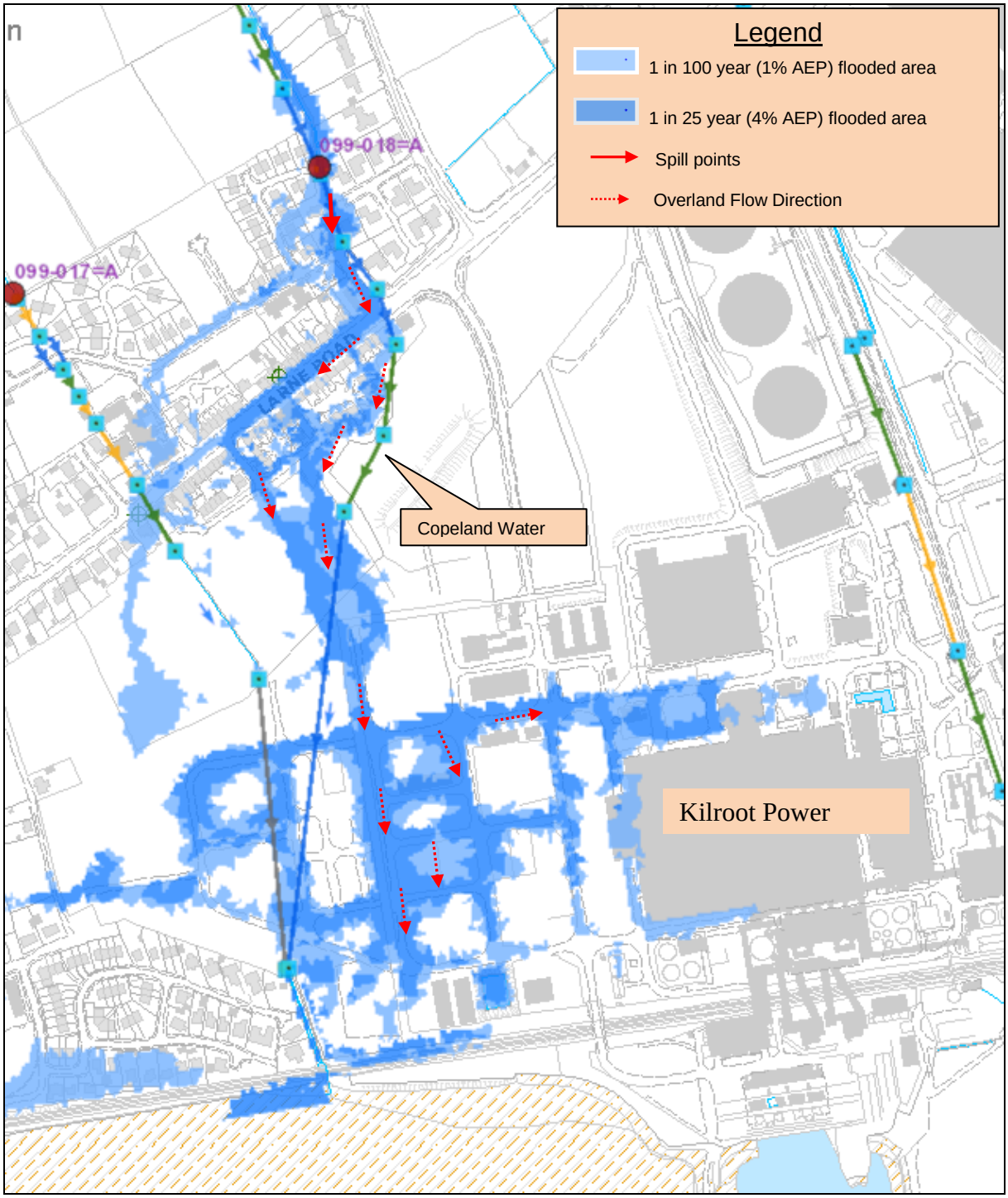


Figure 7.9.4.8 - Carrickfergus & Kilroot PS SFRA, Copeland Water - 1% AEP Floodplain

Northeast Diversion

The Northeast Diversion constructed in the 1980s is essentially a large (1200mm to 1800mm diameter) culvert which has been laid at the outskirts of the town to intercept a proportion of the flows from a number of the natural watercourses before they enter the eastern side of the urbanised zone. The NE Diversion takes a large proportion of the flows from the Sullatober Watercourse, Downshire Road, Bluefield Stream and a

number of minor tributaries. The diverted flow from these watercourses is conducted around the northeast corner of the town and discharges to the Copeland Water which flanks the west side of the town and flows to its outlet with the sea near the Kilroot Power Station. The total combined catchment for watercourse reaches that are substantially captured by the Diversion exceeds 17km^2 and is almost completely rural in nature. The purpose of the Diversion is to substantially lower the flows in the natural watercourses during extreme rainfall events and thereby reduce the likelihood that they will cause flooding to property. The culverts in this watercourse have been assessed to be in a satisfactory structural condition.

The developed areas that are prone flooding from the Northeast Diversion, together with a description of the flooding mechanisms are as follows.

The model predicts that a section of culvert which is located in the grassed area bounded between Broadlands Gardens and Broadlands Park does not have the hydraulic capacity necessary to vent the estimated flow at the 1 in 25 year event. It indicates that the 1800mm diameter culvert surcharges, causing floodwater to rise in the manhole located in the centre of the grassed area and spill on to the surface. However, at this event the area of inundation is limited to the gardens of a few properties in the immediate proximity of the spill point and most of the floodwater finds its way into an open section of the Cloughlands Stream. At the 1 in 100 year event the length of the surcharged culvert increases and floodwater spills from a second manhole located in the garden of Tudor Road. The floodwater flows south over the steeply sloping surface, dividing into three separate streams before spilling into open sections of the Cloughlands Stream and Bluefields Stream after a distance of around 600m. Due to the steep gradient of the general topography, the floodwater skims quickly over the surface in relatively shallow depths (less than 300mm). It is estimated that up to around 100 properties are located within the inundation area for the 1 in 100 year event, although due to the shallow depths it is likely that many of these will avoid internal flooding due to the height of their thresholds.

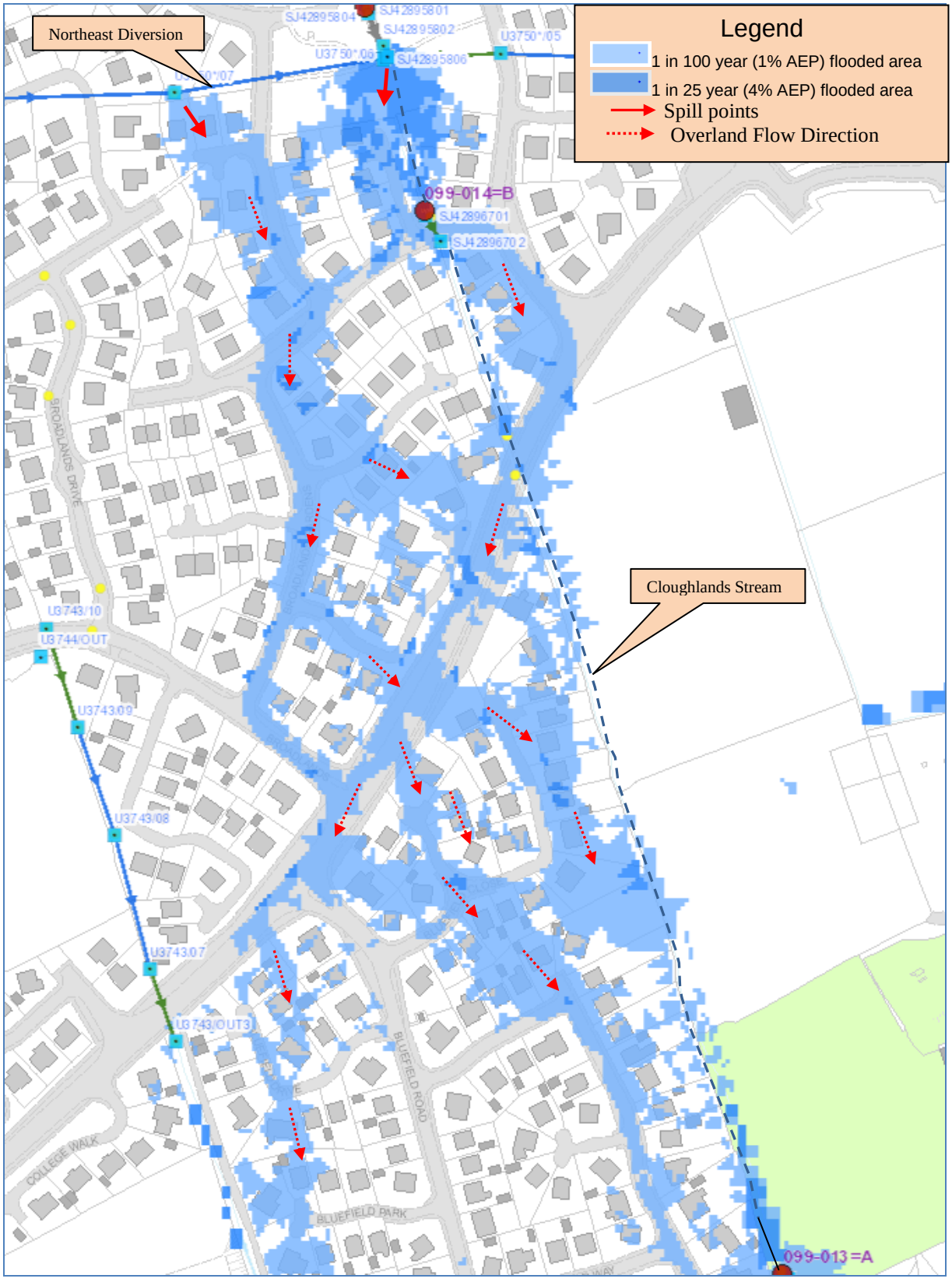


Figure 7.9.4.9 - Carrickfergus & Kilroot PS SFRA, Northeast Diversion - 1% AEP Floodplain

A substantial proportion of the flows from the upper catchment of the Cloughlands Stream are captured by the Northeast Diversion as the watercourse approaches the Broadlands housing development. At the flow

separation structure the main flow is directed into the Diversion and a residual compensation flow for the Cloughlands Stream is passed though a 300mm diameter culvert. The Cloughlands Stream is designated from the flow separation structure and flows in a southerly direction for around 1.6km to its tidal outlet at the site of the Boney Before sewerage treatment works. The upper section of the designated watercourse from the Diversion to a field at the rear of the NK Fencing site flows in an open channel except for a couple of culverted access road crossings. Beyond this, there are a couple of culverted reaches. The first, which extends to a length of around 270m, conducts the watercourse through the Lennox housing development using 900mm diameter pipes. Two sections of this particular culvert, with a combined length of 180m have been assessed to be in a poor/very poor structural condition. Further downstream the second culverted reach, which has a length of around 0.5km, conducts the watercourse under the Cloughlands housing development and through the Boney Before sewerage treatment works to the tidal outfall under the railway embankment. The pipes in this later reach ranges in size from 1050mm to 1200mm diameter and all sections are assessed to be in a satisfactory structural condition.

The developed areas that are prone flooding from the Cloughlands Stream, together with a description of the flooding mechanisms are as follows.

The model predicts that flooding to property begins to occur at the 1 in 50 year (2% AEP) event from two distinct reaches of the watercourses. The first, indentified as Spill-point 1 on the map below, occurs when floodwater overspills the inlet structure for the 900mm diameter culvert that starts at the rear 21 Regent Street. The floodwater flows over the surface through the Lennox housing development before re-entering the next section of open section some 250m downstream.

There are estimated to be in excess of 20 properties located within the predicted 1 in 50 year flood inundation area, rising to around 70 properties at the more extreme 1 in 100 year event. The depth of the flooding within the residential areas is estimated to be relatively shallow, less than 300mm.

Further downstream, at Spill-point 2 the flooding mechanism is similar with floodwater over-spilling the inlet structure to a 1050mm diameter culvert which commences at the rear of 9 Carrickburn Road. The floodwater is predicted to travel over the surface in a narrow band through the Cloughlands housing development, across the site of the Boney Before sewerage treatment works, to pond behind the railway embankment that fringes the coastline.

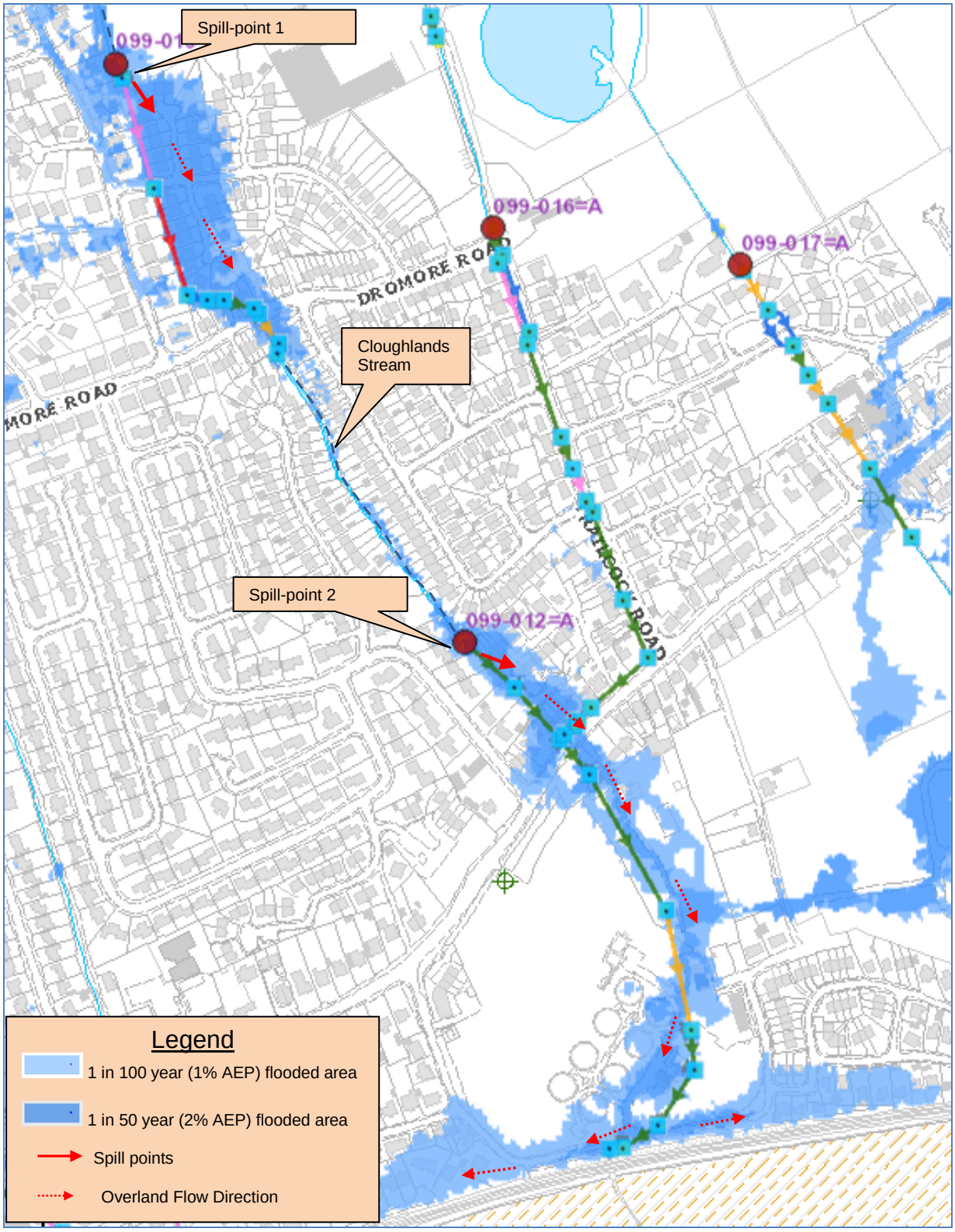


Figure 7.9.4.10 - Carrickfergus & Kilroot PS SFRA, Cloughlands Stream- 1% AEP Floodplain

At the 1 in 50 year event there are estimated to be around 10 properties within the predicted flood inundation area and all of which are located in the vicinity of Cloughlands Park. At the more extreme 1 in 100 year event this increases to around 70 properties and in addition to homes in Cloughlands Park, there are also

predicted to be significant numbers of flooded homes in the Boney Before and Loughview Village developments.

There have been numerous phone calls to the emergency Floodline from homeowners located in proximity to this section of the Cloughlands Stream watercourse. The nature of the calls, which span the period from 1986 to 2002, would indicate that there is a real risk of flooding to property from the watercourse and would validate the findings of the model.

Potential Adverse Consequences

The watercourse drainage network within the Carrickfergus & Kilroot PS SFRA is a relatively complex system due to the hydraulic inter-dependency between the individual watercourses which were created by the construction of the Northwest Diversion and the Northwest Diversion. Therefore, it has been decided that it would be more appropriate to collate the potential adverse consequences data for the whole of the SFRA rather than for individual watercourses because it is unlikely that any capital investment decisions could be determined from the data for a specific watercourse. The measurements for the potential adverse consequences are listed in Figure 7.9.4.1.

Table 7.9.4.1 Carrickfergus & Kilroot PS SFRA – All Watercourses			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	57	182	860
Non Residential (Nr)	2	15	41
Economic Damage (£)	**£235k**	**£324k**	**£1.78m**
Annual Average Damage (£)	**£111k**		
Present Value (£)	**£3.33m**		
IPPC sites (Nr)	**0**	**1**	**0**
Community Assets (Nr)	**0**	**0**	**0**
Care Homes	**0**	**0**	**0**
GP Surgery's	**0**	**0**	**0**
Fire stations	**0**	**0**	**0**
Hospitals	**0**	**0**	**0**
Police Stations	**0**	**0**	**0**
Schools	**0**	**0**	**0**
Key Infrastructure (Nr)	**2**	**2**	**6**
NIW Wastewater Treatment Works	**0**	**0**	**1**
NIW Sewage Pumping Stations	**0**	**0**	**0**
NIW Water Treatment Work	**0**	**0**	**0**
NIW Treated Water Pumping Stations	**0**	**0**	**0**
NIE Substation 6to11kV	**2**	**2**	**5**
NIE Substation 33kV	**0**	**0**	**0**
NIE Substation 275kV	**0**	**0**	**0**
NIE Substation 110kV	**0**	**0**	**0**
Road Service - Trunk Road	**0**	**0**	**0**
Environmental Designated sites (Nr)	**7**	**7**	**7**
AONB	**0**	**0**	**0**
ASSI	**1**	**1**	**1**
Environmentally Sensitive Areas	**0**	**0**	**0**
Maritime Nature Reserve	**0**	**0**	**0**
Nature Reserve	**0**	**0**	**0**
RAMSAR	**1**	**1**	**1**
SAC	**0**	**0**	**0**
Sites of Local Nature Conservation Importance	**3**	**3**	**3**
SPA	**2**	**2**	**2**
RSPB Reserve	**0**	**0**	**0**
UWT Nature Reserve	**0**	**0**	**0**
Built Heritage sites (Nr)	**0**	**0**	**0**
National Trust	**0**	**0**	**0**
Listed Buildings	**0**	**0**	**0**
Sites and Monuments Records	**0**	**0**	**0**
Buildings of Special Architectural or Historical Interest	**0**	**0**	**0**
Areas of Significant Archaeological Interest	**0**	**0**	**0**
Historic Gardens	**0**	**0**	**0**

7.9.5 Proposed Fluvial Flood Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Carrickfergus and Kilroot Power Station SFRA it is important the flood risk is not increased by allowing new development in areas of known flood risk. Planning Policy Statement, PPS 15, Planning and Flood Risk, adopts a precautionary approach to development with the primary aim *'to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere'*.

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the 'Exception' rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to 'Greenfield' built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new Development Plans for Carrickfergus we advise against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 100 year fluvial floodplain/1 in 200 year coastal floodplain/reservoir inundation area or is susceptible elsewhere to surface water flooding.

Rivers Agency will also review the existing Development Plan for Carickfergus (Belfast Metropolitan Area Plan, 2015) with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

The main (undeveloped) flooded areas within the Carrickfergus Significant Flood Risk Area are:

North Road Stream

- Area to the north of Prince William Way.

Copeland Water

- Area to the north below the North East Diversion.
- Area to south of the Larne Road

Cloughlands Stream

- Area to south of the Larne Road

Downshire Stream

- Area to south of Prince Andrew Way

Carnraway Burn

- Fields to the west of the river.

Planning Applications

Fluvial/Coastal Areas at risk

Rivers Agency shall advise against the development of all sites that are located within the 1 in 100 year fluvial floodplain/1 in 200 year coastal floodplain, irrespective of whether they are located within a current development plan or as a single site application outside the plan area.

For those sites within the 1 in 100 year fluvial floodplain/1 in 200 year coastal floodplain where the principle of development has been accepted by Planning NI as meeting the 'Exception Test', Rivers Agency will further consider the application through the appraisal of an accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The main existing developed areas, amongst others, at flood risk within Carrickfergus where re-development may be likely to take place are:-

Fluvial

Copeland Water

- Areas at Beltoy Court and both sides of Larne Road.

Cloughlands Stream

- Cloughlands Park to the north of the Larne Road.
- Lennox Park to the north of the Dromore Road.
- Broadlands Gardens to the north of Prince Andrew Way and Bluefield Close to the south of Prince Andrew Way.

Buskin Burn

- Green Park off Bridewell Drive.
-

Carnraway Burn

- Woodlawn Court and Killaloe to the west of the Burn.

Coastal

- Along the Marine highway.

Areas at Risk of Surface Water flooding

For those sites outside the 1 in 100 year fluvial floodplain/1 in 200 year coastal floodplain that are located in an area where there is evidence of a history of surface water flooding (identified by flood hardship payments), Rivers Agency will further consider the application through the appraisal of the accompanying Drainage Assessment that will need to demonstrate suitable flood mitigation measures.

Where there is potential for surface water flooding predicted by the Surface Water Map (areas highlighted purple), River Agency will advise that the applicant should assess the flood risk and drainage impact to the site and construct in an appropriate manner.

The main areas with a flood history, identified in Carrickfergus as being at surface water flood risk are:-

- At the Birches to the east of Woodburn Avenue.
- At the corner of Albert Road and Thomas Street.
- Rhanbuoy Park, south of the Belfast Road and near the coast.

Areas at Risk of Flood Inundation from Reservoirs

For all development proposals that are located within the potential flood inundation area of a Controlled reservoir we will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures. If it is a new development proposal, Rivers Agency will also need the applicant to demonstrate that the condition, management, and maintenance regime of the reservoir is appropriate to provide sufficient assurance regarding reservoir safety.

Controlled reservoirs identified in the Carrickfergus area are as follows:

- Copeland Reservoir
- Lough Mourne
- Dorisland Reservoir
- South Woodburn Reservoirs (Upper, Middle, Lower)
- North Woodburn Reservoir

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is therefore important that we continue to target investment by providing flood defences, culvert alleviation schemes and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. **The Flood Investment and Planning Group**, FIPG, provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is

represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a Flood Risk Metric Tool' (FRISM) is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total 'damage avoidance benefits' that the scheme will provide to property over the scheme's design life. If the benefit/cost ratio is greater than 1, then the potential scheme will be referred to Rivers Agency's Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely Rivers Agency's responsibility, or is the responsibility of NI Water or Transport NI such as a local drainage or road infrastructure issue, then it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a cost benefit analysis identifies a viable scheme, it will be placed on a prioritisation list and progressed alongside other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take anything from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Having conducted a detailed assessment of the fluvial flood risk from all of the rivers in the Carrickfergus and Kilroot PS SFRA, Rivers Agency has determined that the level of flood risk to property may be sufficient to justify structural flood mitigation measures on a number of watercourses at various locations throughout the town.

However, the watercourse drainage network within the Carrickfergus & Kilroot PS SFRA is a relatively complex system due to the hydraulic inter-dependency between the individual watercourses which was created by the construction of the Northwest Diversion and Northwest Diversion. Because of this complexity it is entirely possible that the solution to flooding from one of the watercourses could be reduced by carrying works at another. Therefore, it has been determined that a holistic flood study and economic appraisal, that takes into consideration the hydraulic dependences between the watercourses, will be undertaken to establish if there are cost/beneficial solutions to alleviate the localised flooding problems identified.

Preparedness

In the Carrickfergus & Kilroot Power Station SFRA it is not possible to prevent or protect against all flooding. Indeed even where flood defences exist it is possible in an extreme event that these could be over topped and flooding could still occur.

Having recognised this fact, considerable effort in recent years has been made by emergency planners in a Government Departments, Councils and the Emergency Services working together and sharing information to ensure a coordinated response.

However, despite these improvements, during significant flood events the emergency response of Government Departments and the Emergency Services can become over stretched. This means that not all calls for assistance during a flood event may be responded to in a timely manner. With this in mind it is important that households and communities, subject to a known flood risk, are prepared. The detail of preparedness actions, including flood warning and informing activities planned from a regional perspective, are provided in Annex E.

This is not Government withdrawing from any undertaking to respond in emergencies but an additional layer of support to ensure Government Departments and the public work together to reduce the overall impacts of flooding.

From the flood risk assessment there at least 9 areas within the Carrickfergus & Kilroot Power Station SFRA that have flooded in the recent past that may benefit from the flood warning and informing proposals, outlined in Annex D.

A pilot project of community engagement to deliver flood warning and informing, held in 2014, identified basic assessment formulae to assess and score areas that could potentially be a focus for flood warning and informing actions. Based on this scoring these areas did not score high enough to be placed within the top 20 communities to be offered a programme of community engagement during the period of this plan. However, if communities want to become more resilient, the Department is committed to providing assistance were possible to develop the consistent approach to resilience. The NI Direct website www.nidirect.gov.uk/ will host further information and advice on what to do in advance of flooding, what to do during flooding and how to recover after flooding. The website will also contain templates for communities wishing to develop their own plan.

7.10 Newtownabbey Significant Flood Risk Area

The core boundary of the Newtownabbey SFRA, which has been determined through the PFRA, is located within the Belfast Lough and Tidal Lagan local Flood Management Area and is illustrated in Figure 7.10.1 below.

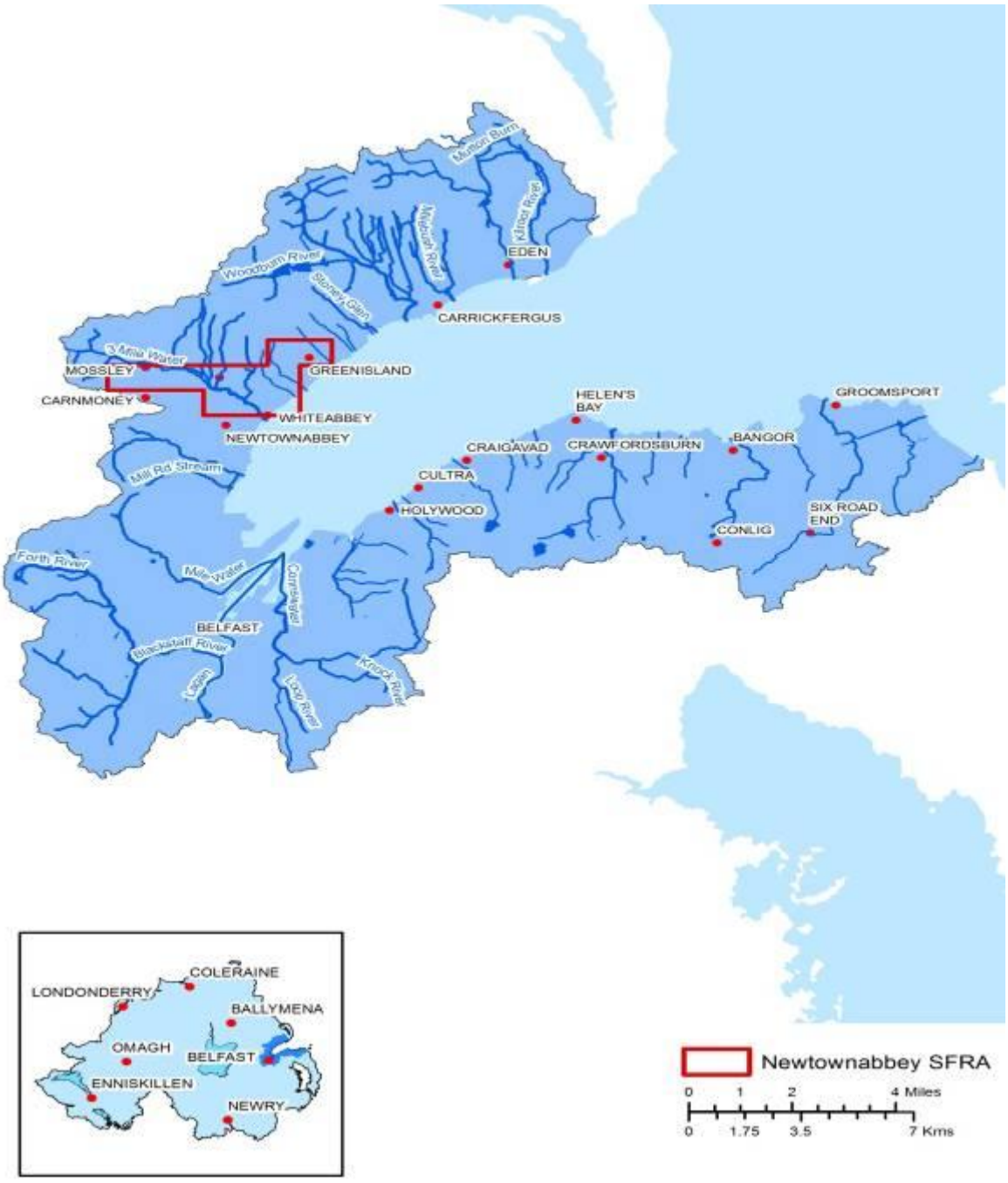


Figure 7.10.1 Belfast Lough & Tidal Lagan Local Flood Management Area and Newtownabbey SFRA

7.10.1 Flooding History

In recent years a number of flooding events have occurred in the Newtownabbey/Whiteabbey area. Historical reports would suggest that these vary in scale and severity of impact and emanate from surface water, watercourses and sewerage/drainage systems. Notable events, which caused significant flooding of the Shore Road and Whiteabbey Village areas, occurred on 19 September 1999 and again on 21 June 2002. The event in June 2002 was particularly severe and was caused by short duration high intensity rainfall which Met Office reports indicate had a storm return period of 1 in 300 years. This extreme rainfall resulted in widespread surface water flooding and disruption in the area and caused internal flooding to at least 40 residential and 15 commercial properties in Whiteabbey. It is also evident from an examination of the database which records details of the telephone calls to the emergency Floodline that there are distinct clusters of calls to indicate potential problems at specific locations such as Monkstown Avenue/Glenville Road, Twinburn and Whiteabbey Village. It has however been relatively uneventful in recent years, as there have been only 5 payments made to the owners of residential properties in the immediate area since the introduction of the Flooding Hardship Payment Scheme in June 2007.

7.10.2 PFRA – Identification of Potentially Significant Flood Sources

According to the Preliminary Flood Risk Assessment (Dec 2011) the town of Newtownabbey, in terms of the potential adverse consequences of flooding, is ranked fifteenth of the twenty SFRA within Northern Ireland (see Figure 4.1).

It should be noted that the PFRA was based on the Strategic Flood Map (NI) Rivers & Sea which, at the time of this assessment, was the best available information upon which to identify the general areas throughout Northern Ireland that may be prone to flooding from rivers and the sea. However, due to the onerous requirement to produce flood maps that cover the whole of the province, it was necessary to develop the strategic flood models using a broad-scale modelling methodology that had clear limitations.

On the basis of this initial assessment, which was undertaken using the Strategic Flood Maps, in excess of 280 properties were estimated to be located within the 1% AEP (1 in 100 year) fluvial floodplains (see Figure 7.10.2.1) below. The locations of the properties that were indentified to be at potential risk from rivers are in the vicinity of the Lynda housing development (Jordanstown), the Whiteabbey Village area and to a lesser extent the Twinburn housing development (Monkstown). However, at the time of the PFRA there was no predictive flood plains (strategic or otherwise) available for a number of ‘unmodelled’ minor watercourses which are identified in illustrated in Figure 7.10.2.1 and consequently, this initial estimate of the number of properties at potential risk of flooding was considered to be a lower bound estimate.

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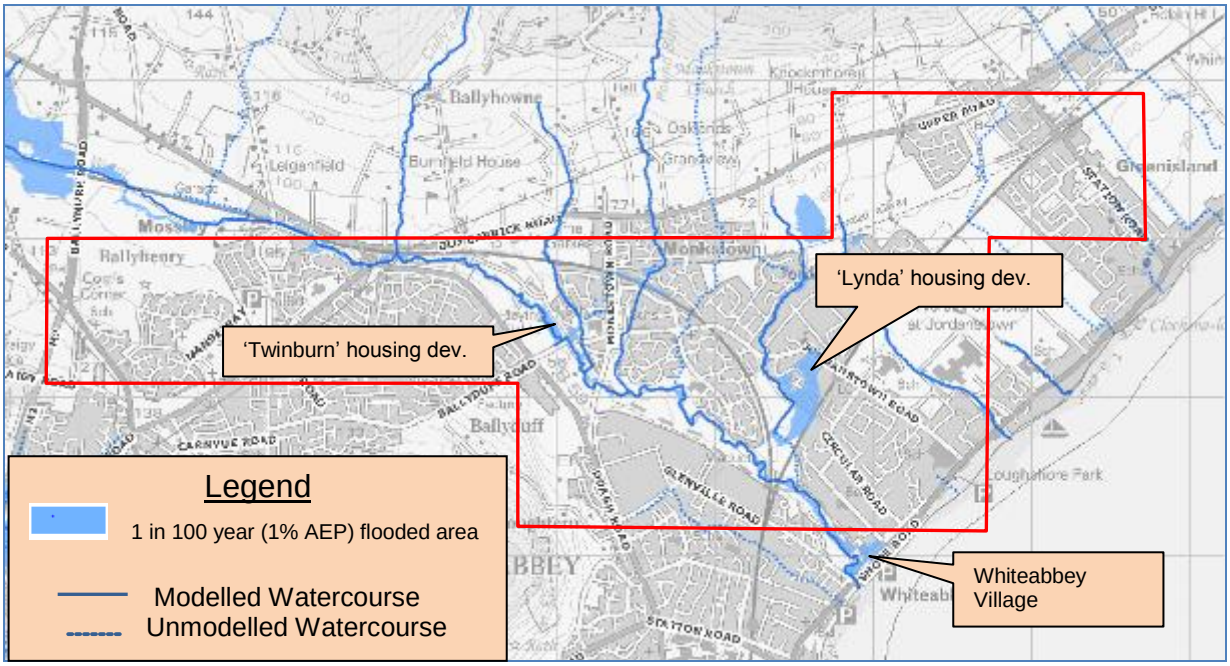


Figure 7.10.2.1 - Newtownabbey–Undefended Fluvial Flood Plains, Strategic 1% AEP (1 in 100 yr)

Although the Newtownabbey area has a coastal fringe, the risk from tidal inundation is not considered to be significant. The estimated economic damages arising from potential future property flooding from the sea are barely 1% of those calculated for the predicted flooding from rivers. According to the strategic flood maps, there are around 20 properties that are estimated to be at risk from tidal inundation at the 0.5% (1 in 200yr). These properties are located in the Whiteabbey Village shopping area and strung out along a 300m section of the 'old' Shore Road between its junctions with the Glenville Road and Circular Road (see Figure 7.10.2.2 below).

The reason that the Strategic Flood Map identifies the area at Whiteabbey Village to be at risk from the sea is that ground levels in some parts are lower than the predicted sea level for the 1 in 200 year event. However, this area is actually protected from direct tidal inundation by the 'new' Shore Road at the seafront. The Shore Road effectively acts as a barrier as it is around 0.5m above the typical ground levels in the village and higher than the predicted 1 in 200 year tidal surge level. Although the sea has no direct overland flow path to the Whiteabbey Village, it could still cause a flooding problem by reducing the discharge capacity of local drainage systems with tidal outfalls or in extreme circumstances by reverse flowing through these systems. Therefore, although the tidal risk is not considered to be 'significant' for the Newtownabbey SFRA and will not be specifically managed through the FRMP, the tidal influence on the watercourses will be taken into account.

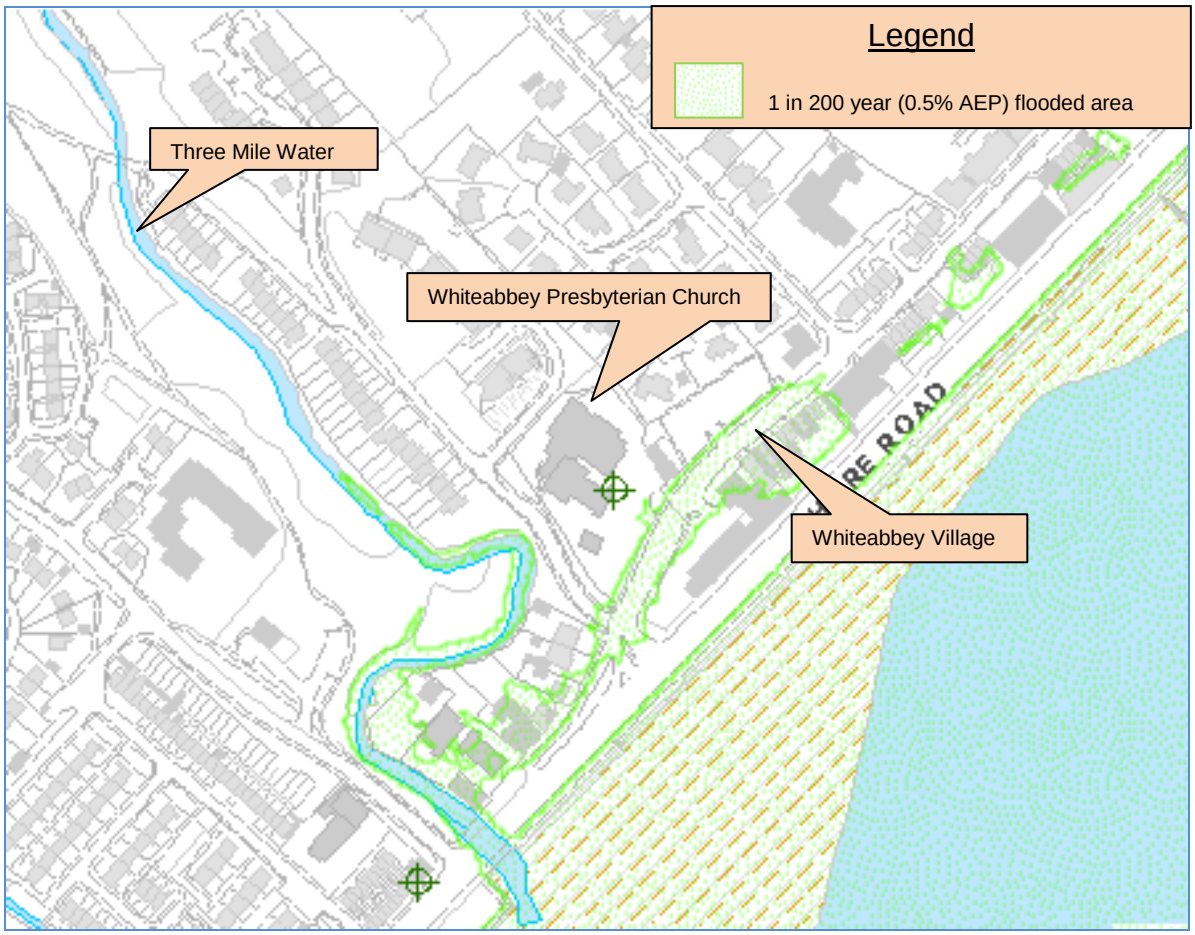


Figure 7.10.2.2 – Newtownabbey SFRA – Undefended Tidal Flood Plain, Strategic 0.5% AEP (1 in 200 yr) event

Although the PFRA established that there may be in excess of 280 properties in Newtownabbey at risk of flooding from rivers, it was acknowledged that there was a high degree of uncertainty with this figure as it was based on the Strategic Flood Maps. To reduce this uncertainty and facilitate a more robust assessment of the level of fluvial flood risk to Newtownabbey, Rivers Agency developed detailed predictive flood models for each of the watercourses within the town. The Flood Hazard Maps produced using the detailed flood models are more accurate than the strategic maps which may be over estimating or under estimating the number of properties at risk of flooding. Details of the models and their output are described in the following sections.

7.10.3 Catchment Description

The borough of Newtownabbey, which has a population in excess of 80,000, is the fourth largest settlement in Northern Ireland. Although the Borough comprises a substantial number of urban residential communities and traditional farming communities, the Newtownabbey SFRA is largely focused on an area that comprises Monkstown, Jordanstown, Whiteabbey and Greenisland. These residential areas are drained by a series of watercourses that arise from the slopes of the Antrim Plateau Escarpment to the west and northwest. Apart

from the Three Mile Water which has a significant and predominantly rural catchment with an area exceeding 20km2, all of the other watercourses have small and largely urban catchments which are typically less than 2km2. Most of the watercourses, apart from the Three Mile Water are heavily engineered and substantially culverted throughout the urban areas. The SFRA has a coastal fringe at the north shore of Belfast Lough and all of the watercourses have a sea outfall at locations along the shoreline between Whiteabbey and Greenisland.

7.10.4 Fluvial Flood Risk Assessment

Fluvial Modelling Methodology and Scope

Fundamental to the detailed fluvial risk assessment was the development of a hydrodynamic model for each of the six main watercourses (and tributaries) which have the potential to adversely impact the urbanised areas within the Newtownabbey SFRA. The names, location and extents of the watercourses which were modelled in detail are indicated in Figure 7.10.4.1 below.

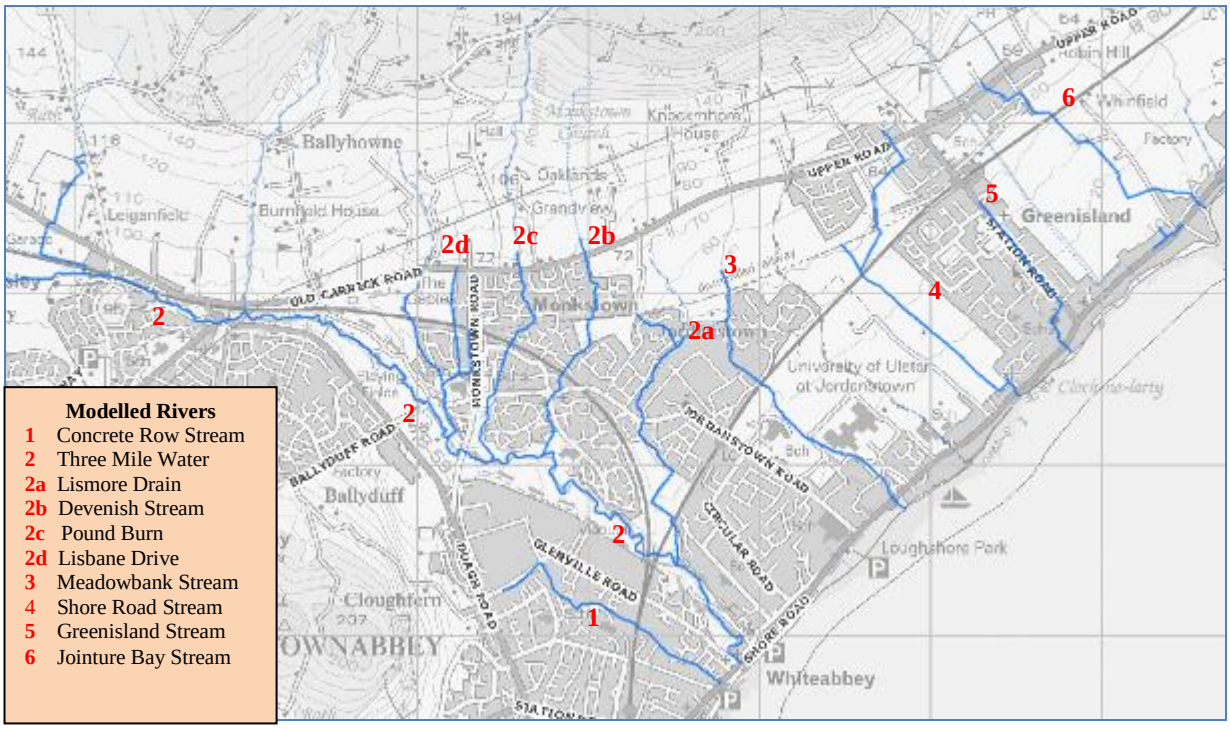


Figure 7.10.4.1 - Newtownabbey SFRA – Modelled Watercourses

The detailed models indicate that there is virtually no risk of flooding from the Meadowbank Stream or Shore Road Stream and therefore these are excluded from any further consideration within the plan. The risk to property from each of the other watercourses in the Newtownabbey SFRA is assessed in the following sections.

Flood Mechanisms

Concrete Row Stream

The Concrete Row Stream drains a small (1.4km^2) catchment which extends from above the Monkstown Road, to the sea outfall at the Shore Road. The catchment area is significantly urbanised except for a relatively small patch of grassland and scrub to the west of the Doagh Road which equates to less than 20% of the total area. The watercourse first arises in overgrown land fringing the Redon's coal yard site adjacent to Monkstown Road. If flows in a south easterly direction for a distance of around 1.6km to its sea outfall to Belfast Lough near the Shore Road/Dillon's Avenue Junction. The watercourse flows in an open channel for around 640m and within culverts for the other 1000m. Along the route of the watercourse there are as many as six separate culverted sections interspersed with the open sections and these culverts have been laid to facilitate the Abbeyhill, Bleechgreen, Glenview and Glenville housing developments. The lower section of the watercourse between the railway crossing and the tidal outfall is designated by Rivers Agency whilst the upper 1 km reach is currently undesignated and responsibility for its maintenance rests with the riparian owners.

The culverts in the lower 'designated' section of the watercourse are of mixed construction types and include large concrete pipes (1500mm diameter), arches and rectangular boxes. These culverts, which have a combined length of 260m, have been assessed to be in a satisfactory structural condition except for a short 30m length of 1030mm x 750mm rectangular box culvert at the bottom of the Glenville Road. The culverted sections of the upper 'undesignated' reach are all concrete pipes which typically range in size from 1050mm to 1350mm diameter except for a few short sections of small (300mm diameter) pipes at the upper limits around King's Crescent. Although undesignated, these culverts (with a combined length of around 740m) have been inspected by Rivers Agency and are known to be in a satisfactory structural condition except for a short (60m) section of 300mm diameter culvert in the gardens of the properties at 42/44 King's Crescent.

The predictive model indicates that two principle flood risk locations exist within the Concrete Row Stream catchment. The location of the developed areas affected by flooding and the flood mechanisms are described below.

Flood Location 1

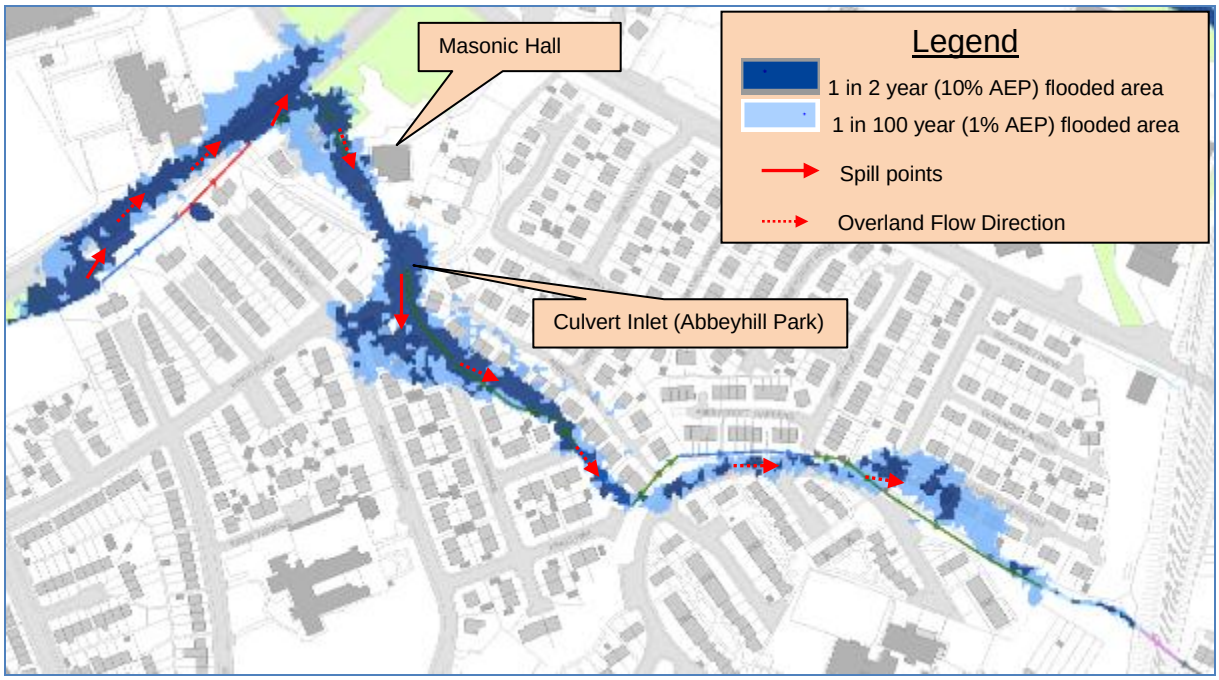


Figure 7.10.4.2 - Newtownabbey SFRA –Concrete Row Stream (1% AEP) – Flood location 1

The model shows that at the very frequent 50% (1 in 2 year) flood event, floodwater begins to spill from a number of locations at a section of the watercourse in the vicinity of the Whiteabbey Masonic Centre. This section of the watercourse is undesignated and the flooding arises from localised restrictions in the culvert network in this area. The principle restriction is at the inlet to the culvert through Abbeyhill Park, which was recently laid to facilitate the construction of the housing development. Although the new culvert is typically 1050mm diameter, it was connected into an existing 450mm pipe which crosses under an access road at its upstream end and this restriction severely inhibits the hydraulic capacity of the watercourse at this location.

Other localised spill points exist at a number of culverted crossings laid under minor access roads and the most upstream section of culvert that runs parallel with Monkstown Avenue, which is only 300mm diameter and undersized for the predicted flows. As floodwater spills from the channel at the Masonic Hall, it flows overland through Kings Crescent, Abbeyhill Park and Glenabbey Crescent and may adversely affect up to 40 properties at the 1 in 100 year event.

Flood Location 2

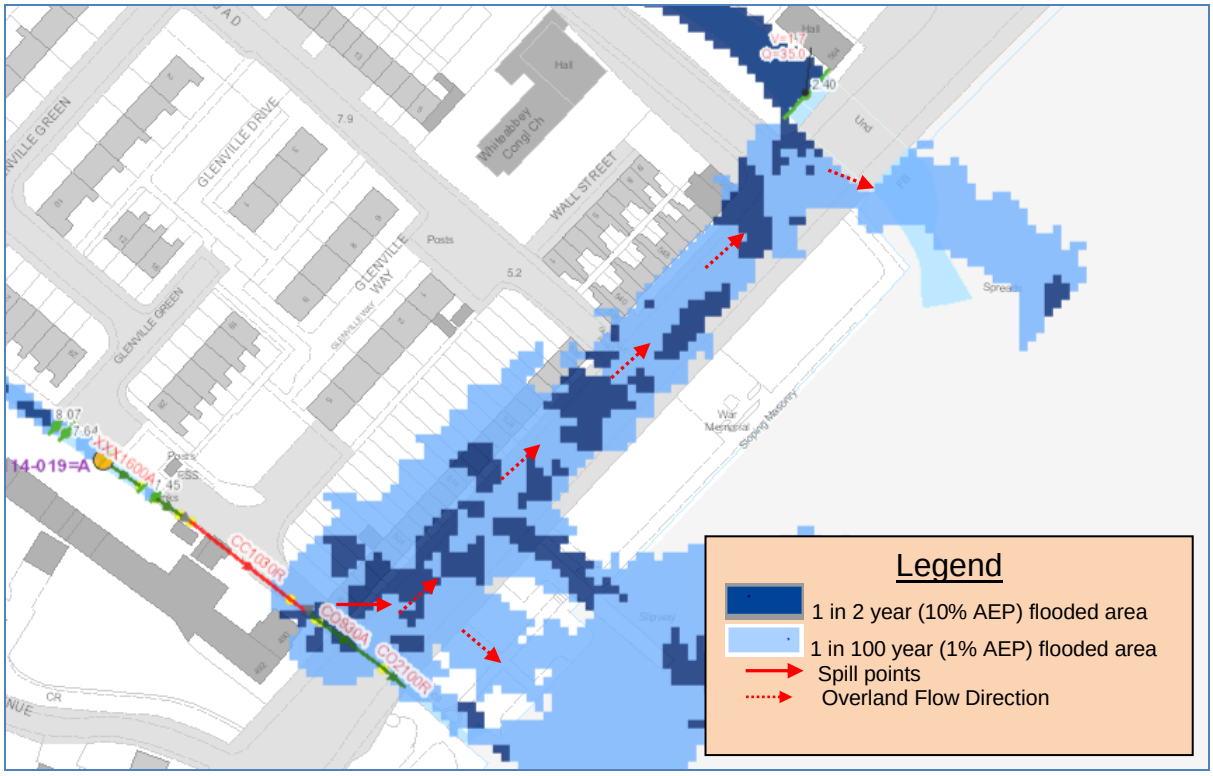


Figure 7.10.4.3 - Newtownabbey SFRA – Concrete Row Stream (1% AEP) – Flood location 2

The model predicts that at the very frequent 50% (1 in 2 year) flood event, the culvert sections just upstream of the sea outfall begin to surcharge, forcing floodwater to spill from a manhole located in the narrow vehicular passageway between numbers 490 and 494 Shore Road. The floodwater flows along the Shore Road carriageway in a north-easterly direction and, after a distance of around 150m, spills into the channel of the Three Mile Water. It is estimated that floodwater will pond on the Shore Road to a depth of up to 300mm and that around 30 terraced properties and a fish restaurant may suffer internal flooding at the 1 in 100 year event.

It has been determined that the culverts at this location are generally undersized and cannot vent the design flows and that other factors including unapproved service obstructions within culverts and hydraulically restrictive inlet structures are increasing the potential for flooding. It is estimated that 64 homes and 6 non-residential properties may be flooded at the 1 in 10 year event, rising to 71 homes and 6 non-residential at the 1 in 100 year event. The total cost of the predicted property damages of future floods from the Concrete Row Stream is estimated to have a present day value of around £552k.

Table 7.10.4.1 Newtownabbey SFRA – Concrete Row Stream			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	64	66	71
Non Residential (Nr)	6	8	6
Economic Damage (£)	34,145	54,923	159,863
Annual Average Damage (£)	18,411		
Present Value (£)	**552k**		
IPPC sites (Nr)	**0**	**0**	**0**
Community Assets (Nr)	**0**	**0**	**0**
Care Homes GP Surgery's Fire stations Hospitals Police Stations Schools			
Key Infrastructure (Nr)	**2**	**2**	**2**
NIW Wastewater Treatment Works NIW Sewage Pumping Stations NIW Water Treatment Work NIW Treated Water Pumping Stations NIE Substation 6to11kV NIE Substation 33kV NIE Substation 275kV NIE Substation 110kV Road Service - Trunk Road	2	2	2
Environmental Designated sites (Nr)	**1**	**1**	**1**
AONB ASSI Environmentally Sensitive Areas Maritime Nature Reserve Nature Reserve RAMSAR SAC Sites of Local Nature Conservation Importance SPA RSPB Reserve UWT Nature Reserve	1	1	1
Built Heritage sites (Nr)	**0**	**0**	**0**
National Trust Listed Buildings Sites and Monuments Records Buildings of Special Architectural or Historical Interest Areas of Significant Archaeological Interest Historic Gardens			

Greenisland Stream

The Greenisland Stream is a relatively short watercourse which first issues within the Greenisland development from a small culvert in the front garden of 119 Station Road. Upstream of this position little is known about the watercourse although in all likelihood, it is conducted via small diameter culverts for at least 650m through a developed area to beyond the Upper Road, where it reverts to an open channel in farmland. The upper reach of the watercourse from 119 Station Road downstream to 67 Station Road is undesignated. This undesignated section, which has a length of around 400m, flows within an open channel that runs through the front gardens of properties which fringe the north side of the Station Road carriageway. This section of open watercourse is repeatedly interrupted (up to around 20 times) by short length of culverts that have been laid under the driveways to the properties.

The lower reach of the watercourse from 67 Station Road to the sea outfall some 750m downstream is designated and fully culverted throughout its length. The designated culverts vary in structural form and size and include: Rectangular (330mm x 500mm to 700mm x 1200mm), Circular (450mm to 1050mm) and Arched Roof (800mm x 670mm). A recent survey of these culverts show them to have numerous blockages and a number of sections, with a combined length in excess of 170m are assessed to be in an unsatisfactory structural condition.

The catchment area draining to the watercourse is around 0.6km2 and substantially urbanised, with development extending from the sea outfall to the Upper Road. North of the Upper Road the remainder of the catchment is agricultural. At present around 50% of the catchment is calculated to be urbanised and based on the Belfast Metropolitan Area Plan, this could rise in the future to around 60%. The small size of this catchment, together with its high degree of urbanisation, will result in the relatively rapid and intense generation of flood flows within the watercourse for high rainfall events.

Transport NI is planning to upgrade the A2 Shore Road between Jordanstown and Seapark by constructing a dual carriageway and this new road corridor will cross the Greenisland Stream at the lower reaches near the sea outfall. Transport NI has agreed that it will upgrade the sections of the Greenisland Stream culverts located within the new A2 corridor as required to prevent flooding.

The developed areas that are prone flooding within the Concrete Row Stream, together with a description of the flooding mechanisms are as follows.

The model indicates that flooding from the Greenisland Stream begins to adversely affect property along the length of the Station Road at the relatively frequent 10% AEP (1 in 10 year) event. Floodwater is predicted to overspill the banks at a number of locations along the undesignated open watercourse from as far upstream as the Knockfergus Park/Station Road Junction. Floodwater also spills onto the Station Road at the inlet to the designated and wholly culverted lower reach of the watercourse and from various manholes on route to the sea outfall. This flooding is caused by under capacity throughout the length of the system and exacerbated by the disparate nature of the channel in the undesignated section which constantly changes from open to culverted sections from property to property.

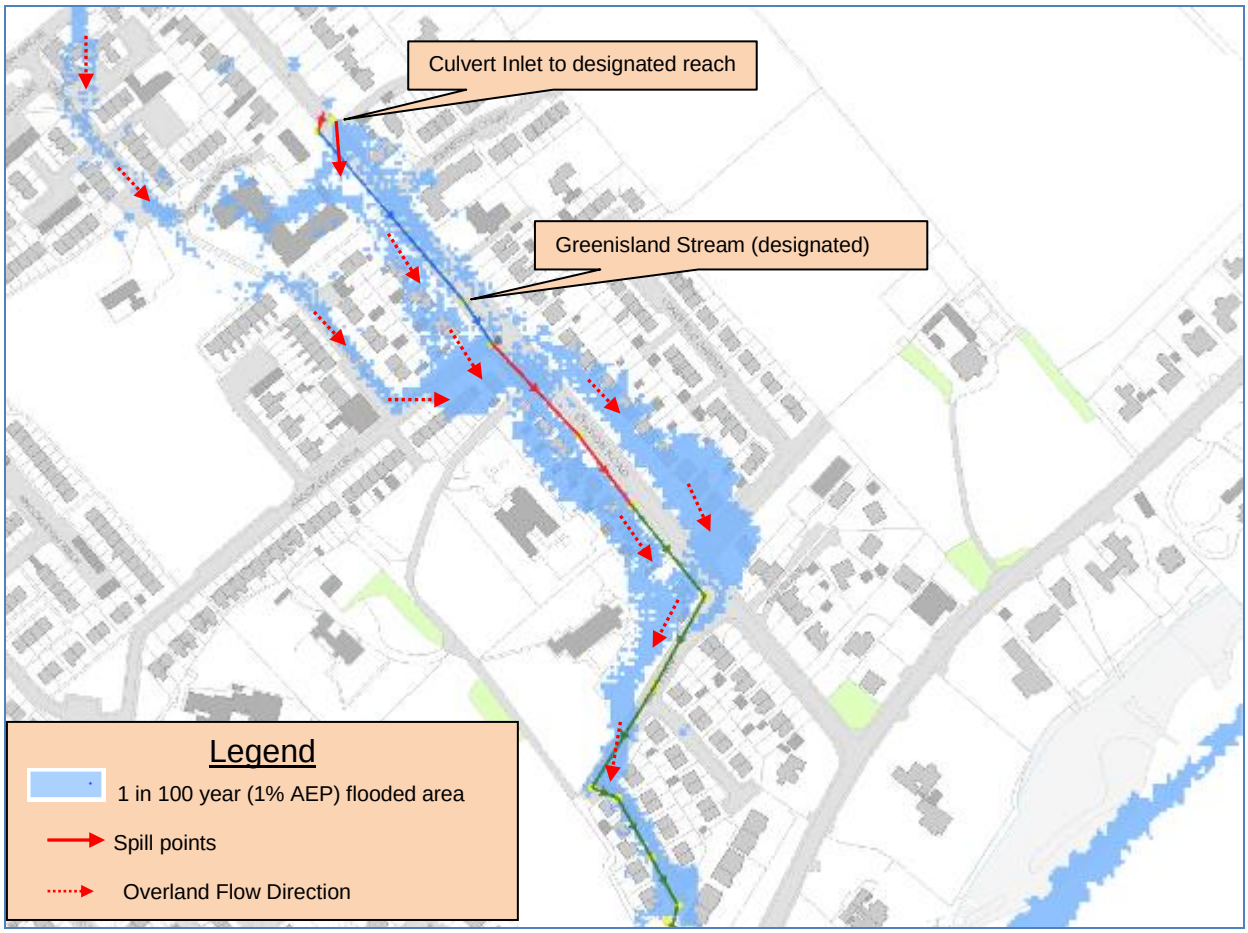


Figure 7.10.4.4 - Newtownabbey SFRA – Greenisland Stream– Fluvial inundation area (1% AEP)

It is estimated that 48 residential properties may be flooded at the 1 in 10 year event, rising to 76 residential and 6 non-residential (which includes a GP Surgery) at the 1 in 100 year event. The total cost of the predicted property damages of future floods is estimated to have a present day value of around £915k.

Table 7.10.4.2 Newtownabbey SFRA – Greenisland Stream			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	48	68	71
Non Residential (Nr)	0	3	6
Economic Damage (£)	54k	93k	1001k
Annual Average Damage (£)	30.5k		
Present Value (£)	**915k**		
IPPC sites (Nr)	0	0	0
Community Assets (Nr)	**1**	**1**	**1**
Care Homes GP Surgery's Fire stations Hospitals Police Stations Schools	1	1	1
Key Infrastructure (Nr)	**0**	**0**	**0**
NIW Wastewater Treatment Works NIW Sewage Pumping Stations NIW Water Treatment Work NIW Treated Water Pumping Stations NIE Substation 6to11kV NIE Substation 33kV NIE Substation 275kV NIE Substation 110kV Road Service - Trunk Road			
Environmental Designated sites (Nr)	**0**	**0**	**0**
AONB ASSI Environmentally Sensitive Areas Maritime Nature Reserve Nature Reserve RAMSAR SAC Sites of Local Nature Conservation Importance SPA RSPB Reserve UWT Nature Reserve			
Built Heritage sites (Nr)	**0**	**0**	**0**
National Trust Listed Buildings Sites and Monuments Records Buildings of Special Architectural or Historical Interest Areas of Significant Archaeological Interest Historic Gardens			

Three Mile Water (and tributaries)

The Three Mile Water flows from its source in the Antrim Plateau Escarpment through a valley between Carmoney Hill to the South and My Lords Mountain, Carntall and Knockagh to the North. The watercourse crosses the A8 Larne Road (near Corr's Corner), flows through the Mossley and Ballyhenry areas before reaching its sea outfall at the Shore Road/Glenville Road junction. The watercourse, which flows in a south easterly direction from source to sea, is approximately 8.7km long. The upper sections of the watercourse, from its source to Mossley, are relatively flat with an approximate gradient of 1:200. There is a marked increase in the steepness of the watercourse from Mossley to the sea outfall as it flows though a steep-sided valley within a channel which has an average gradient of around 1:65. The steepness of the valley sides immediately adjacent to the river channel have largely prevented development encroaching close to the flow channel.

The watercourse flows mainly within an open channel, and is culverted only at road and railway crossings. The Three Mile Water has a number of significant tributaries which flow from the north to join at various locations along its left bank and include the Ballyearl Stream, Cully's Burn, Brookmount Stream, Twinburn Stream, Lisbane Stream, Pound Burn, Devinish Stream and Lismore Drain. These tributaries drain high ground in the northern segment of the overall rural catchment from My Lord's Mountain and Knockagh to the A8 and beyond this, the urbanised areas of Monkstown and Jordanstown. The lower urbanised reaches of the Three Mile Water are designated from just west of the Monkstown Road, downstream to the sea outfall. Further upstream, a short (500m) section of the watercourse is designated near the Mossley Mill Civic Centre.

The developed areas that are prone flooding within the Three Mile Water (Main Channel) and its tributaries (Brookmount Stream, Twinburn Stream and Lismore Drain) , together with a description of the flooding mechanisms are as follows.

<u>Three Mile Water – Main Channel</u>

The model predicts that at the 1 in 100 year flood event there is no flooding to property from the main channel of the Three Mile Water. This would indicate that there is no need for structural flood alleviation measures to be undertaken for this watercourse. There is however some concern that at the lower reaches near the tidal outfall, the water level at the 1 in 100 year event rises to within 60mm on the left bank adjacent to the relatively new Glenavna Manor Housing development. Therefore, a very slight increase in the river levels would cause floodwater to overspill the bank and result in flooding to property at Glenavna Manor and the Whiteabbey Village. It is known that the site of the Glenavna Manor development flooded during the extreme event in 2002 and in all likelihood the properties constructed since that time would flood if a similar event was to occur in the future.

Brookmount Stream/Twinburn Stream (TMW tributaries)

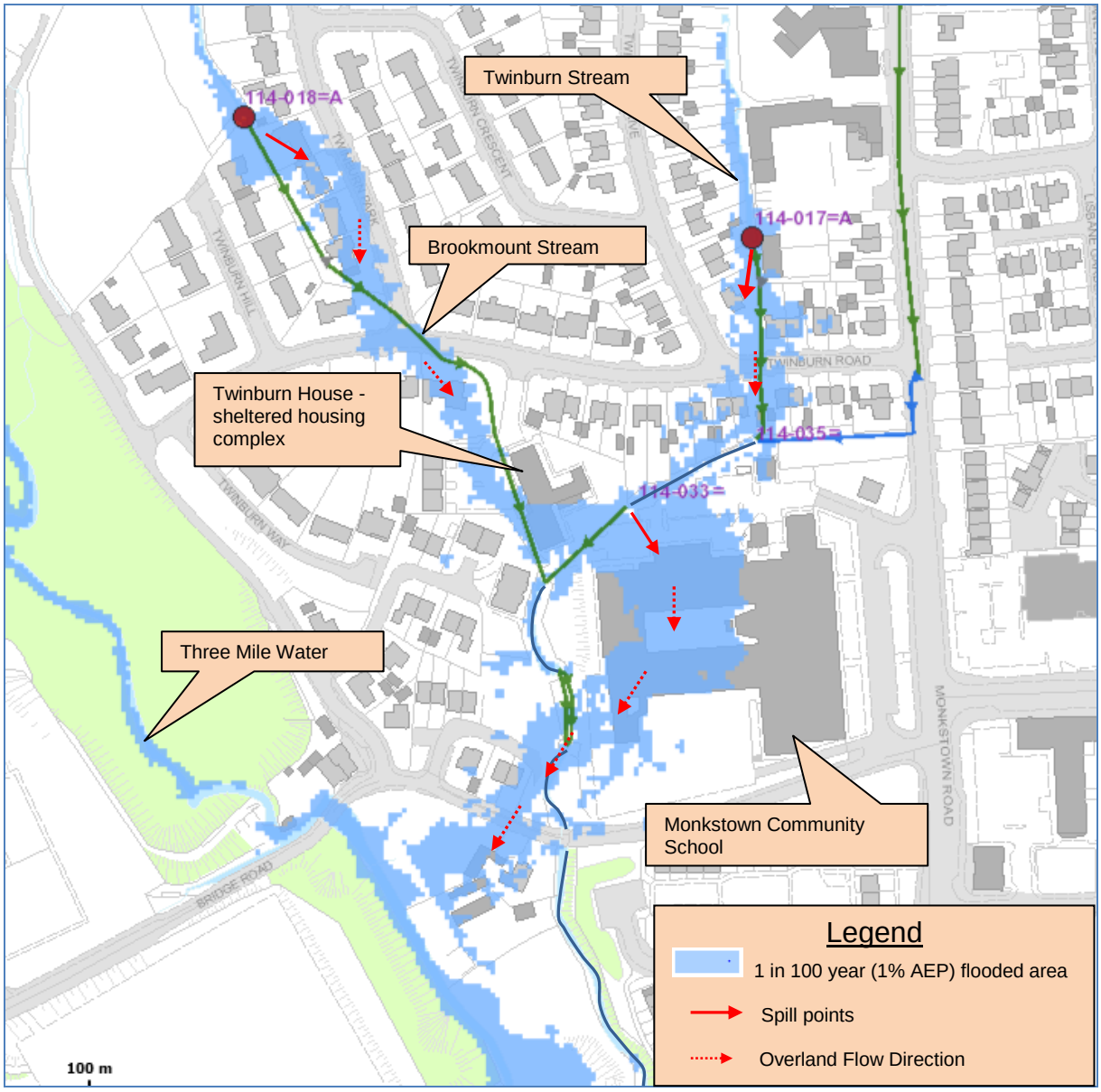


Figure 7.10.4.5 - Newtownabbey SFRA – Brookmount Stream/ Twinburn Stream Fluvial inundation area (1% AEP)

The model predicts that flooding to properties from both the Brookmount Stream and Twinburn Stream begins to occur at the 4% AEP (1 in 25 year) event. It shows that floodwater spills over the banks of open sections of the watercourses at the inlets to culverts located in the grounds of the Monkstown Community School, and the rear gardens of two residential properties (5 Twinburn Drive and 11 Twinburn Park). It is estimated that at this location up to 26 residential properties and 3 non-residential properties which includes Monkstown Community School and Twinburn House sheltered housing complex are at risk of flooding at the 1 in 100 year event. There is historical evidence of flooding in the Twinburn area and during the period 1986 to 2005 there have been at least 9 telephone calls to the flood emergency helpline from homeowners to request assistance from the flood authorities.

Lismore drain (TMW tributary)

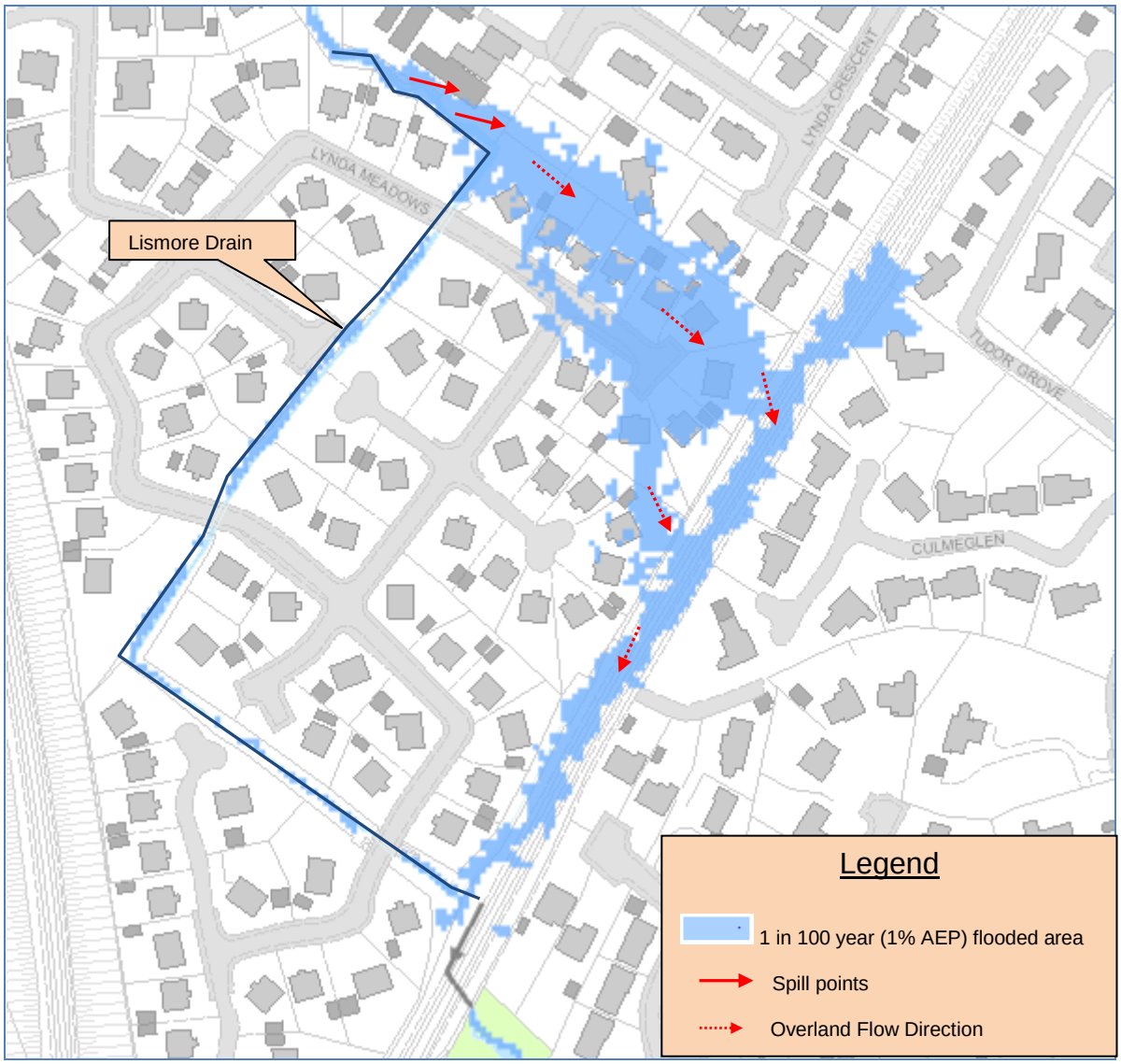


Figure 7.10.4.6 - Newtownabbey SFRA – Lismore Drain– Fluvial inundation area (1% AEP)

The model predicts that localised flooding of the Lynda Meadows development begins to occur at the 1.33% AEP (1 in 75 year) event as floodwater overspills the left bank at an acute bend in the open watercourse section adjacent to 14 Lynda Meadows (See Figure 7.10.4.6). At this event up to 8 properties may be affected by shallow flooding to depths less than 300mm. At the more extreme 1 in 100 year event the number affected may rise to around 16, although in all cases the depth of flooding will be shallow and at some properties may be limited to their gardens and out buildings. There is absolutely no evidence of flooding at this area in the past.

The assessment shows that flood risk to property from the Three Mile Water and its tributaries (Brookmount Stream, Twinburn Stream and Lismore Drain) is relatively low and that very few properties adversely are likely to be adversely affected by frequent flooding. It is estimated that across the whole of the catchment 46 homes and 4 non-residential properties may be flooded at the 1 in 100 year event and that the total cost of the predicted property damages of future floods is estimated to have a present day value of around £54k

Table 7.10.4.3 Newtownabbey SFRA – Three Mile Water			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	1	1	46
Non Residential (Nr)	0	1	4
Economic Damage (£)	52	52	56,586
Annual Average Damage (£)	1,813		
Present Value (£)	**54k**		
IPPC sites (Nr)	0	0	0
Community Assets (Nr)	**0**	**1**	**1**
Care Homes			
GP Surgery's			
Fire stations			
Hospitals			
Police Stations			
Schools		1	1
Key Infrastructure (Nr)	**0**	**0**	**0**
NIW Wastewater Treatment Works			
NIW Sewage Pumping Stations			
NIW Water Treatment Work			
NIW Treated Water Pumping Stations			
NIE Substation 6to11kV			
NIE Substation 33kV			
NIE Substation 275kV			
NIE Substation 110kV			
Road Service - Trunk Road			
Environmental Designated sites (Nr)	**0**	**0**	**0**
AONB			
ASSI			
Environmentally Sensitive Areas			
Maritime Nature Reserve			
Nature Reserve			
RAMSAR			
SAC			
Sites of Local Nature Conservation Importance			
SPA			
RSPB Reserve			
UWT Nature Reserve			
Built Heritage sites (Nr)	**5**	**5**	**8**
National Trust			
Listed Buildings	5	5	8
Sites and Monuments Records			
Buildings of Special Architectural or Historical Interest			
Areas of Significant Archaeological Interest			
Historic Gardens			

Jointure Bay Stream

The Jointure Bay Stream is a minor watercourse which arises at the base of Knockagh Hill and flows in a south easterly direction for a distance of around 2km to its tidal outfall to Belfast Lough at Jointure Bay, Greenisland. The lower 1.2km of the watercourse is designated from its crossing of the Belfast/Larne railway line downstream to the sea outfall. The lower 600m of the designated section of the watercourse is culverted with 1200mm diameter concrete pipes which have been assessed to be in a satisfactory condition. Upstream of the railway line the Jointure Bay Stream is undesignated and flows within an open channel alongside the Downshire Road. A culverted tributary, the Downshire Gardens Stream which flows through the Downview development connects to the head of the undesignated open section of the Jointure Bay Stream. The final two sections of the Downshire Gardens Stream culvert, which link to the Jointure Bay Stream, are undesignated and their condition is unknown.

The developed areas that are prone flooding within the Jointure Bay Stream, together with a description of the flooding mechanisms are as follows.

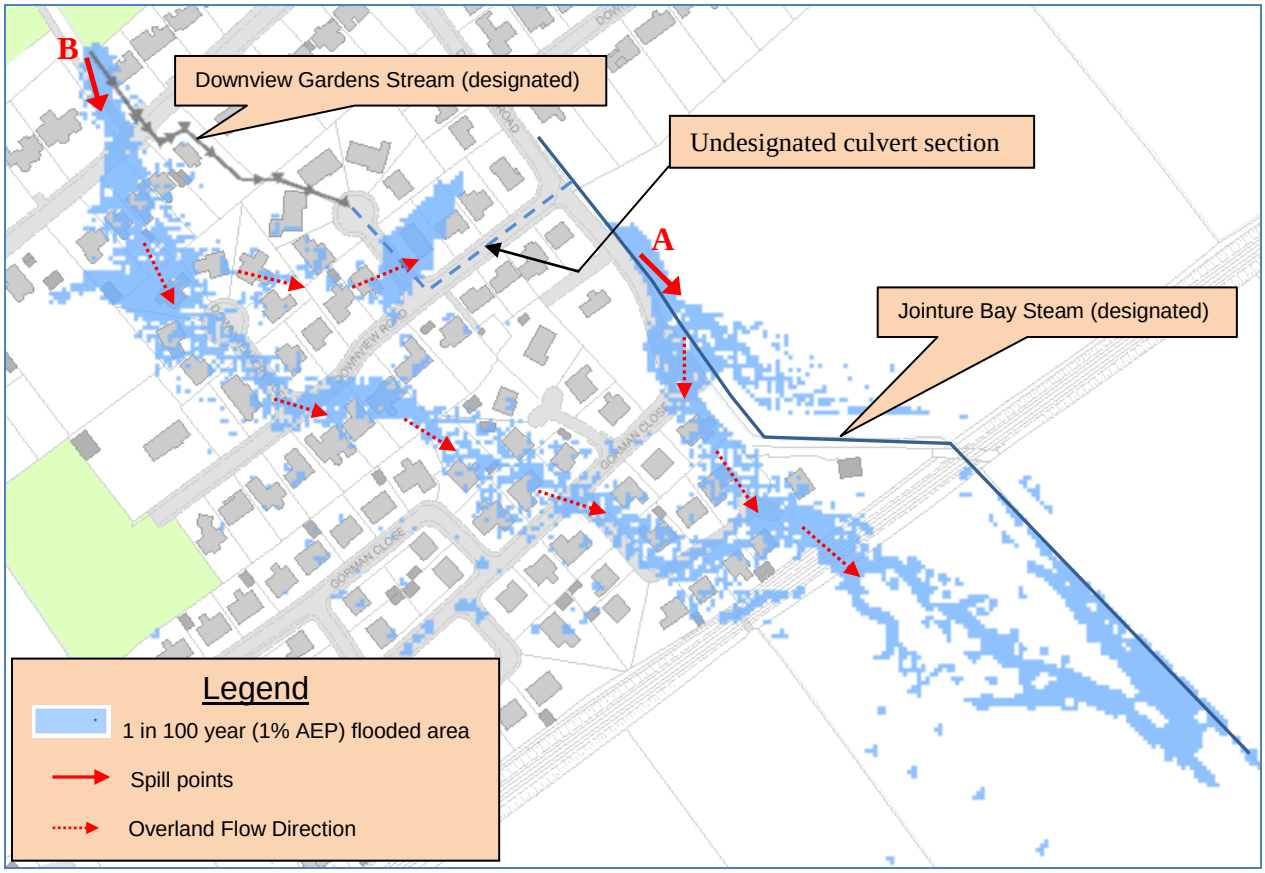


Figure 7.10.4.7 - Newtownabbey SFRA –Jointure Bay Stream & Downshire Gardens Stream Fluvial inundation area (1% AEP)

The model predicts that flooding within the Downview housing development from the Jointure Bay Stream and Downshire Gardens Stream begins to occur at the very frequent 20% AEP (1 in 5 year) event. Although in this scenario it is unlikely to adversely affect any more than 3 properties. Flooding occurs from two specific locations identified as 'A' and 'B' on the Figure 7.10.4.7. At 'A' floodwater overspills the banks of an

open section of the Jointure Stream which runs along the east side of the Downshire Road carriageway and flows overland via the carriageway to inundate properties at Gorman Close. At 'B' floodwater is predicted to overspill the banks of the Downview Gardens Stream at the inlet to a culvert located to the rear of 196 Upper Greenisland Road. The floodwater flows across the surface through the Downshire estate to join with overland flows from the Jointure Bay Stream behind the railway embankment at Gorman Close. It is estimated that at the 1 in 100 year event, flooding from these watercourses may adversely affect up to 57 homes and 4 non-residential properties. There have been numerous phone calls to the flood emergency helpline from the owners of homes in the Downshire housing development. These span the period 1986 to 2006 and relate to a number of homes that are clustered around Downshire Gardens Stream and appear to indicate that there is a capacity problem with the section of undesignated watercourse which links the Downshire Gardens Stream to the Jointure Bay Stream. The cost of the predicted property damages of future floods is estimated to have a present day value of around £793k.

Table 7.10.4.4 Newtownabbey SFRA – Jointure Bay Stream			
Potential Adverse Consequences – Fluvial Flooding			
	Flood Event % AEP		
	10% AEP	**4% AEP**	**1% AEP**
Residential (Nr)	6	33	57
Non Residential (Nr)	0	0	4
Economic Damage (£)	33,585	46,527	68,429
Annual Average Damage (£)	26,429		
Present Value (£)	**793k**		
IPPC sites (Nr)	0	0	0
Community Assets (Nr)	**0**	**0**	**1**
Care Homes			
GP Surgery's			
Fire stations			
Hospitals			
Police Stations			
Schools			
Key Infrastructure (Nr)	**0**	**1**	**1**
NIW Wastewater Treatment Works			
NIW Sewage Pumping Stations			
NIW Water Treatment Work			
NIW Treated Water Pumping Stations			
NIE Substation 6to11kV		1	1
NIE Substation 33kV			
NIE Substation 275kV			
NIE Substation 110kV			
Road Service - Trunk Road			
Environmental Designated sites (Nr)	**3**	**3**	**3**
AONB			
ASSI			
Environmentally Sensitive Areas	1	1	1
Maritime Nature Reserve			
Nature Reserve			
RAMSAR	1	1	1
SAC			
Sites of Local Nature Conservation Importance			
SPA	1	1	1
RSPB Reserve			
UWT Nature Reserve			
Built Heritage sites (Nr)	**0**	**0**	**0**
National Trust			
Listed Buildings			
Sites and Monuments Records			
Buildings of Special Architectural or Historical Interest			
Areas of Significant Archaeological Interest			
Historic Gardens			

7.10.5 Proposed Fluvial Flood Mitigation Measures

Prevention

As well as managing the existing flood risk to people and properties in Newtownabbey it is important the flood risk is not increased by allowing new development in areas of known flood risk. Planning Policy Statement, PPS 15, Planning and Flood Risk, adopts a precautionary approach to development with the primary aim *'to prevent future development that may be at risk of flooding or that may increase the risk of flooding elsewhere'*.

Rivers Agency's Planning Advisory Unit provides Planning NI with advice at both the Development Plan and Planning Application stages. Flood mapping information is used to inform the local Development Plans to ensure, where possible, that new zonings are located outside the identified flood risk areas. In the determination of planning applications any proposed development within a flood risk area will either be advised against or will be further considered if it meets one of the 'Exception' rules in PPS 15 and is accompanied by a suitable Flood Risk/Drainage Assessment. Applications that relate to 'Greenfield' built development in fluvial floodplains are unlikely to be accepted, whereas applications for recreation purposes and amenity open space will usually be accepted.

Development Plans

In the preparation of new Development Plans for Newtownabbey, Rivers Agency will advise against bringing forward sites or the zoning of any land, particularly for built development, that has been identified from the flood maps as being within the 1 in 100 year fluvial floodplain/1 in 200 year coastal floodplain/reservoir inundation area or is susceptible elsewhere to surface water flooding.

Rivers Agency will also review the existing Development Plan for Newtownabbey (Belfast Metropolitan Area Plan, 2015) with a view to addressing flood risk issues which have only recently been identified as a result of the new flood maps.

The main (undeveloped) flooded areas, amongst others, within the Newtownabbey Significant Flood Risk Area are:-

Three Mile Water

- A number of areas immediately upstream of the Monkstown Road.
- A number of areas downstream of the Monkstown Road as far as the railway line crossing.

Planning Applications

Fluvial/Coastal Areas at risk

We shall advise against the development of all sites that are located within the 1 in 100 year fluvial floodplain/1 in 200 year coastal floodplain, irrespective of whether they are located within a current Development Plan or as a single site application outside the plan area.

For those sites within the 1 in 100 year fluvial floodplain/1 in 200 year coastal floodplain where the principle of development has been accepted by Planning NI as meeting the 'Exception Test', Rivers Agency will further consider the application through the appraisal of an accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures.

The main existing developed areas, amongst others, at flood risk within Newtownabbey were re-development may be likely to take place are:

Fluvial

Concrete Road Stream

- Areas along Monkstown Avenue and downstream to the railway track crossing.

Lisbane Stream

- Areas in Twinburn upstream of confluence with the Three Mile Water.

Lismore Drain

- Areas at Lismore Meadows upstream of confluence with Three Mile Water.

Greenisland Stream

- Areas along the Station Road.

Coastal

- Along the Shore Road at the outlets of the Concrete Road Stream and the Three Mile Water.

Areas at Risk of Surface Water flooding

For those sites outside the 1 in 100 year fluvial floodplain/1 in 200 year coastal floodplain that are located in an area where there is evidence of a history of surface water flooding (identified by flood hardship payments), Rivers Agency will further consider the application through the appraisal of the accompanying Drainage Assessment that will need to demonstrate suitable flood mitigation measures.

Where there is potential for surface water flooding predicted by the Surface Water Map (areas highlighted purple) Rivers Agency will advise that the applicant should assess the flood risk and drainage impact to the site and construct in an appropriate manner.

The main areas with a flood history, identified in the Newtownabbey SFRA as being at risk from surface water are at:

- Hollybank Drive off Devenish Drive.
- Ballyfore Park off the Fairview Road.
- Neills Lane off the Shore Road.
- Greenisland Terrace on the Upper Station Road above the railway Line.

Area's at Risk of Flood Inundation from Reservoirs

For all development proposals that are located within the potential flood inundation area of a Controlled reservoir we will further consider the application through the appraisal of the accompanying Flood Risk Assessment that will need to demonstrate suitable flood mitigation measures. If it is a new development proposal we will also need the applicant to demonstrate that the condition, management and maintenance regime of the reservoir is appropriate to provide sufficient assurance regarding reservoir safety.

Controlled reservoirs identified in the Carrickfergus area are as follows: **Mossley Mill**

Protection

Structural measures are still one of the main options in providing flood protection to people and property impacted by the effects of extensive flooding. It is therefore important that we continue to target investment by providing flood defences, culvert alleviation schemes and infrastructure upgrade works to those communities at greatest need.

The alleviation of surface water flooding, in particular, will require input from a number of bodies. **The Flood Investment and Planning Group**, FIPG, provides a coordinated approach across Government in relation to the investigation of flooding, agreeing responsibilities and identifying collaborative solutions. The group is represented by Rivers Agency, NI Water and Transport NI, amongst others, with flood risk management responsibilities.

There are a number of stages to follow when procuring a flood alleviation scheme. The potential scheme needs to be first subjected to a feasibility study that will also include an economic appraisal. From the detailed Hazard and Risk Maps a Flood Risk Metric Tool' (FRISM) is used in urbanised flooded areas to get an estimate of the likely property damages as a result of a range of flood events. The estimated cost of a scheme is then compared to the total 'damage avoidance benefits' that the scheme will provide to property over the scheme's design life. If the benefit/cost ratio is greater than 1, then the potential scheme will be referred to Rivers Agency's Capital Procurement Unit for a feasibility study to be undertaken.

If the flooding issue identified is not solely Rivers Agency's responsibility, or is the responsibility of NI Water or Transport NI such as a local drainage or road infrastructure issue, then it will be referred either to FIPG or directly to the responsible body, for their further consideration.

If a cost benefit analysis identifies a viable scheme, it will be placed on a prioritisation list and progressed alongside other competing schemes. The position on the list will depend on a set marking criteria, such as the benefit/ cost ratio and the overall scheme costs. Depending on the availability of resources it may take anything from between 2 – 5 years for the scheme to progress from the start of the feasibility study to construction works commencing on the ground.

Having conducted a detailed assessment of the fluvial flood risk to Newtownabbey, Rivers Agency has determined that potential flood alleviation schemes may be justified for the Concrete Row Stream, Greenisland Stream, Jointure Bay Stream and to a lesser extent the Three Mile Water and its tributaries.

Concrete Row Stream

A feasibility study for the Concrete Row Stream was completed in December 2014 and this identified that a flood alleviation scheme may be cost beneficial. The detailed design and economic appraisal for the proposed flood alleviation scheme has commenced and shall be completed in summer 2015. The findings of this will be taken into consideration in the final version of the FRMP (December 2015). If a flood alleviation scheme is confirmed to be economically viable, then the scheme will be placed on the Rivers Agency's Capital Works Programme and undertaken in line with its prioritisation compared to other viable schemes, if and when resources are available.

Greenisland Stream

Rivers Agency is currently undertaking a feasibility study for the Greenisland Stream which is programmed for completion in January 2015. If this feasibility study identifies that a potential flood alleviation scheme is likely to be economically viable Rivers Agency may, subject to resources and pressures from other potential schemes, commence the detailed design in 2015. The final version of the FRMP (December 2015) will contain firm details as to whether or not an engineering solution to the flooding from this watercourse is likely to be undertaken.

Jointure Bay Stream

Flooding to property in the Downshire housing development from the Jointure Bay Stream (and its tributary, the Downshire Gardens Stream) is considered to be significant and a flood alleviation scheme to mitigate the risk may be economically viable. Rivers Agency will produce a pre-feasibility report for the Jointure Bay Stream for inclusion within its prioritised Flood Study Programme.

Three Mile Water (and tributaries)

Although the flood model for the Three Mile Water predicts that there are no properties located within the 1 in 100 year flood plain of the main channel, there is a concern that flooding to the Whiteabbey Village in 2002

may be related to overland flows which arose from overtopping of the watercourse's left bank at an acute bend near the Whiteabbey Presbyterian Church. An added concern is that since 2002 the Glenavna Manor housing development has been built adjacent to the rivers edge at the location of this suspected breach point and that this could flood if a similar event was to reoccur. The model predicts that at the 1 in 100 year flood event, the level of the river rises to within 60mm of the top of the bank adjacent to Glenavna Manor. Given this lack of freeboard, there is reasonable cause to be concerned that flooding at this location may occur again and consequently, Rivers Agency has undertaken a feasibility study to examine this potential problem in greater detail and this will be completed in January 2015. If the feasibility study identifies that a potential flood alleviation scheme is likely to be economically viable, Rivers Agency may, subject to resources and pressures from other potential schemes, commence the detailed design in 2015. The findings of this report and any further progress will be reported in the final version of the FRMP (December 2015).

The flood model predicts a relatively low flood risk to property in the Twinburn area from two of the Three Mile Water tributaries, the Brookmount Stream and Twinburn Stream. The model output is supported by historical records of minor flooding at this location over an extended period of time. Rivers Agency will produce a pre-feasibility report for the Brookmount Stream / Twinburn for inclusion in its prioritised Flood Study Programme. However, this potential problem is unlikely to be awarded a priority that is sufficiently high to justify the commencement of a detailed feasibility study for a potential engineering solution within the term of this FRMP.

Preparedness

In Newtownabbey it is not possible to prevent or protect against all flooding. Indeed even where flood defences exist it is possible in an extreme event that these could be over topped and flooding could still occur.

Having recognised this fact, considerable effort in recent years has been made by emergency planners in a Government Departments, Councils and the Emergency Services working together and sharing information to ensure a coordinated response.

However, despite these improvements, during significant flood events the emergency response of Government Departments and the Emergency Services can become over stretched. This means that not all calls for assistance during a flood event may be responded to in a timely manner. With this in mind it is important that households and communities, subject to a known flood risk, are prepared. The detail of preparedness actions, including flood warning and informing activities planned from a regional perspective, are provided in Annex E.

This is not Government withdrawing from any undertaking to respond in emergencies but an additional layer of support to ensure Government Departments and the public work together to reduce the overall impacts of flooding.

From the flood risk assessment there at least 6 areas within the Newtownabbey SFRA that have flooded in the recent past that may benefit from the flood warning and informing proposals, outlined in Annex D.

A pilot project of community engagement to deliver flood warning and informing, held in 2014, identified basic assessment formulae to assess and score areas that could potentially be a focus for flood warning and informing actions. Based on this scoring these areas did not score high enough to be placed within the top 20 communities to be offered a programme of community engagement during the period of this plan. However, if communities want to become more resilient, the Department is committed to providing assistance were possible to develop the consistent approach to resilience. The NI Direct website www.nidirect.gov.uk/ will host further information and advice on what to do in advance of flooding, what to do during flooding and how to recover after flooding. The website will also contain templates for communities wishing to develop their own plan.

Section 8

8. Implementation

This section details how the measures to manage flood risk for each Significant Flood Risk Area (SFRA) will be implemented. It also explains how they will influence future actions and highlights the benefits of their implementation.

The measures (Prevention, Protection and Preparedness) are identified for each SFRA in Sections 5, 6, and 7 of this document.

The detail on specific protection measures, that is, the appraisal and development of flood alleviation schemes, including natural flood risk management options if feasible, will be developed throughout the cycle of the Plans.

8.1 Prevention

8.1.1 Prevention – Implementation

The Prevention measure will be implemented by providing advice to Planning NI, at both the planning and application stages of the planning process, on proposed development in floodplains that it considers to be inappropriate.

The role of Rivers Agency's Planning Advisory Unit (PAU) will be key in implementing this measure.

The detail of the approaches that underpin *Prevention* are expanded upon in the text for each SFRA in Sections 5, 6, and 7. The implementation of this measure will continue throughout the cycle of these Plans.

8.1.2 Prevention – Drivers for future actions

The implementation of this measure will drive the following:-

- The need to review, as necessary, Planning Policy PPS15.
- The need to have up to date flood risk and hazard mapping.
- The need to further engage with critical infrastructure providers on the appropriate location and resilience of their installations.
- The need to link development emergency response plans, compiled as part of a flood risk assessment, with broader community emergency plans taken forward in implementing the preparedness measure.

8.1.3 Prevention – Key Benefits of Implementation

In Northern Ireland the application of a robust planning policy in relation to land use planning, has already been beneficial in ensuring that the overall numbers of properties and critical infrastructure at risk of flooding do not increase and that any re-development is built with suitable flood resistance/resilience measures.

In Northern Ireland, the number of properties at risk of flooding is around 1 in 18, compared to 1 in 6 in England.

The critical factor in keeping this figure so low in Northern Ireland has been the strict application of a sustainable land-use policy (PPS15). It is vital, therefore, that this policy is strictly adhered to throughout the duration of these Plans and beyond.

8.2 Protection

8.2.1 Protection - Implementation

Protection measures will be implemented by the completion of already identified and programmed flood alleviation schemes, infrastructure upgrade works and maintenance activities, as well as carrying out studies to identify further works to be taken forward.

This will involve Transport NI, NI Water and Rivers Agency both individually and, where necessary, collectively, working together particularly through the auspices of the Flood Investment and Planning Group (FIPG).

The detailed analysis of each of the 20 SFRAs identifies, as appropriate, the need for further studies to determine approaches in implementing protection measures. In some locations this will build upon the investment in flood alleviation schemes already made in these areas.

The Plans do not deal with the detail of individual schemes or definite scheme proposals, as this is not possible for all 20 SFRAs at this stage. The focus, in the first instance, is on assessing the potential benefit, in terms of damage avoided, for each of the SFRAs.

This strategic approach, at this stage, is reasonable as the draft Plans are intended to consider a proactive approach to protection measures, as opposed to a post flood event reactive approach. It also allows for a broader approach in the development of flood protection infrastructure, in terms of funding, partners and the implementation of natural flood risk management techniques.

Details of flood protection measures for any of the 20 SFRAs already underway, or at an advance stage of development will be presented at Local Flood Forums in January 2015.

8.2.2 Protection – Drivers for future actions

The implementation of this measure will drive the following:-

- The need for continued inspection and maintenance of drainage and flood protection infrastructure including designated watercourses, culverts, sewerage systems and road drainage systems.

- A proactive, strategic approach, in the development of flood protection measures and work programmes.

- The development of Natural Flood Risk Management techniques and the necessary underpinning policies to allow for a wider range of options to be used in developing flood protection measures.

- Greater integration with all flood protection, drainage and watercourse infrastructure providers in developing joint schemes with multi benefits.

- The opportunity to review investment and financing options from a wider catchment based perspective.

8.2.3 Protection – Key Benefits of Implementation

The key benefits in providing and maintaining flood protection and drainage infrastructure over the duration of these Plans are:

- The avoidance of risk to life and damage to property and infrastructure, which would otherwise be unprotected from flood risk.

- Opportunities for 'joined up' working with other infrastructure providers in terms of scheme development and investment efficiency.

- Opportunities to look at flood risk from a catchment-wide perspective with other water resource interested organisations and explore 'multiple benefits' that could be realised.

Other benefits include improved quality of life for those currently anxious about their property's vulnerability to flooding. Less pressure on emergency response resources, in protected areas, will mean improved efficiency in responding to those still exposed to a greater level of flood risk.

Preparedness

8.3.1 Preparedness – Implementation

Preparedness measures will be implemented by a range of approaches. These include continuing to work together with co-responders, voluntary sector groups and communities to ensure a co-ordinated and timely emergency response when flooding occurs. The role of Local Government Emergency Planning Co-ordination Officers (EPCOs) is essential in implementing this element of preparedness activities. In addition, lessons learnt from post flood event debrief reports will inform improvements for the future.

Emergency planning exercises will, as resources permit, be held to add clarity to roles and responsibilities and share knowledge.

Flood Warning and Informing activities will also be key to ensuring responders and the public are able to put the necessary preparations in place in the event of flooding.

A capital grant scheme for Individual Property Protection, if approved, will also be implemented during the period of these Plans. This will improve the ability of householders and communities to enhance their resilience to flooding.

Enhancement of the 'Flooding Incident Line' will also take place. This will not only improve the reporting of flooding by the public but also communication between co-responders during a flooding event.

8.3.2 Preparedness – Drivers for future actions

The implementation of this measure will drive the following:-

- The need for further emergency planning exercises.
- A review of 'flood Warning and Informing' activities to inform further development in this area.
- Development of the Flooding Incident Line to improve this service for the public and provide real time data to co-responders during a flooding event.

8.3.3 Preparedness – Key Benefits of Implementation

The key benefits in implementing the preparedness measures in these Plans are:-

- Improved emergency response from 'Government' during a flooding event.
- Better integration with co-responders in relation to information sharing before and during a flooding event.
- Communities at known risk more resilient in dealing with flooding.
- Improved communications in relation to reporting a flooding event.

Section 9

This section gives an overview of the costs of implementing the measures to manage flood risk identified in these Plans.

It is intended to give a broad estimate of the annual cost of flood risk management, what accelerated spend would look like and an estimate of costs in beginning to address issues with infrastructure which does not form part of the public network.

9. The Cost of Implementation

The PEDU report, published in 2012, recommended "that Rivers Agency, Roads Service and NI Water work with their parent Departments to review current flood defences expenditure priorities and report to the Executive on their adequacy to meet the potential threats over the next 10 years".

This 10 year period encompasses the duration of these Flood Risk Management Plans. The report also included an estimate to accelerate implementation and the costs of undertaking 'new activities' to address issues of exceedance and infrastructure not part of the public network. The findings of this report were presented to the Executive in April 2013.

It was estimated that a combined figure of approximately £24 million of resource expenditure and £36 million of capital investment per year for all the Drainage Agencies, was needed to maintain drainage infrastructure and execute a programme of flood alleviation projects, to reduce flood risk.

These estimates were based on plans and a broad estimate of necessary works at the time the PEDU report was compiled.

The measures identified in this draft Plan would require this level of investment as a minimum to reduce flood risk.

These minimum estimates do not include for the operational costs in relation to emergency planning and the administration of PPS 15. Costs of other organisations, such as Local Councils, PSNI, NIFRS and Consumer Council, who play a significant role in the emergency response to flooding are also not included.

As part of the PEDU spending review it was recognised that investment could be increased annually, to accelerate programmes of capital investment and improve maintenance of infrastructure, a critical aspect in the management of flood risk.

An additional combined figure of £4 million resource expenditure and £36.5 million of capital investment, per year for all the Drainage Agencies was identified.

It was also estimated, that in order to address vulnerabilities in infrastructure not part of the public network, approximately £12 million per year, of mainly capital investment, would be required.

Whilst the PEDU estimates do not directly read across to **all** the activities to implement the measures in these Plans they are the most recent broad indicative costs of managing flood risk in Northern Ireland. More detailed estimates will be provided over the life time of these Plans as more information, particularly in relation to flood protection activities, is known.

Working through investment needs, particularly where more than one organisation is involved, will require a strategic targeted approach. These Plans give the overall regional strategic approach to collectively managing flood risk. Groups such as the Strategic Drainage Infrastructure Programme Board and Flood Investment and Planning Group (FIPG) have a key role in facilitating appropriate targeted investment in areas of joint responsibility.

It should be noted, however, that the resourcing pressures, particularly in terms of resource funding, facing all Departments will impact directly on the maintenance of critical drainage infrastructure and the risk of flooding could increase as a result.

The advances made in relation to flood emergency response with co-responders outside of the Drainage Agencies, particularly PSNI, NIFRS and Local Councils could regress as they also are facing significant resourcing pressures. The effect of any stalling or regression in progressing this measure would be magnified by the fact that public expectation will not reduce.

In addition, the pace of delivery in relation to flood alleviation schemes will be linked to levels of capital investment available and this will mean that priorities for funding will need to be kept under review and reprofiling of programmes may be necessary.

Section 10

This section details the monitoring and review arrangements for the implementation of these Plans.

10.1 Monitoring

Progress on the implementation of these Plans will be reported on an annual basis to the European Commission through the normal reporting process.

10.2 Reviewing

The EU Floods Directive requires that the FRMPs are reviewed on a 6 year cycle. The time line of the next cycle is:-

- Further Preliminary Flood Risk Assessment – 22 December 2018
- Flood Hazard and Risk Maps update – 22 December 2019
- The Flood Risk Management Plans update – 22 December 2021

The 20 Significant Flood Risk Areas identified were based on the coarse Strategic Flood Map information. They are already under review due to the availability of the detailed Flood Hazard and Risk Maps produced in 2014. Further reviews of the SFRAs will be ongoing as new and updated information, such as recent flood history and changes in levels of protection, becomes available.

Regular reviewing and updating of the flood maps is an ongoing process. This will include the validation of existing mapping information and updating the maps based on new hydrometric information, tide level data, historical flood events and climate change factors. Based on new information, the effectiveness of existing defences and the likelihood of overtopping for predicted design events will also be reviewed.

Section 11

11.1 Next Steps

In terms of next steps, towards the later part of the consultation period a consultation response document, outlining all the responses received, will be prepared. Actions to be taken to address the points raised will be considered and this may result in making amendments to the draft Plans. Following this, the final Plans will be published by 22 December 2015.

11.2 Conclusion

This consultation process will give everyone the opportunity to contribute their views on the draft Flood Risk Management Plans over the next 6 months. The Plans will seek to build on past successes and provide a more coordinated approach to managing flood risk at the River Basin District level.

Using the Flood Hazard and Risk Maps it is now possible to identify, not only historical flooding, but also predict with more accuracy future flooding. This has facilitated the development of a range of measures to mitigate flooding in the 20 significant flood risk areas. Rivers Agency will continue to build on relationships with others with a role in flood risk management. The forming of inter-departmental groups on flood risk management, such as the Flood Investment and Planning Group, (FIPG} and the Strategic Drainage Infrastructure Programme Board means that roles and responsibilities can be agreed, as well as funding arrangements and approaches to joint solutions and responses. There haves been significant developments in improving collaboration between Agencies and other organisations in relation to flooding emergency response, and this is welcome.

These Plans will now be recognised as being the key source of information in taking forward the business of flood risk management in Northern Ireland and driving the activities necessary to manage the risk. They will also help provide focus in bidding for resources and setting targets.

During the 6 year life of the plans our knowledge and understanding of flood risk will continue to improve, as new information emerges and new technologies are developed. This will help us to start to repeat the process towards the delivery of the next 6 year cycle. Your views on this consultation are welcomed and will help develop approaches in relation to the management of flood risk during the cycle of these Plans and beyond.

Appendices

Annex A

List of consultees

General

Association of British Insurers
Ballinderry Fish Hatchery
Bann Systems Ltd
Belfast City Centre Management
Belfast Harbours Commission
Canoe Association of NI
Chartered Institution of Water and Environmental Management(CIWEM)
Coleraine Harbour Commissioners
Council for Nature Conservation and the Countryside
Countryside Alliance
DCAL Inland Fisheries
DOE NI Ireland Environment Agency
Drainage Council
DRD Water Policy Unit
DSD Weir Manager
Federation of Lough Neagh and Lough Beg Wildfowlers
Engineers Ireland
Freshwater Taskforce
GMB (Trade Union)
HSENI
Inland Waterways Association
Institution of Civil Engineers
Invest NI
Irish Amateur Rowing Union
Irish Water Ski and Wakeboard Association
Kilrea Angling Club
Lands Tribunal
Lough Neagh Fisheries Co-operative Society
Lough Neagh Rescue
Lough Neagh Sand Traders Association
Loughs Agency
Met Office
National Trust
NI Authority for Utility Regulation
NI Chamber of Trade
NI Environment Link
NI Fire and Rescue
NI Tourist Board
NIPSA Trade Union
Northern Ireland Agriculture Producers Association
Northern Ireland Housing Executive
Northern Ireland Water
OFMDFM Civil Contingencies Policy
PSNI
Public Health Agency
River Bann and Lough Neagh Association
Royal Yacht Association
RSPB
Rural Development Council
Rural Support
Shaftesbury Estate of Lough Neagh
Sports Council NI
Strangford Lough Wildfowlers and Conservation Association
The Honourable The Irish Society
Ulster Angling Federation
Ulster Coarse Fishing Federation
Ulster Farmers Union
Ulster Wildlife Trust
Waterways Ireland
World Wildlife Trust

OFMDFM GUIDANCE

Belfast Solicitors Association
CBI
Citizens Advice Bureau
Civil Law Reform Division
Departmental Library
District Judge (Magistrates Court)
Equality Commission
Federation of Small Businesses
General Consumer Council
HM Council of County Court Judges
Human Rights Commission
Law Centre
Law Society
Legal Deposit Libraries
National Library of Ireland
NI Chamber of Commerce and Industry
NI Council for Voluntary Action
NI Court Service (2)
NI Local Government Association
Northern Ireland Law Commission
Northern Ireland Ombudsman
Northern Ireland Publications
Resource (NIPR).
Queen's University, School of Law
University of Ulster, School of Law
The British Library.
The Executive Council of the Inn of Court of NI
The Library, Queen's University Belfast.
TSO Bibliographic Department.
Food Standards Agency
NIC/ICTU (Trade Union)
Society of Local Authority Chief Executives
HM Revenue & Customs
Ministry of Defence
Northern Ireland Judicial Appointments Commission
Catholic Bishops of Northern Ireland
Community Relations Council
Participation and the Practice of Rights Project

District Councils (26)

NI Executive

OFMDFM
Dept of Social Development
Dept of Enterprise Trade and Investment
Dept of Education
Dept of Regional Development
Dept of Employment and Learning
Dept of Environment
Dept of Health, Public Safety and Social Services
Dept of Agriculture and Rural Development
Dept of Culture, Arts & Leisure
Dept of Finance and Personnel
Dept of Justice
The Speaker of the Assembly
Assembly Departmental Committee
Assembly Business Office
Members of the Northern Ireland Assembly
Assembly Bill Office
Northern Ireland Assembly Library
Office of the Legislative Counsel
Northern Ireland Affairs Committee
Northern Ireland Office
Central Management Unit (CMU)
Legislative Programme Secretariat
Machinery of Government Division

All Political Parties in NI Assembly
All Political Parties not represented in NI Assembly
All Northern Ireland MPs and MEPs who are not MLAs
All Political Parties Spokespersons
All MLAs

Section 75 Groups
Floods Directive Steering Group Members
Local Flood Forum Members

Appendix B

Consultation Response Form

Consultation on the Draft Flood Risk Management Plans including, the Strategic Environmental Assessment and Habitats Regulatory Assessment.

Your details

Name:	
Postal address (including postcode):	
Email address:	

Please select from which of the following groups you belong to:

☐ **Individual**
☐ **Individual at perceived flood risk**
☐ **Utilities/Infrastructure provider**
  ☐ **Business sector**
  ☐ **Consultant / contractor**
  ☐ **Environmental management**
  ☐ **Academia/Research**
  ☐ **Farming / land management**
  ☐ **Local Government**
  ☐ **Central Government**
  ☐ **Leisure/tourism**
  ☐ **Manufacturing**
  ☐ **Transport / navigation**
☐ **Developer**
☐ **Other (*please specify below*)**

After the 6 month consultation period we will publish our response document and will let you know what people have said, how we have taken their comments into account and what changes will be made before we publish the final FRMP by 22nd December 2015.

Freedom of Information Act 2000 – Confidentiality of Consultations

Please note that your response and the responses of others to the consultation may be disclosed on request. The Department can only refuse to disclose information in exceptional circumstances. Before you submit your response please read the paragraphs in the consultation document on the confidentiality of consultations which provide guidance on the legal position about any information given by you in response to this consultation.

Questions on the Draft Flood Risk Management Plans:

Question 1

Do you agree that, using the methodology noted, the draft plan highlights the most significant flood risk areas in each of the three River Basin Districts?

☐ **Yes**

☐ **No**

If not, please give your reasons below.

Question 2

Do you understand and agree with the objectives as described in the draft plan?

☐ **Yes**

☐ **No**

If not, please give your reasons below.

Question 3

Do you agree that there is the right balance between the social, economic and environmental objectives?

☐ **Yes**

☐ **No**

If not, what could be done to redress the balance?

Question 4

Do you agree with the proposed measures identified for each of the significant flood risk areas?

☐ **Yes**

☐ **No**

If not, what would you change and why?

Question 5

What measures do you think should be given the highest priority to manage the flood risk in your area?

Please explain what they are and why they should be included?

Question 6

Do you see any ways that you or your community can support and contribute to any of the measures set out in the draft plan to reduce the flood risk?

☐ **Yes**

☐ **No**

If yes, explain what could be done.

Question 7

Are there things you think should be done to improve the co ordination of river basin and flood risk management planning?

☐ **Yes**

☐ **No**

If yes, explain what could be done.

Questions on the environmental report:

A strategic environmental assessment (SEA) has been undertaken to consider how the draft flood risk management plan could affect communities and the wider environment. The environmental report presents the results of this assessment and summarises the effects that are significant for the river basin district.

Question 8

Do you agree with the conclusions of the environmental assessment?

☐ **Yes**

☐ **No**

If not, please explain why.

Questions 9

Are there any further significant environmental effects of the draft plan which you think should be considered?

☐ **Yes**

☐ **No**

If yes, please describe what they are.

Question 10

Are there further mitigations or opportunities that should be considered for the plan?

☐ **Yes**

☐ **No**

If yes, please explain.

Returning your response

Your response to this consultation needs to be returned by 22nd June 2015.

You can return your completed response form by:-:

email to: Alan.Reddick@dardni.gov.uk

post to:

ALAN REDDICK
STRATEGIC PLANNING UNIT
RIVERS AGENCY
HYDEBANK
4 HOSPITAL ROAD
BALLYDOLLAGHAN
BELFAST
BT8 8JP

Appendix C

Department of Agriculture and Rural Development

Equality and **Human Rights** Screening Template

December 2014

DARD Equality and Human Rights

Department of
Agriculture and
Rural Development
www.dardni.gov.uk

Screening Template

DARD has a statutory duty to screen. This includes our strategies and plans, policies, legislative developments; and new ways of working such as – the introduction, change or end of an existing service, grant funding arrangement or facility. This screening template is designed to help business areas consider the likely equality and human rights impacts of their proposed decisions on different groups of customers, service users, staff and visitors.

Before carrying out an equality screening exercise it is important that you have received the necessary training first. To find out about the training needed, contact - equalitybranch@dardni.gov.uk. All screening exercises must be supported by evidence and cleared at Grade 3 level.

The accompanying **Screening Guidance** note provides straightforward advice on how to carry out equality screening exercises. Detailed information about the Section 75 equality duties[1] and what they mean in practice is available on the Equality Commission's website.

The screening template has 4 sections to complete. These are:

Section A - asks you to provide details about the policy / decision that is being screened.

Section B - has 4 key questions that require you to outline the likely impacts on equality groups, and all supporting evidence.

Section C - has 4 key questions in relation to obligations under the Disability Discrimination Order and the Human Rights Act.

Section D - is the formal record of the screening decision.

[1] ECNI 'Section 75 of the NI Act 1998: A Guide for Public Authorities' April 2010. www.equalityni.org

Section A

Details about the policy / decision to be screened

Title of policy / decision to be screened:- Draft Flood Risk Management Plans
These policy proposals will help meet the Programme for Government, Priority3: Protecting our People, Environment and Creating Safer Communities by contributing to the Floods Directive building block supporting this priority.

Brief description of policy / decision to be screened:-
The Draft Flood Risk Management Plans are part of the process towards the implementation of the European Directive on the Assessment and Management of Flood Risks (2007/60/EC). The Draft Plans apply only to areas within NI that have been identified as being at significant flood risk. The Draft Plans set objectives for the purpose of managing flood risk and then identify a range of measures/actions that can be taken to achieve these objectives.

Aims and objectives of the policy / decision to be screened:-
The Draft Plans objectives are aimed at reducing the risk to human health, the environment, cultural heritage and economic activity. The Draft Plans measures fall into 3 main headings, Flood Prevention through the implementation of appropriate land use planning policies; Flood Protection by structural and non-structural measures and Flood Preparedness through flood forecasting, flood warning and emergency response procedures. Coordination with the Water Framework Directive and engagement with interested parties and the public is also a requirement of the Directive.

On whom will the policy / decision impact?

Consider the internal and external impacts (both actual or potential)

- Staff
- service users
- rural community
- other public sector organisations
- voluntary / community groups / trade unions
- others, please specify

The implementation of the policy will mainly impact on government departments who have roles and responsibilities for managing flood risk.
The Draft Plan measures when applied will reduce the impact of flooding to all communities that have been identified as being within significant flood risk areas in NI, irrespective of their type or background.

Are there linkages to other NI Departments / NDPBs?

Yes. There are a number of other NI Departments and public bodies that have flood risk management interests and responsibilities. These include DRD – NI Water, Transport NI; DOE – Northern Ireland Environment Agency, Planning NI; DHSSPS – Blue Light Services, OFMDFM – Civil Contingencies Planning and Local Councils.
Thoughout the implementation of the Directive, these bodies have attended informal stakeholder group meetings with their views/information reflected in the Draft plans proposals.

Section B

1. What is the likely impact on <u>equality of opportunity</u> for those affected by this policy, for each of the Section 75 equality categories? What is the level of impact?

Section 75 category	Details of likely impact	Level of impact? Minor/Major/None
Religious belief	Flooding is indiscriminate. The plans provide flood mitigation measures to predicted flooding from the 4 main sources of flooding, rivers, seas, surface water and reservoirs. The measures undertaken will reduce the flood risk to people and property, irrespective of the Section 75 category, living or working in the flooded area. The plans therefore do not make any distinction between the different Groups.	None
Political opinion	As above	None
Racial group	As above	None
Age	As above	None
Marital status	As above	None
Sexual orientation	As above	None
Men and women generally	As above	None
Disability	As above	None
Dependants	As above	None

2. Are there opportunities to better promote <u>equality of opportunity</u> for people within the Section 75 equalities categories?

Section 75 category	**If Yes, provide details**	**If No, provide reasons**
Religious belief		There is no opportunity in the Draft Plans proposals to better promote equality of opportunity.
Political opinion		As above
Racial group		As above
Age		As above

Marital status		As above
Sexual orientation		As above
Men and women generally		As above
Disability		As above
Dependants		As above

3. To what extent is the policy likely to impact on <u>good relations</u> between people of different religious belief, political opinion or racial group? What is the level of impact?

Good relations category	Likely impact?	Level of impact? Minor/Major/None
Religious belief	None	None
Political opinion	As above	As above
Racial group	As above	As above

4. Are there opportunities to better promote <u>good relations</u> between people of different religious belief, political opinion or racial group?

Good relations category	If Yes, provide details	If No, provide reasons
Religious belief	The plans may have a positive impact on good relations through the reduction in flooding by recommending flood protection measures and the opportunity for people to work together through community engagement and planning to manage the threat of flooding.	
Political opinion	As above	
Racial group	As above	

Available evidence

What evidence / information (both qualitative and quantitative) have you gathered to inform this policy? Set out all evidence below along with details of the different groups you have met and / or consulted with to help inform your screening assessment.

Section 75 category	Details of evidence / information and engagement
Religious belief	None. The Plan measures are applied to all people and properties at flood risk and take no account of any or all of the Section 75 Groups.
Political opinion	As above
Racial group	As above
Age	As above
Marital status	As above
Sexual orientation	As above
Men & women generally	As above
Disability	As above
Dependants	As above

No evidence held? Outline how you will obtain it:

The Draft Plan proposals and this initial screening document will be subject to the public consultation process. All Section 75 groups will have the opportunity to make comment and to influence the proposed measures outlined. The consultation will be take place over a 6 month period in the first half of 2015.

Section C

DARD also has legislative obligations to meet under the Disability Discrimination Order and Human Rights Act (insert links) Questions 5 -9 relate to these two areas.

Consideration of Disability Duties

5. Does this proposed policy / decision provide an opportunity for DARD to better **promote positive attitudes** towards disabled people?

Explain your assessment in full **Yes**
The measures on preparedness in regard to flood resilience to property and emergency access and egress will give designers and community planners the opportunity to consider suitable arrangements for disabled people. The policy should indirectly increase the safety of all Section 75 Groups including disabled people.

6. Does this proposed policy / decision provide an opportunity to actively **increase the participation** by disabled people in public life?

Explain your assessment in full **Yes**
The plans measures when implemented should give disabled people the opportunity to participate in community engagement and contribute to local emergency flood plans and resilient construction measures. The policy should increase the safety of all Section 75 Groups.

Consideration of Human Rights

7. The Human Rights Act (HRA) 1998 brings the European Convention on Human Rights (ECHR) into UK law and it applies in N Ireland. Indicate below (place an X in the appropriate box) any potential *adverse impacts* that the policy / decision may have in relation to human rights issues.

Right to Life	**Article 2**	☐
Prohibition of torture, inhuman or degrading treatment	**Article 3**	☐
Prohibition of slavery and forced labour	**Article 4**	☐
Right to liberty and security	**Article 5**	☐
Right to a fair and public trial	**Article 6**	☐
Right to no punishment without law	**Article 7**	☐
Right to respect for private and family life, home and correspondence	**Article 8**	☐
Right to freedom of thought, conscience and religion	**Article 9**	☐
Right to freedom of expression	**Article 10**	☐
Right to freedom of peaceful assembly and association	**Article 11**	☐
Right to marry and to found a family	**Article 12**	☐
The prohibition of discrimination	**Article 14**	☐
Protection of property and enjoyment of possessions	**Protocol 1 Article 1**	☐
Right to education	**Protocol 1 Article 2**	☐
Right to free and secret elections	**Protocol 1 Article 3**	☐

Consideration of Human Rights (cont)

8. **Please explain any adverse impacts on human rights that you have identified.**

None

9. **Please indicate any ways which you consider the policy positively promotes human rights**

The plan positively promotes human rights. Protocal1, Article 1 and Article2 ; Protection of property and the enjoyment of possessions and the Right to Life will be enhanced through the reduction in the flooding impact. Implementation of the Draft Plans will ultimately protect people and property from the risk of flooding through Prevention, Protection and Preparedness measures.

Monitoring Arrangements

Section 75 places a requirement on DARD to have equality monitoring arrangements in place in order to assess the impact of policies and services etc; and to help identify barriers to fair participation and to better promote equality of opportunity.

Outline what data you will collect in the future in order to monitor the impact of this policy / decision on equality, good relations and disability duties**.**

Equality	**Good Relations**	**Disability Duties**
No specific data will be collected	No specific data will be collected	No specific data will be collected

Section D

Formal Record of Screening Decision

Title of Proposed Policy / Decision being screened – Floods Directive Draft Flood Risk Management Plans.

I can confirm that the proposed policy / decision has been screened for –

☒	equality of opportunity and good relations
☒	disabilities duties; and
☒	human rights issues

On the basis of the answers to the screening questions, I recommend that this policy / decision is –

***place an X in the appropriate box below**

☐	***Screened In** – Necessary to conduct a full EQIA

☒	***Screened Out** – No EQIA necessary (no impacts) The Draft Flood Risk Management Plans identify a range of measures, namely Prevention, Protection and Preparedness that aim to remove or reduce the impact of flooding to people and property. All these measures would be considered as having a positive effect on people and are applied indiscriminatingly to all areas that are at significant flood risk across NI, and irrespective of what Section 75 equality group that people belong to.

☐	* **Screened Out -** Mitigating Actions (minor impacts)

Formal Record of Screening Decision (cont)

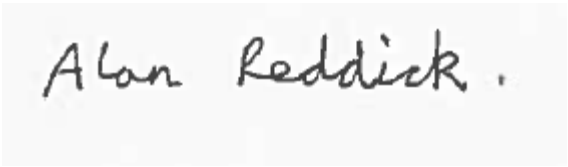
Screening assessment completed by (Staff Officer level or above) -

Name: Alan Reddick Grade: 7

Date: 24th November 14

Branch: Rivers Agency

Signature:



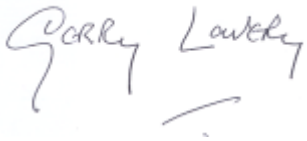
Screening decision approved by (must be Grade 3 or above) -

Name: Gerry Lavery Grade: 3

Date: 25 November 2014

Branch: Central Services Group

Signature: please insert a scanned image of your signature below



Please save the final version of the completed screening form in the TRIM container below as soon as possible after completion and forward the TRIM link to Equality Branch at equalitybranch@dardni.gov.uk. The screening form will be placed on the DARD website and a link provided to the Department's Section 75 consultees.

Strategic Management DARD - Equality Promotion & Implementation - Equality Schemes - Equality Screening of Departmental Policies:tr5

For more information about equality screening, go to - http://dardintranet/coord_intranet/EqualityBranch/index.shtml

Or contact –

DARD Equality Branch
Room 509
Dundonald House
Upper Newtownards Road
Belfast BT4 3SB
Telephone 028 9052 4435
Textphone 028 9052 4420

equalitybranch@dardni.gov.uk.

Annex D

Flood Warning and Informing initiatives for Northern Ireland

Flood warning and informing activities suitable for Northern Ireland commenced in 2013. Northern Ireland does not have a flood forecasting centre, unlike the rest of the UK. The reason for this is that catchments here are smaller and any warning time would be much shorter. This would greatly reduce the benefit of such a centre in Northern Ireland. However there are improvements in this area that have been be made.

Flood Warning and Informing provision suitable for Northern Ireland is being progressed via 4 stage strategy summarised as follows:-

I. Formal engagement with the Met Office in a 'partnering' approach to better inform the impact assessment of National Severe Weather Warnings for heavy rainfall.

An MOU between Rivers Agency and Met Office has been established. This MOU allows for contact between the Met Office and Rivers Agency at the consideration stage of a severe weather warning for heavy rainfall. Consideration is given to river levels and ground saturation conditions which enables a better assessment of the potential flood impacts of a significant rainfall event and informs the level and detail of the heavy rain warning. This allows communities and responders to tailor their responses.

II. Ensuring adequate 'Informing' in relation to flood risk to enable responders and the public to be effective in dealing with flooding.

In order to ensure that the 'Informing' aspect of this initiative is delivered effectively, a standardised, regional strategy is necessary. This involves input from a wide range of public and voluntary sector organisations and, to this end, the Regional Community Resilience Group (RCRG) has been formed. This Group is co-chaired by Local Government and Rivers Agency. Detail on the work of the RCRG is found in Annex E.

Through the auspices of the RCRG, work is now complete in relation to:-

- Identification of communities, using pre- agreed criteria, to be initially engaged in relation to flood warning and informing;
- Preparation of standard community resilience plans and household pack templates;
- Agreement on information to be communicated e.g. sharing of weather warning and river level information, assistance in relation to Individual Property Protection initiatives, and education on the limitations of any flood warning capability, response provision and infrastructure capacity.

III. Public dissemination of water level information. This includes the use of River level text warnings, where these are likely to be beneficial.

Subject to a successful pilot with community groups, the third stage will be to provide flood alert station and gauging station data as close to real time as possible on the Rivers Agency website.

IV. Review and Development

Stage 4 will involve a review of progress and the effectiveness of the 3 previous stages and will also consider the need for further refinement, taking into account national advances in this area and feedback from community groups and the wider public.

These staged improvements will be of benefit mainly in terms of river flood warning and informing to both responders and the public. The limitations of any flood warning needs to be recognised. Effective warning for heavy thundery downpours, which often result in surface water flooding, is not yet possible.

Annex E

Regional Community Resilience Group and Outline of Group Activities

Despite the improvements made in developing emergency plans and in providing improved levels of response during significant flood events, because of finite resources, the responses of Government and the emergency services can become over-stretched. This means that not all calls for assistance during a major flood event may be responded to in a timely manner. With this in mind it is important that households and communities that are subject to known flood risk are better prepared to deal with flooding.

To facilitate this, a pilot Regional Community Resilience project commenced during 2014 to engage with flood risk communities to help them be better prepared and be ready for flooding. **This support for Community Resilience is not Government withdrawing from any undertaking to respond in emergencies but an additional layer of support to ensure Government Departments and the public work together to reduce the overall impacts of and the misery induced by flooding.**

The detail of preparedness actions including flood warning and informing activities planned from a regional perspective are in Annex D.

Regional Community Resilience Group

The Regional Community Resilience Group (RCRG) was formed in January 2013 under the Joint Chairmanship of Rivers Agency and Local Government to bring partner organisations together to develop a Community Resilience Delivery Programme across the region. Over the course of 2013 the membership of the Group has expanded to include Rivers Agency and LGEMG (Joint Chairs); Belfast City Council; the four district council groupings responsible for civil contingencies matters at sub-regional level; Belfast Resilience; PSNI; NIFRS; NI Water; the Met Office; Roads Service; Red Cross, the Consumer Council; and NIE.

The purpose of the RCRG is to work on a multi-agency basis to facilitate consistent, prioritised and focussed planning and preparation for community response and recovery activities that will help pre-identified communities deal with emergency incidents. The Group has adopted flood risk as the initial topic on which to engage communities but will look to address a broader range of risks as their work develops.

Experience elsewhere shows that the benefits of this type of initiative are to help individuals and communities to be better prepared and more self-reliant during emergencies. In that context enhanced community resilience has the potential to contribute significantly to the overall effectiveness of the response and to wider resilience to the impacts of civil emergencies.

A four stage Community Engagement Plan has been developed with the objectives of:-

- explaining the potential and limitations of Community Resilience to communities;
- briefing communities on information available and the facilitation of self-help initiatives;
- providing continued support to households and businesses; and
- reviewing and validating all elements of the community engagement activities.

Annex F

Reservoirs Bill – Background and Legislative Development

Background

1. The Floods Directive requires member states to identify, manage and assess potential flood risks. The resulting preliminary flood risk assessment for Northern Ireland estimated that 66,000 people would be at risk from total dam failure of the 156 impounding reservoirs with a capacity of 10,000m³ or more. The number of reservoirs has since been revised downwards to 150.

2. The Northern Ireland Executive at its meeting on 11 November 2011 agreed that the Minister for the Department of Agriculture and Rural Development should bring forward primary legislation to regulate reservoir safety in Northern Ireland. This primary legislation is the Reservoirs Bill which is currently progressing through the Northern Ireland Assembly legislative process.

Reservoirs Bill – Main Components

3. The main components of the Reservoirs Bill, which reflect industry best practice are as follows:

- **Controlled Reservoirs**

  The Bill will introduce the term 'controlled reservoirs'. The definition of a 'controlled reservoir' will include structures or areas designed or used for collecting and storing water, artificial or partly artificial lakes, or other artificial areas which are capable of holding 10,000 cubic metres or more of water above the natural level of any part of the surrounding land.

- **Reservoir Managers**

  Responsibility for managing or operating a controlled reservoir will be placed on persons or organisations referred to as 'the reservoir manager'. Controlled reservoirs may be managed by one or by multiple reservoir managers.

- **Registration**

  Reservoir managers will be required to register a controlled reservoir with the Department. The Department will maintain this register and make it available for public inspection. The register will include the name and location of the reservoir, its maximum capacity, the name and address of the reservoir manager as well as copies of any reports or certificates relating to the reservoir.

- **Reservoir Designation**

  The Department will be required to give a controlled reservoir a designation as soon as reasonably practicable after the reservoir is registered. The Department will also be required to undertake a periodic re-assessment of the reservoir's designation. Controlled reservoirs will be designated as High Consequence, Medium Consequence, or Low Consequence depending on the impact that an uncontrolled release of water from the reservoir would have on life, economic activity, the

environment, or cultural heritage.

- **Reservoir Supervision**

  Controlled reservoirs that are designated as either High or Medium Consequence will be required to be supervised by a supervising engineer. The supervising engineer will be required to give the reservoir manager an annual written statement of the steps that they have taken and any measure taken by the reservoir manager, in the interests of safety or to maintain the reservoir.

- **Reservoir Inspection**

  A High Consequence reservoir will be inspected within one year of the date on which its designation takes effect and every 10 years thereafter unless an earlier inspection is recommended by a supervising or inspecting engineer.

  A Medium Consequence reservoir will be inspected within one year of the date on which its designation takes effect. Further inspections will only take place if recommended by the supervising or inspecting engineer.

  Inspection of reservoirs designated as Low Consequence will not be required.

- **Reservoir Construction**

  The construction or alteration of controlled reservoirs will be regulated by a requirement on the reservoir manager to appoint a construction engineer to supervise any works carried out on a controlled reservoir and by imposing a system of reporting and certification in respect of the works. This will apply to all controlled reservoirs regardless of their reservoir designation.

- **Incident Reporting**

  The Department may make provision in regulations for reporting incidents which may affect the safety of controlled reservoirs. The Bill will provide an indicative list of the contents of the regulations.

- **Flood Plans**

  The Department may make provision in regulations for the preparation of flood plans for controlled reservoirs. These plans would set out the action which the reservoir manager would take to control or mitigate the effects of flooding likely to result from any escape of water from the reservoir. The Bill will provide an indicative list of the contents of the regulations.

- **Emergency Powers**

  The Bill will contain provision that will allow the Department to take emergency action to protect people or property against an escape of water from a controlled reservoir that may cause harm. When required the Department will commission an appropriate panel engineer to make recommendations regarding actions to be taken and to supervise the required works. The Department will also notify the

reservoir manager of the actions to be taken, or actions which it has taken.

- **Stop Notices**

  The Department may make regulations to permit the serving of a stop notice on a reservoir manager. A stop notice is a notice prohibiting the carrying on of an activity, or permitting the carrying on of an activity by another until such steps as specified in the notice have been taken. The Bill will list the conditions the Department must meet before exercising its power under the regulations.

- **Powers of Entry**

  The Bill will contain provision that will allow the Department to authorise any person to enter land for the purposes of carrying out its functions under the Bill. The power to enter land will include the power to enter buildings and other structures, integral to the functioning of the reservoir, by virtue of the definition of 'land' in the Interpretation Act (Northern Ireland) 1954.

Annex G

Civil Contingencies Multi-Agency Preparedness Structures with a role in Flooding Emergencies

The Civil Contingencies Group (NI) is the principal strategic emergency preparedness group for the public sector and provides strategic leadership in relation to civil contingencies policy and strategy on cross cutting issues on a multi-agency basis.

The Group has a corporate governance function, identifying and agreeing civil contingencies priorities for action.

In addition there are five Sub-Regional Civil Emergency Preparedness Groups (EPGs). These multi-agency groups agree a joint approach to emergency preparedness and response for their respective areas.

Taken together these groups consider a wide range of civil contingencies issues including flooding.

When necessary, the EPGs will cooperate with neighboring emergency planners in the Republic of Ireland in preparing for and responding to emergencies of a cross-border nature.

Annex H

Flood Risk Management Plans – Objectives and Measures Template

Objectives	Objectives Activities		Measures	Measures Type	Measures Activities
Economic Activity	• Reduce economic damages to properties. • Reduce economic costs on business caused by the disruption to essential infrastructure and services. • Optimise economic return on Flood Risk Management investment.		**Flood Prevention**	**Keep new development outside Flood Risk Areas**.	• Try to ensure that new zonings are located outside flood risk areas. • Try to ensure that individual applications are located outside flood risk areas.
				Ensure new development within Flood Risk Areas is suitably constructed.	• In accordance with PPS 15 try to ensure that any development which is located "by exception" in flood risk areas is appropriately built with flood resistance/resilience measures. • All proposed development applications are accompanied by a Flood Risk or Drainage Assessment.
				Surface Water Management.	• Promote the application of SuDS to all new developments.
			Flood Protection	**Maintenance of the Existing Drainage and Flood Defence Network.**	• Continue to inspect and maintain designated watercourse grilles as appropriate and as funding allows. • Continue to regularly inspect the condition of all drainage and Flood Defence Assets. • Continue to implement a prioritised programme of works for the maintenance of all Drainage and Flood Defence Assets. • Continue to implement a prioritised programme of works for the maintenance of public sewers schemes.
Human Health and Social	• Reduce the risk to life. • Raise awareness of the consequences of flood risk. • Reduce risk to health and wellbeing. • Reduce the impact on people caused by the disruption to essential Infrastructure and services. • Improve recreation and public amenities.			**New Flood Alleviation Schemes**	• Continue to carry out feasibility studies to identify viable solutions. • Continue to implement a prioritised programme of works of flood defence and culvert alleviation schemes. • Continue to implement a prioritised programme of works of integrated surface water drainage schemes. • Continue to implement a prioritised programme of works to separate surface water systems from combined sewer systems.
				Catchment Based Management	• Look for opportunities to work with others through partnership arrangements.
			Flood Preparedness	**Flood Emergency Response**	• We will continue to engage with other responsible bodies on identifying local flooding hotspots and co ordination of response procedures along with Blue Light responders. • We will continue to prepare and engage with other responders on multi Agency flood emergency response plans to those areas at known flood risk, eg coastal flood response plans. • We will continue to test emergency response plans through Multi Agency 'Exercising'. • We will continue to work with Co responders in line with Flood Emergency Response "Best Practice Guidelines".

				Flood Warning and Forming suitable for NI	4 Stage Approach • Formal engagement with the Met Office in a 'partnering' approach to better inform the impact assessment of National Severe Weather Warnings for heavy rainfall. Ensuring adequate 'Informing' in relation to flood risk to enable responders and the public to be effective in dealing with flooding.Public dissemination of water level information. This includes the use of River level text warnings, where these are likely to be beneficial. • Review and Development.
Environmental (including cultural heritage)	• Consider the impact of Climate Change • Under the Water Framework Directive, support the achievement of good ecological potential/status for water bodies. • Reduce the risk of pollution. • Avoid or mitigate impact on priority species and habitats. • Avoid or mitigate impact on designated environmental areas, including those of cultural heritage importance.			**Community Engagement**	• Rivers Agency is working with the other drainage agencies, the emergency services, local government, NIHE, Red Cross, Consumer Council, Met Office, etc, to develop and establish a consistent approach to flood warning and informing activities across Northern Ireland.
				Communication of Flood Risk	• We will continue to engage with communities to facilitate the informing aspect of 'Flood Warning and Information' proposals. • We will continue to update and improve flood risk information on the Flood Maps (NI). • We will continue to improve information on flooding on the NI Direct Website. • We will continue to work with NI Direct in the development of the Flooding Incident Line (FIL). • Continue to consult and hold flood forums with stakeholders and others to make them aware of their role and responsibilities in assessing and managing flood risk. • Seek to issue timely media messages to inform the Public of significant flooding events.
				Individual Property Protection	• A proposed scheme for grant aiding Individual Property Protection is currently being progressed. Eligibility will be assessed on the likelihood of future flooding and the frequency of past flooding events. • The introduction of such a scheme would be a significant step forward and be a key 'building block' in enhancing community resilience to flooding.
				Flood Recovery, Welfare and Insurance Issues	• We will continue to carry out and contribute to post flood investigations to gather information and improve knowledge and action on future flood events. • We will continue to work with Councils and local communities at flood risk in providing advice and information to aid recovery after a flood event. • We will continue to engage and work with voluntary section organisations such as the Red Cross in providing Welfare Support. • We will continue to work with the insurance industry to assist them in introducing "FloodRe" to NI to help address long term flood insurance affordability issues.

Annex I

Flood Warning and Informing Areas for Community Engagement

	Significant Flood Risk Area	Area of focus for community engagement and Flood Warning and Informing activities
1	Belfast	Clarawood Park area
2	Belfast	Stockmans Lane
3	Belfast	Finaghy Road north area
4	Belfast	Gilnahirk Road / Kingsway Park area
5	Belfast	Greystown Avenue / Finton Gardens area
6	Newcastle	Bryansford Avenue / Shimna Road
7	Antrim	Abbeyview and Alexandra Park
8	Belfast	York Park / Pittsburg Street area
9	Belfast	Loopland Park area
10	Belfast	Montgomery Road
11	Antrim	Riverside & Masserene Street
12	Lurgan	Westwood / Sperrin Drive
13	Newry	Bridge Street / Cleary Crescent area
14	Omagh	Town Centre
15	Dundonald	Dunlady Park / Canberra Park area
16	Lurgan	Knockramer Meadows / Silverwood Leaves
17	Portadown	Park Road area
18	Ballymena	Ballymoney Road
19	Ballymena	Leighinmohr Avenue / Phoenix Fields
20	Glengormley & Mallusk	Sandholme Park / Sandyknowes Park