WARRINGTON
Borough Council

Economic Regeneration, Growth & Environment

Warrington Preliminary Flood Risk Assessment 2017-2023

Engineering & Flood Risk Management Team

Warrington Borough Council – Lead Local Flood Authority

Date: May 2017

Version: Final01

Executive Summary

This Preliminary Flood Risk Assessment has been prepared by Warrington Borough Council as Lead Local Flood Authority (LLFA) in order to meet its duty to manage local flood risk and deliver the requirements of the Flood Risk Regulations (2009) and the Flood and Water Management Act (2010).

The production of the Preliminary Flood Risk Assessment (PFRA) is a requirement of the Flood Risk Regulations (2009) and it is the first step in the management of local flood risk. The PFRA process is aimed at providing a high level overview of flood risk from local flood sources through a review of historic flooding incidents and the predicted future extents of flooding, based on the outputs of computer models from both Warrington Borough Council and the Environment Agency.

Section 17 of the Flood Risk Regulations (2009) states subsequent reviews must be carried out at intervals of no more than 6 years. This document is the first review of the original PFRA published in June 2011.

In January 2017, the Department for Environment, Food and Rural Affairs (DEFRA) and the Environment Agency (EA) replaced its guidance on significant risk for the identification of flood risk areas for Lead Local Flood Authorities (LLFAs). The new guidance updated the criteria for assessing and reviewing whether a risk of flooding is significant. The Regulations require LLFAs to determine whether any part or parts of their area face significant risk of flooding and to identify any such areas as Flood Risk Areas (FRAs).LLFAs are only required to do this in relation to local flood risks which include flooding from:

- Surface Water.
- Groundwater.
- Ordinary Watercourses.

LLFAs do not need to consider the risk of flooding from the sea, main rivers or reservoirs, except where these may affect flooding from another source. Flood hazard and risk maps and flood risk management plans must subsequently be prepared for the FRAs identified.

The purpose in reviewing the results lies with the determination of whether the level of flood risk is severe enough to be reported at both a European and National scale. DEFRA has identified that a FRA containing a cluster of over 30,000 people would be considered for significant European importance. There are no indicative FRAs located within the administrative area of Warrington Borough Council.

It is the responsibility of the LLFA to decide what it considers as a historical flood with “significant harmful consequences” at a local level. Initially there was no specific guidance determining the national flooding importance level.

Warrington Borough Council has liaised with several neighbouring LLFAs in shaping and finalising this significance level. This has led to the formation of the Cheshire Mid-Mersey Partnership with the aim to identify and resolve flooding issues at both the Tactical and Strategic levels whilst adhering to best industrial practices.

Warrington Borough Council has decided that a flood of "significant harmful consequences" would have one or more of the following characteristics:

Table A: Flood Event of Significant Harmful Consequences

Impact of flooding on:	Category	Consequence
Human Health	Number of individuals	≥ 200
Economic Activity	Number of critical services	≥ 2
	Number of residential properties	≥ 83
	Number of non-residential properties	≥ 20

Information on past flood incidents has been received from various stakeholders, both locally and nationally, which include water and sewerage companies, utility companies, the Emergency Services, and other Risk Management Authorities. There has been 1 flooding event identified from local sources that have been deemed to have "significant consequences".

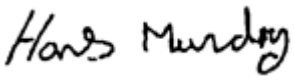
An analysis of data available on future flood risk has found that there could be flooding with adverse consequences as a result of surface water flooding. Modelling outputs provided by the Environment Agency indicate that up to 1032 properties (890 residential, 117 business, 25 critical services), could be at risk from surface water flooding in a 1% (1 in 100) annual probability rainfall event.

To progress Warrington Borough Council's approach to flood risk management, including ongoing work post-PFRA submission, it will be designed to meet its objectives under the Flood Risk Regulations (2009) and the Flood and Water Management Act (2010) to:

- Continue to develop links with adjacent LLFAs and other bodies responsible for flood risk management;
- Utilise data collected to maintain a manageable GIS database, controlled centrally, for use on future development control queries, investigation, planning etc.;
- Provide assessments to identify the flood risk management prioritisations over the entire administrative area;
- Update the current Local Flood Risk Management Strategy;
- Continually update the Asset Register;
- Record, document and (where appropriate) investigate future floods.
- Require developers to give priority attention to the use Sustainable Urban Drainage Systems (SuDS), unless demonstrated to be inappropriate.

Revision Schedule: Preliminary Flood Risk Assessment

	Originator:	Checked by:	Reviewed by:	Approved by:
Revision	**Name** Jonathan Dawson-Parry	**Name** Jim W Turton	**Name** Jim W Turton	**Name** Jim W Turton
Date **February 2017** **DRAFT01**	**Signature** 	**Signature** 	**Signature** 	**Signature** 
	Position Asset & Flood Risk Engineer	**Position** Engineering & Flood Risk Manager	**Position** Engineering & Flood Risk Manager	**Position** Engineering & Flood Risk Manager
Document Status: DRAFT01 – Issued to Environment Agency / United Utilities for review in accordance with the Flood Risk Regulations 2009.				

Revision	**Name** Jonathan Dawson-Parry	**Name** Jim W Turton	**Name** Jim W Turton	**Name** Cllr Hans Mundry
Date **May 2017** **Final01**	**Signature** 	**Signature** 	**Signature** 	**Signature** 
	Position Asset & Flood Risk Engineer	**Position** Engineering & Flood Risk Manager	**Position** Engineering & Flood Risk Manager	**Position** Portfolio Holder Highways, Transportation & Public Realm
Document Status:				

Warrington Borough Council
Economic Regeneration, Growth & Environment
New Town House
Buttermarket Street
Warrington
WA1 2NH
Tel: 01925 44 33 22
Fax: 01925 44 32 55
www.warrington.gov.uk

Document Information

Disclaimer

Although every effort has been taken to ensure the accuracy of the information contained within the pages of this report, we can't guarantee that the contents will always be current, accurate or complete.

This report has been prepared as part of Council's responsibilities under the Flood Risk Regulations (2009) and Flood and Water Management Act 2010 as Lead Local Flood Authority (LLFA).

The findings of this report are based on a subjective assessment of the information available and therefore may not include all relevant information. Therefore it shouldn't be considered as a definitive assessment of all factors.

The opinions, conclusions and any recommendations in this report are based on our assumptions when preparing this report, including, but not limited to those key assumptions noted in the reports, including reliance on information provided by third parties.

The Council expressly disclaims responsibility for any error in, or omission from, this report arising from or in connection with any of the assumptions made being incorrect. The opinions, conclusions and any recommendations in these reports are based on conditions encountered and information reviewed at the time of preparation and the Council expressly disclaims responsibility for any error in, or omission from, this report arising from or in connection with those opinions, conclusions and any recommendations.

The Council forbids the reproduction of this report or its contents by any third party without prior agreement.

Control & Distribution

This document is owned, maintained, and updated by the Engineering & Flood Risk Team, Warrington Borough Council.

All users are asked to advise the Engineering & Flood Risk Team of any changes in circumstances or information that may materially affect this document.

Information should be sent to:

Mr Jim Turton MBA I.Eng MICE MCIHT
Engineering & Flood Risk Manager
Warrington Borough Council
New Town House 3F
Buttermarket Street
Warrington
WA1 2NH

Tel: 01925 44 2542

E-mail: floodrisk@warrington.gov.uk

Environment Agency (Self-Assessment Form – January 2017)

The Environment Agency have produced and written a Self-Assessment Form (January 2017) and associated guidance for the LLFA with options for its delivery for the 2nd Edition Review. Warrington Borough Council has rewritten the PFRA and is not adding an amendment to the existing PFRA (2011). To adhere to the requirements the following table is produced as a checklist.

PFRA report section			Activity for PFRA/FRA review	Response
1	Governance and partnership	1.1	Since publication of the PFRA in 2011, have there been any changes to, or creation of new, risk management authorities (RMAs) with responsibilities in the LLFA area?	New FWMA Schedule Enactment
		1.2	Are all roles and responsibilities for collecting and recording flood risk data and information clearly defined, including the respective roles and responsibilities of upper and lower tier authorities and other RMAs where relevant?	
2	Data systems and management	2.1	Do you have an up to date record of relevant sources of flood risk data and information for the LLFA area, including those held by other organisations?	EA modelling data has been revised and utilised since June 2011. Asset Register in place since June 2011. With Flood Contractor Framework being renewed in April 2017.
		2.2	Have sources of 'locally agreed surface water information' been established and maintained for the LLFA area and agreed with relevant partners?	
		2.3	Are systems in place to collect, record and share data and information for the purpose of assessing flood risk in the LLFA area?	
		2.4	Are systems in place to assure the quality and security of data and information recorded for the purpose of assessing flood risk in the LLFA area?	
		2.5	Do you understand the condition and performance of the public, third party and private assets in your register in terms of flood risk?	
3	Past floods since Dec 2011 only) required for reporting to the European Commission	3.1	Have any flood events occurred since publication of the original PFRA report in December 2011 that have added to or changed your understanding of significant flood risk in the LLFA area? See the guidance document on which floods to report.	Updated records from storm events since the June 2011 Release.
		3.2	Has your current understanding of significant flood risk in the LLFA area changed as a result of the consequences of floods that have occurred since 2011? How?	

PFRA report section			Activity for PFRA/FRA review	Response
4	Future flood information Information on future floods is required for reporting to the European Commission	4.1	Have you created or received new information on potential future floods that has added to or changed your understanding of significant flood risk in the LLFA area since publication of your original PFRA report in 2011?	EA modelling data has been revised and utilised since June 2011. Ongoing investigations and data gathering from storm events and FWMA section 19s.
		4.2	Have you created or received new information to improve the understanding of the future impact of climate change on flood risk in the LLFA area?	
		4.3	Have you created or received new information on long term developments to improve your understanding of flood risk in the LLFA area?	
		4.4	Has your understanding of flood risk in the LLFA area changed since 2011 as a result of new information on the potential consequences of future floods, the impact of climate change or long term developments? How?	
5	Identification of Flood Risk Areas for 2nd planning cycle Identified FRAs are required for reporting to the European Commission	5.1	Are the indicative FRAs an appropriate representation of significant surface water flood risk in your LLFA area?	Information within the PFRA 2017-23
		5.2	Do the consequences of flooding from other local sources, i.e. groundwater or ordinary watercourses, or from combined multiple sources, indicate any other areas of significant risk?	
		5.3	Has your PFRA review identified any other information which indicates other areas of significant risk?	
		5.4	On the basis of the national evidence provided and your review, do you agree with the indicative FRAs for your area?	
		5.5	On the basis of local evidence and your review, are you amending or identifying any additional FRAs for your area?	
6	Updating the original preliminary assessment	6.1	Have you completed an addendum to update your preliminary assessment report? Updates are required for reporting to the European Commission	Information within the PFRA 2017-23

Contents

List of Tables

Abbreviations & Definitions

Abbreviation list

AOD	Above Ordinance Datum
AStSWF	Areas Susceptible to Surface Water Flooding
AStGwF	Areas Susceptible to Groundwater Flooding
BGS	British Geological Survey
BUA	Built-up Areas
BUASD	Built-up Areas Sub-divisions
CFMP	Catchment Flood Management Plan
COW	Critical Ordinary Watercourse
DEFRA	Department for Environment, Food and Rural Affairs
EA	Environment Agency
EC	European Commission
EU	European Union
FWMA	Flood and Water Management Act 2010
FRA	Flood Risk Area
GIS	Geographical Information Systems
IPCC	Intergovernmental Panel on Climate Change
LDF	Local Development Framework
LGF	Local Government Forum
LLFA	Lead Local Flood Authority
LoSA	Level of Service Agreements
LPA	Local Planning Authority
LRF	Local Resilience Forum
MoU	Memorandums of Understanding
NRD	National Receptor Database
NRD:	National Receptor Dataset
OEFRPG	Operational Emergency Flood Response Plan Groups
OFWAT	Water Services Regulation Authority
OS	Ordinance Survey
PFRA	Preliminary Flood Risk Assessment
RBD	River Basin District
RFCC	Regional Flood and Coastal Committee
RoFSW	Risk of Flooding from Surface Water
SAB	SuDS Approving Body
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Urban Drainage Systems
SWMP	Surface Water Management Plan
UKCP09	United Kingdom Climate Projections 2009
uFMfSW	Updated Flood Map for Surface Water
UU	United Utilities
WBC	Warrington Borough Council

Definitions

Catchment	The area contributing surface water flow to a point on a drainage or river system. Can be divided into sub-catchments.
Discharge	The discharge of a river is the volume of water, which flows through it in a given time. It is usually measured in cubic meters per second (m^3/s). The volume of the discharge will be determined by factors such as climate, vegetation, soil type, drainage basin relief and the activities of man.
Flood	A temporary rise of the water level, as in a river or lake or along a seacoast, resulting in its spilling over and out of its natural or artificial confines onto land that is normally dry. Floods are usually caused by excessive runoff from precipitation or snowmelt, or by coastal storm surges or other tidal phenomena.
Return Period	Also known as a recurrence interval is an estimate of the interval of time between events, in the instance of a 1 in 200 year storm the propability is 0.005%, however it does not mean that it will occur once, multiple instances of the same event can occur in each year.
SuDS	Sustainable drainage systems or sustainable (urban) drainage systems: a sequence of management practices and control structures designed to drain surface water in a more sustainable fashion than some conventional techniques (may also be referred to as SuDS).
Significant	Defined threshold of flooding consequence.
Consequence	A condition or occurrence traceable to a cause e.g. the flood was an inevitable consequence of the prolonged, heavy rains.

1 Introduction

1.1 Background

Following extensive flooding across the United Kingdom in 2007, Sir Michael Pitt on behalf of the UK Government undertook a comprehensive review of the lessons to be learned from the floods and made a series of recommendations. The Pitt Review (2008) was the catalyst for Local Authorities and partner agencies to become more responsible for flood risk with many of the recommendations incorporated into the Flood and Water Management Act 2010 (FWMA 2010).

The FWMA 2010 identified a number of responsibilities, powers and duties to be executed in phases to help manage flood risk in a more holistic way. The FWMA 2010 defines a lead role for local authorities and designated Warrington Borough Council a Lead Local Flood Authority (LLFA) responsible for the management of local sources of flooding such as surface water. An overview of these duties is provided in Section 3. The Environment Agency retained its role in managing flood risk from main rivers and coastal sources.

Alongside the Act, the EC Floods Directive (Directive 2007/60/EC) on the assessment and management of flood risk was transposed into domestic law in England and Wales under the European Communities Act 1972 via the Flood Risk Regulations 2009 (FRR 2009).

The purpose of the EC Floods Directive is to establish a framework for assessing and managing flood risk across the European Community.

Warrington Borough Council as a “Lead Local Flood Authority” (LLFA) has a duty to prepare a Preliminary Flood Risk Assessment (PFRA) in accordance with Part 2 of the FRR 2009 which sets out the requirements.

Warrington Borough Council published its original PFRA in June 2011 and subsequent reviews must be carried out at intervals of no more than 6 years. This document is the first revision of the original PFRA.

The PFRA (and any subsequent maps and plans) form part of the local flood risk management strategy that Warrington Borough Council is required to prepare under the FWMA 2010.

1.2 Preliminary Flood Risk Assessments (PFRA)

The PFRA is a high level screening exercise to identify areas in which the risk of local flooding is significant and warrants further examination through the production of maps and management plans.

The Flood Risk Regulations (2009) provide a framework for managing flood risk over a 6 year cycle, comprising:

1. **Production of a Preliminary Flood Risk Assessment report;**
2. **Identification of Flood Risk Areas;**
3. **Production of appropriate Flood Hazard and Flood Risk Maps and,**
4. **Preparing Flood Risk Management Plans.**

This report marks the first of the four stage process. The outcome of the review is to provide evidence for the identification of Flood Risk Areas (Stage 2). The PFRA makes use of existing and available data, and focuses on local flood risk sources.

The identification of FRAs will establish whether or not the final two stages of preparing hazard and risk maps and flood risk management plans are required for the administrative area.

Local sources of flood risk for the purposes of the PFRA are:

- **Groundwater** - Water that flows out from the ground due to high water tables locally or regionally;
- **Ordinary Watercourses** - Out of channel flows from small watercourses such as streams, brooks and drainage ditches that are not regarded to be main river by the Environment Agency;
- **Surface runoff** - Water that flows over land following a heavy rainfall event, before it enters a natural watercourse or an artificial drainage network.

The Manchester Ship Canal is deemed a "principle watercourse" although privately owned and managed and not technically a main river. Flood risk management issues are currently being led via the Environment Agency (EA) due to the size and extent of the canal. Therefore this watercourse is not considered a local issue and is not currently considered by Warrington Borough Council or the EA to be a local flood risk management issue for the purposes of the PFRA.

Table 1 indicates the work required to meet the requirements of the FFR. This PFRA aims to meet the first two requirements.

Table 1: Elements of Work required under the Flood Risk Regulations, 2009.

Timescale for first edition	Assessment or Plan	Description	Timescale for first review / revision
22nd June 2011	Prepare Preliminary Flood Risk Assessment Report	The PFRA should focus on local flood risk arising from surface water, groundwater, Ordinary Watercourses, and canals.	22nd June 2017
22nd June 2011	On the basis of the PFRA, identify Indicative FRAs	Indicative Flood Risk Areas are a defined term, and are areas of nationally significant risk affecting 30,000 people or more. The PFRA is also required to record "locally significant risk areas" which are flood areas, above a locally determined threshold of affected people, and having significant harmful consequences.	22nd June 2017
22nd June 2013	Prepare Flood Hazard Maps and Flood Risk Maps for each FRA	The hazard and risk maps will show the likely extent, depth, direction, speed of flow and probability of possible floods and their consequences.	22nd June 2019
22nd June 2015	Prepare Flood Risk Management Plans for each FRA	The Flood Risk Management Plans will set out what the risk management objectives are, the measures proposed to achieve those objectives and how the measures are to be implemented.	22nd June 2021

1.3 UK Exit from European Union

Depending on the approach taken to EU exit, there may be potential to make changes to the FRR in the coming years. EU exit does not, however, alter the requirement for LLFAs to review preliminary assessment reports and FRAs by 22nd June 2017 as the UK will still be a full member of the EU at that point. Any proposals to refine the approach to mapping flood hazard and risk or preparing FRMPs will be consulted on later in the cycle.

2 Aims and Objectives of the PFRA

2.1 Aims

The primary aim of this PFRA is to review historical flood events and provide an assessment of potential local flood risk by applying a high level screening exercise across the administrative area of Warrington Borough Council; hereby referred to as the study area.

The PFRA review is an opportunity to not only review flood risk across the Borough but to ensure governance arrangements, partnership working arrangements and information sharing arrangements with adjacent LLFA areas and other Risk Management Authorities are fit for purpose.

The risk of local flooding is defined as significant by European Standards for the PFRA if the flooding is affecting a cluster of more than 30,000 people. These local flooding risks are grouped in areas and are deemed Indicative FRAs. If these areas are found to exist within the Local Authority Boundary then they may warrant further examination at a later stage through the production of Flood Risk and Hazard maps and Flood Management plans.

2.2 Objectives

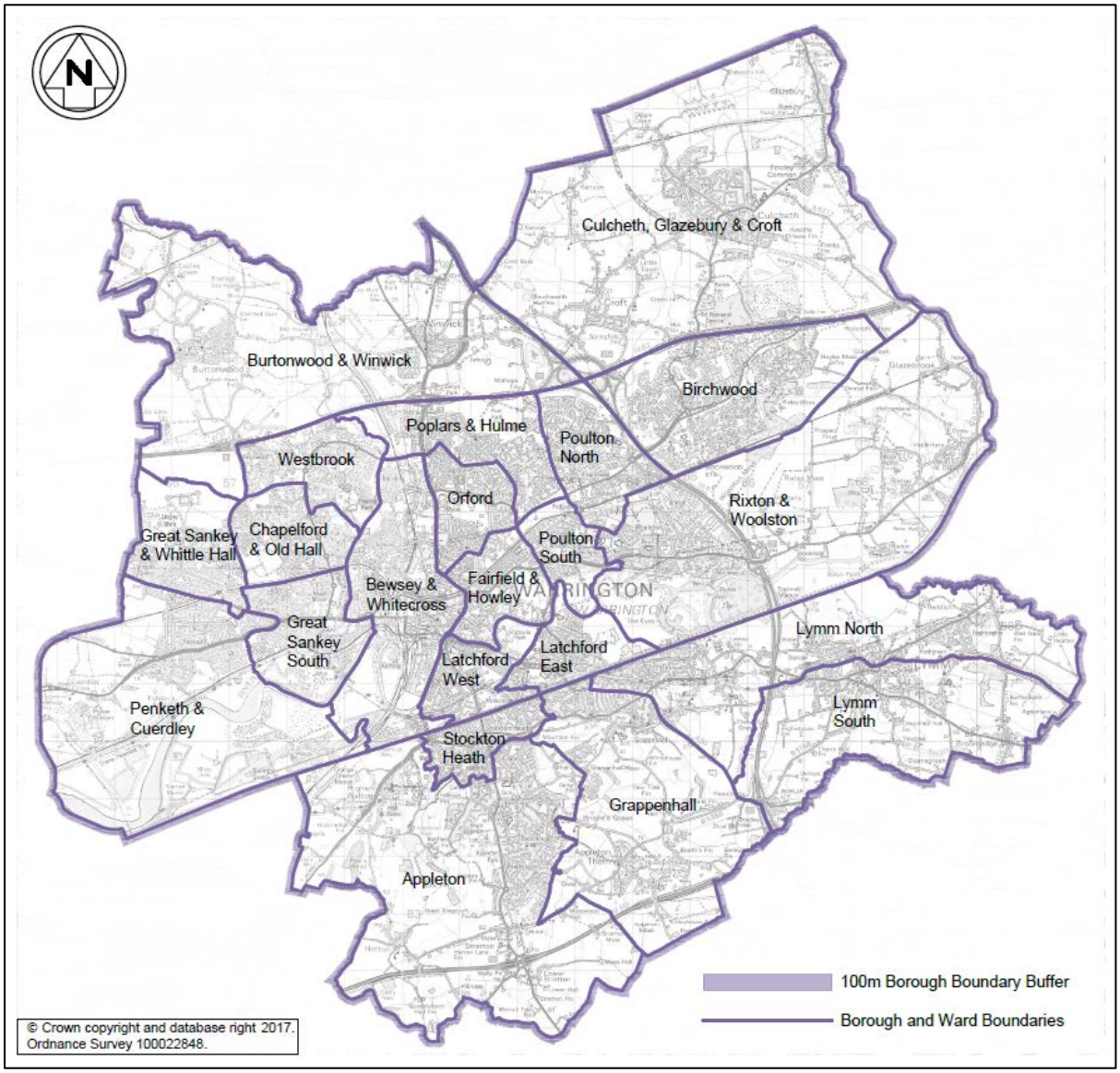
The objectives of this PFRA are to:

- Identify relevant partner organisations involved in future assessment of flood risk and summarise the means of future and ongoing stakeholder engagement.
- Describe arrangements for partnership and collaboration for ongoing collection, assessment and storage of flood risk data and information.
- Provide a summary of the systems used for data sharing and storing including provisions for quality assurance, security and data licensing arrangements.
- Summarise the methodology adopted for the PFRA with respect to data sources, availability and review procedures.
- Assess historic flood events within the study area from local sources of flooding (including flooding from surface water, groundwater and Ordinary Watercourses) and where possible, the consequences and impacts of these events.
- Establish an evidence base of historic flood risk information which will be built upon in the future and will support and inform the Warrington Borough Council Local Flood Risk Strategy.
- Assess the potential harmful consequences of future flood events within the study area.
- Review the provisional national assessment of indicative FRAs provided by the Environment Agency and provide an explanation and justification for any amendments required to the FRAs.

2.3 Warrington's Study Area

The study area for Warrington Borough Council's PFRA is the administrative boundary of the Borough. The PFRA study area is shown in Figure 1 of Appendix A and below.

Figure 1: Study Area (Warrington Borough Council Administrative Area)



Warrington Borough is the most northerly of the local authorities in the Cheshire area. It shares boundaries with Halton, Cheshire West and Chester, Cheshire East, and the four metropolitan boroughs of St Helens, Wigan, Salford and Trafford.

The Borough of Warrington covers some 176km² (68mi^2) and is situated in the North West of England between Manchester and Liverpool. At mid-2010, it had an estimated population of 198,900.

The town of Warrington, which is by far the largest settlement in the Borough, owes its existence to the presence of a crossing point across the River Mersey, the importance of which can be traced back as far as pre-roman times.

In 1968 Warrington was designated as a New Town, primarily to take economic advantage of its unique position at the hub of the region's communication network, evidently aided by the arrival of the regions motorways. The Warrington New Town Outline Plan, approved in 1973, set out a strategy to expand the town's population from about 120,000 to 200,000 by the year 2000. Whilst

the planned rate of growth was not fully achieved, the town physically expanded further outwards, the population grew significantly and the growth that took place has markedly changed the status, profile and character of the town. As a result Warrington has evolved from being a medium-sized industrial town to the home of major national and international companies, attracting working people from across the region. Since the end of the New Town era, strategic planning policies sought to arrest outward growth of the Town partly through recognition that it was nearing its natural limits to expansion and partly through recognition that the New Town development had remarkably little effect on the older urban areas of Inner Warrington.

Warrington lies at the hub of the region's communications network. The M6, M56 and M62 motorways intersect within the borough, providing good access to all parts of the region and beyond. Warrington also situated on the regions main North-South (West Coast Main Line) and East-West (Trans-Pennine) rail routes. The Borough is also traversed by the Manchester Ship Canal, an important commercial waterway linking the Port of Manchester with the River Mersey. Manchester International and Liverpool John Lennon Airports both lie within easy reach. Warrington's excellent connectivity is not solely confined to conventional transport routes. Green corridors such as the strategically important River Mersey, Trans Pennine Trail and regionally significant Bridgewater Canal act to highlight the potential of the Borough's greenway network in fulfilling active travel objectives. This connectivity has enabled the Borough to develop a strong and resilient economy with the town constituting a significant centre of employment in the North West, and being widely recognised as a key driver and contributor to the North West's economy.

The Borough has extensive areas of high-grade agricultural land, a varied landscape character and important areas of nature conservation value, mostly within the relatively narrow gaps of open land separating Warrington from urban areas to the west, north and east. The area is generally flat and below 20mAOD with low-lying land within the Mersey floodplain.

The average annual rainfall in the WBC area is approximately 600mm which is reasonably distributed throughout the year with an average low of 40mm in May and an average peak of 69mm in October.

Two significant waterways cross the main urban area; the River Mersey which passes close to the town centre and further south, the Manchester Ship Canal. Various small urban watercourses drain to the River Mersey in a roughly north south direction.

The River Mersey is tidal with the normal tidal limit being at Howley weir in the centre of the town of Warrington. The Manchester Ship Canal runs through Warrington having split from the River Mersey at Bollin Point. Upstream from Warrington the Manchester Ship Canal receives flows from the River Mersey at Irlam and the Rivers Irwell, Irk and Medlock in Manchester. The total catchment area draining into the Manchester Ship Canal upstream of Bollin Point covers an area of approximately 1,965 km2.

There are three canals operated by subsidiary companies on behalf of Peel Ports Group within Warrington, they are:

- Bridgewater Canal operated by the Bridgewater Canal Company Ltd,
- Manchester Ship Canal operated by Manchester Ship Canal Company Ltd,
- New Cut Canal operated by Manchester Ship Canal Company Ltd.

Warrington Borough Council owns and maintains parts of the St Helens Canal within the Warrington Borough Council boundary.

The water company that serves the administrative area is United Utilities.

3 Lead Local Flood Authority Responsibilities

3.1 Introduction

The preparation of a PFRA is just one of several responsibilities of LLFAs under the FRR 2009 and FWMA 2010. This section provides an overview of other responsibilities that Warrington Borough Council is obliged to fulfil under its role as a LLFA.

Table 2: Flood Risk Responsibilities

Level of Flood Risk	Organisation	Responsibilities
National Flood Risk	Environment Agency	Responsible for Main Rivers, the Sea and Reservoirs
Local Flood Risk	Lead Local Flood Authority	Responsible for Canals (where not in private ownership), Groundwater, Ordinary Watercourses, and Surface runoff. Note for Canals – Peel Ports Group and the Rivers and Canals Trust do not have any specific statutory responsibilities (under FWMA 2010) in relation to flooding and, therefore, their responsibilities are those of an owner and operator of canals and other waterways.
Local Flood Risk	Water Company (i.e. United Utilities)	Responsible for sewers except where it is wholly or partly caused by rainwater entering the system. Floods or raw sewage caused by blocking of a sewer for example are not covered by the regulations, neither is flooding from burst water mains.

3.2 Coordination of Flood Risk Management

In his Review of the Summer 2007 flooding, Sir Michael Pitt stated that "the role of Local Authorities should be enhanced so that they take on responsibility for leading the coordination of flood risk management in their areas". As the designated LLFA, Warrington Borough Council is therefore responsible for leading local flood risk management across the area.

Local knowledge and technical expertise necessary for Warrington Borough Council to fulfil its duties as a LLFA lies with the Council and other partner organisations. It is therefore crucial that the Council works alongside these partners as they undertake their responsibilities to ensure effective and consistent management of local flood risk. Since the first publication of the PFRA in June 2011, a number of partnerships and working groups have been established across different organisations.

3.2.1 Stakeholder Engagement

As part of the PFRA, Warrington Borough Council has sought to engage stakeholders representing the following organisations and authorities:

- United Utilities;
- Environment Agency;
- Local Fire and Rescue Service;
- Local Police Service.
- Peel Ports Group (Including Manchester Ship Canal Company & Bridgewater Canal Company)

Data has also been collated internally within the Council.

It is crucial that the Council continues to forge successful partnerships with the Environment Agency, United Utilities and other important key stakeholders including Peel Ports Group to ensure effective coordination and management of flood risk across the area.

3.2.2 Other Lead Local Flood Authority (LLFA) Engagement

Due to the study area being situated within the River Mersey catchment, the Council is in consultation with neighbouring Local Authorities.

Warrington Borough Council is part of a sub-regional LLFA working group formed in 2010; the Cheshire and Mid-Mersey Flood Partnership. The partnership operates at operational, tactical and strategic levels.

The Risk Management Authorities (RMAs) of the Partnership are:

- Warrington Borough Council – Partnership Lead;
- Cheshire East Council;
- Cheshire West and Chester Council;
- Halton Borough Council;
- St Helens Borough Council;
- Staffordshire County Council;
- Environment Agency;
- United Utilities.

The Partnership has a critical role to play in managing the risk of flooding from all sources and in working with communities to help them become more resilient. It provides a forum to enable RMAs, other partners and communities, to identify how they can work together to deliver an improved and more effective and efficient flood risk management service.

The Operational Group

Engineers from Warrington Borough Council, United Utilities and Environment Agency meet on a quarterly basis or as required if flood events occur to discuss issues and scheme delivery. The Operational Level is where day-to-day Flood Risk Management activities take place.

The Tactical Group

Technical and operational leads/managers meet on a monthly basis to coordinate delivery, share skills and implement decisions made at the Strategic level. The Tactical Group is chaired by Warrington Borough Council and reports directly to the Strategic Group who are responsible for setting the overall strategic direction of the partnership.

The Strategic Group

Elected Members and senior representatives from the RMAs meet each quarter. The meetings are timed to coincide with the financial planning cycle of the Regional Flood & Coastal Committee (RFCC) The Strategic Group sets the direction for joint working and the management of flood risk across the Partnership.

Regional Flood & Coastal Committee (RFCC)

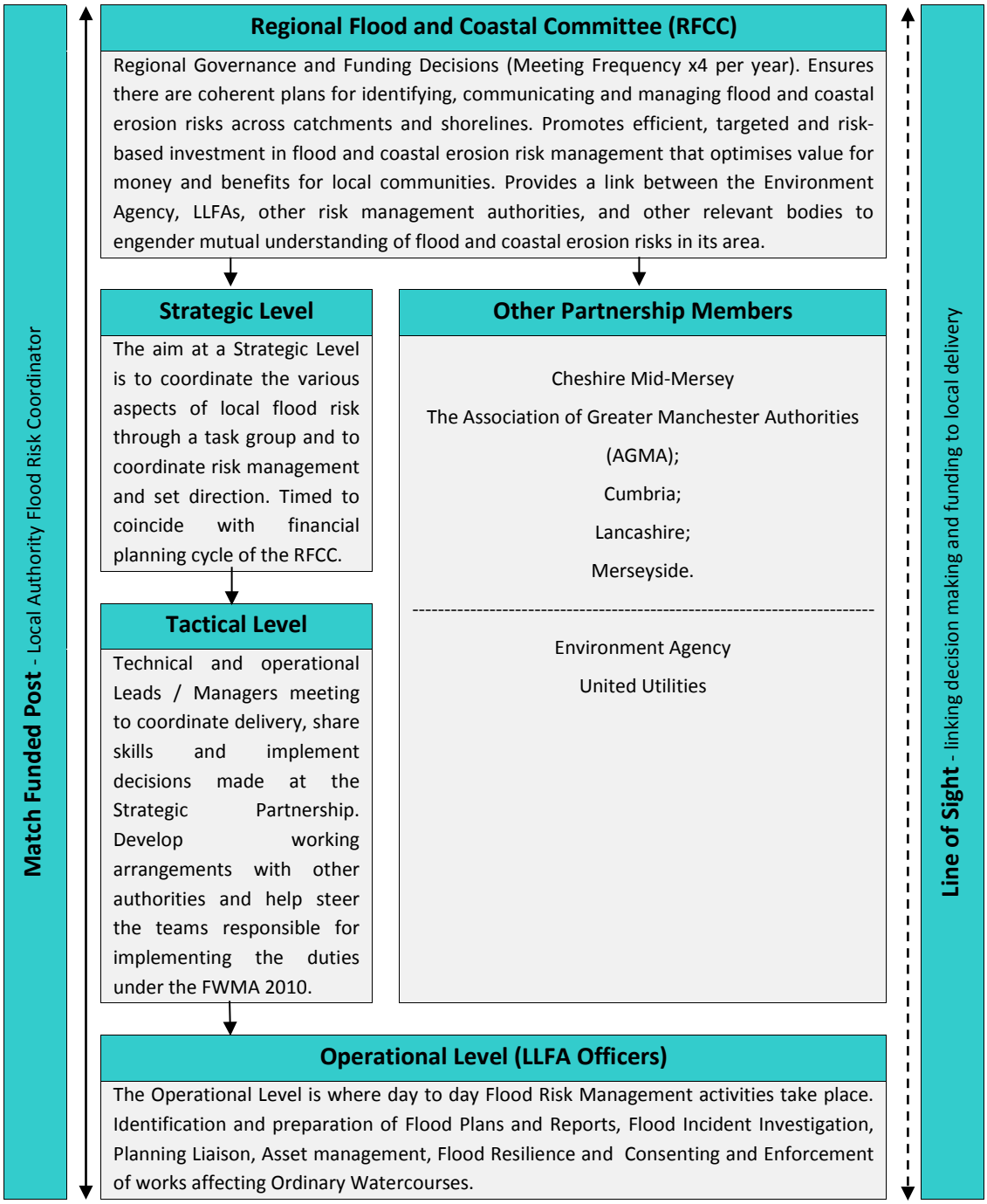
The RFCC for the North West region provides a local democratic role in the management of flood and coastal erosion risk in order to ensure the purposeful and efficient spending of public money and other resources.

The RFCC works across LLFAs, the Environment Agency and other RMAs to develop a mutual understanding of risk across its locality, and use this understanding to help develop plans to manage risk reflecting DEFRA's aims for flood and coastal erosion risk management. RFCC meetings are held each quarter, although there may be additional meetings at a sub-group level where local authorities are working together.

The RFCC provides a platform for frequent knowledge transfer with all Partnerships situated in the North West region. These are;

- Cheshire Mid-Mersey
- The Association of Greater Manchester Authorities (AGMA);
- Cumbria;
- Lancashire;
- Merseyside.

Figure 2: Cheshire Mid-Mersey Flood and Coastal Erosion Risk Management Partnership Structure

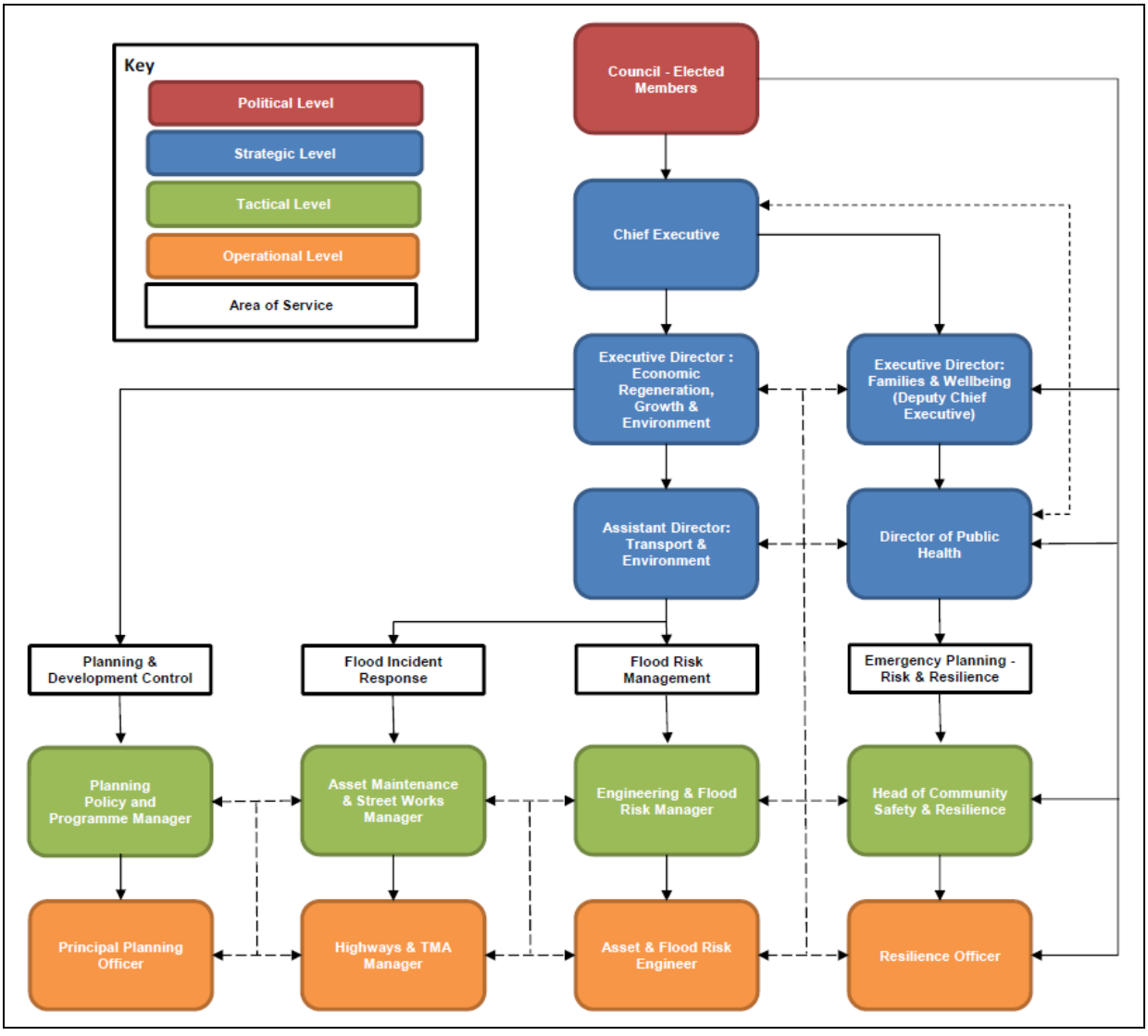


3.2.3 Public Engagement

It is recognised that members of the public may also have valuable information to contribute to local flood risk management. The Environment Agency's 'Building Trust with Communities' (2005) document provides the basis of how to communicate risk including the causes, probability and consequences to the general public and professional forums such as local resilience. The FRR 2009 and FWMA 2010 accelerated the need for Councils to increase public engagement. This has brought significant benefits to local flood risk management including building trust, gaining access to additional local knowledge and increasing the chances of stakeholder acceptance of options and decisions proposed in future flood risk management plans.

3.3 Governance of Flood Risk Management within Warrington Borough Council

Figure 3: Governance of Flood Risk Management within Warrington Borough Council



3.4 Further Responsibilities

In addition to improving partnership relations, coordinating, and leading on local flood management there are a number of other key responsibilities that have arisen for LLFAs since the introduction of the FRR 2009 and FWMA 2010. These responsibilities include:

- **Investigating flood incidents (S19, FWMA 2010)** – LLFAs have a duty to investigate and record details of significant flood events within their area. This duty includes identifying which authorities have flood risk management functions and what they have done or intend to do with respect to the incident, notifying risk management authorities where necessary and publishing the results of any investigations carried out.
- **Asset Register (S21, FWMA 2010)** – LLFAs have a duty to maintain a register of structures or features which, in the opinion of the authority, are likely to have a significant effect on a flood risk in its area, and a record of information about each of those structures or features, including information about ownership and state of repair. The register must be available for inspection.
- **Statutory Planning Consultee** – In December 2014, the Government announced changes to the planning system that required developers to prioritise the use of SuDS where technically feasible and economically viable. LLFAs became statutory consultees for major development proposals from April 2015. These changes are set out in Paragraph 103 of the National Planning Policy Framework (NPPF) and are supported by DEFRA's Non-Statutory Technical Standards for SuDS.
- **Local Strategy for Flood Risk Management (S9, FWMA 2010)** – LLFAs are required to develop, maintain, apply and monitor a local strategy for flood risk management in its area. The local strategy will build upon information such as national risk assessments and will use consistent risk based approaches across different local authority areas and catchments.
- **Works powers (Amendment to Land Drainage Act 1991: S14)** – LLFAs have powers to undertake works to manage flood risk from surface runoff and groundwater, consistent with the local flood risk management strategy for the area.
- **Designation powers (Schedule 1 & S30, FWMA 2010)** – LLFAs and the Environment Agency have powers to designate structures and features that affect flooding or coastal erosion in order to safeguard assets that are relied upon for flood or coastal erosion risk management.
- **Duty to Cooperate and Share information** – LLFAs, as well as other Flood Authorities (Environment Agency, Water Company, other LLFAs) have a duty to cooperate with each other, and also the power to request information, in connection with flooding, of any person or body.
- **Consenting changes to Ordinary Watercourses (Amendment to Land Drainage Act 1991: S23, S24 and S25)** – 'Regulation' is the management of activities undertaken on watercourses. It involves granting consent for acceptable work to be carried out and taking enforcement action if work is unacceptable. If riparian owners wish to build a culvert/structure or make any alteration likely to affect the flow of an ordinary watercourse, land drainage consent is required from the Council as an LLFA.

Warrington Borough Council has fully complied with the aforementioned responsibilities since the first publication of the PFRA and will continue to strengthen these for the period 2017 – 2023.

4 Methodology and Data Review

4.1 Introduction

The PFRA is a high-level screening exercise used to identify areas where the risk of flooding is considered to be significant and warrants further examination and management through the production of flood risk and flood hazard maps and flood risk management plans.

In January 2017, DEFRA replaced its guidance on 'significant risk' for the identification of FRAs for LLFAs. The guidance updated the criteria for assessing and reviewing whether a risk of flooding is significant. This replaced the previous guidance published in 2010 (updated March 2011).

The PFRA involves:

- Collecting information on past (historic) and future (potential) floods.
- Assembling the information into a preliminary assessment report.
- Identifying FRAs.

4.2 Methodology

The following phased process has been undertaken in order to produce this report:

Table 3: Report Phases

Phase	Description
1	• Key partnership liaison - internal and external data collection • Stakeholder partnership meetings
2	• Review and analysis of historic flood risk data • Review and analysis of future flood risk data • GIS mapping of data • Draft report writing
3	• Review of indicative FRAs • GIS mapping • Draft report writing
4	• Internal draft report review from EA and internal Council staff • Council approval • Draft PFRA submitted to EA by 22nd June 2017

4.3 Phase 1 – Data Collection

4.3.1 Partner Organisations

The following authorities and organisations that were identified and contacted to share data for the preparation of the PFRA include:

- United Utilities;
- Environment Agency;
- Emergency Services.
- Cheshire Fire and Rescue Service

4.3.2 Critical Services

For the purpose of the PFRA, critical services are defined by the EA as:

- Schools;
- Police Stations / Prisons;
- Nursing / Care / Retirement Homes;
- Fire Stations / Ambulance Stations / Hospitals;
- Electricity Installations / Sewage Treatment Works.

4.3.3 Data Collection

Table 5 catalogues the relevant information and datasets received from partner organisations and provides a description of each of the datasets that were obtained by Warrington Borough Council.

The data is geo-referenced where possible. This has made it possible to display this information using GIS software and overlay layers to identify the spatial distribution of historic flood events and relate these datasets to receptor information, in order to assess the overall flood risk.

The majority of the data has been specifically provided for this PFRA study and is not publicly available due to data protection requirements, therefore there are restrictions on data use. Warrington Borough Council must adhere to these data security measures. All data collected is stored on secured local servers, which are password protected. Table 4 illustrates the restrictions on the use of this data.

Table 4: Summary of data restrictions and licensing details

Organisation	Restrictions on Use of Data
United Utilities	The use of provided data is restricted to Warrington Borough Council and their partners for the preparation of its preliminary flood risk assessment
Environment Agency	The use of some data is restricted to Warrington Borough Council for the preparation of its preliminary flood risk assessment. The use of other data is unrestricted.

Table 5: Relevant Information and Datasets Description

Owner	Dataset	Description	Confidence Rating
Environment Agency	Risk of Flooding from Surface Water (RoFSW)	Published 2013 national surface flood map supersedes: • Areas Susceptible to Surface Water Flooding maps (2008) • Updated Flood Map for Surface Water (2010) Dataset provides banding for High, Medium and Low risk to depth and velocity. Dataset is updated annually.	2
	Flood Map (Rivers & Sea)	Shows the extent of flooding from rivers with a catchment of more than 3km^2 and from the sea.	2
	Areas Susceptible to Groundwater Flooding (AStGF)	1 kilometre square grid that identifies at a broad scale areas susceptible to flooding from groundwater on the basis of geological and hydrogeological conditions.	3
	National Receptor Database (NRD)	A national dataset of social, economic, environment and cultural receptors including residential properties, school, hospitals, transport infrastructure and electricity substations.	2
	Indicative Flood Risk Areas	Nationally identified flood risk areas, based on the definition of 'significant' flood risk described by DEFRA.	2
	Historic Flood Map (HFM)	GIS layer showing the maximum extent of all individual Recorded Flood Outlines from river, the sea and groundwater springs and shows areas of land that have previously been subject to flooding	3

Owner	Dataset	Description	Confidence Rating
	Mersey Estuary Catchment Flood Management Plan (CFMP)	CFMP's consider all types of inland current and future flooding, from rivers, groundwater, surface water and tidal flooding and are used to plan and agree the most effective way to manage flood risk in the future.	2
	LiDAR Data	Topographic Information held for Warrington is generally high resolution data.	1
	Rain Gauge Information	2no. Gauge information available at selected sites across Warrington – available on request	2
	Telemetry	EA operates telemetry system across Warrington, watercourse level and flow information collected. – available on request	1
Warrington Borough Council	Anecdotal information	Anecdotal information: flood risk, flood history and local flood hotspots.	4
	Area Flood Risk Studies	Flood Risk Studies commissioned by the Council for: • Grappenhall • Longford / Orford • Croft • Culcheth • Burtonwood	2
	CMM Partnership Ordinary Watercourse Critical Asset Identification & Condition Survey	Outputs from partnership work consist of: • Identification of critical assets • CCTV survey of identified culverts • Flood modelling • Ordinary Watercourse Condition data	2
	Warrington Flood Risk Asset Inspection Project	Borough wide asset inspection works undertaken by Consultant on behalf of WBC & Blockage Sensitivity Testing.	2
	Strategic Flood Risk Assessment Level 1	The Stage 1 SFRA focuses on collecting information regarding all sources of flooding. This helps to identify the spatial distribution of flood risk sources.	3
	Strategic Flood Risk Assessment Level 2	The Stage 2 SFRA focuses on the details nature of flood hazard taking into account the presence of flood risk management measures such as flood defences and the location of key development and regeneration areas.	2
	Critical Infrastructure dataset	Contains information of critical infrastructure.	2
	Water Cycle Strategy	The Water Cycle Strategy identifies the water services infrastructure that is needed to support and enable sustainable development in the mid Mersey area.	2
	Surface Water Management Plan Flood Depth Mapping	Surface Water Flood Modelling conducted as part of the SWMP Stage 2.	2
	Surface Water Management Plan Stage Interim Reports	Information on future surface water flood risk is outlined in these documents.	2
	S19 Flood Investigation reports	LLFAs have a duty to investigate and record details of significant flood events within their area. Reports include photographic evidence recorded during and after flood events.	2
	Historic Flooding Records	Historic records of flooding from surface water, groundwater and ordinary watercourses.	2
	Asset Register / Record	Register of flood risk management assets.	2
	Scheme Business Cases	Business cases for schemes contain information regarding risk and potential solutions.	2

Owner	Dataset	Description	Confidence Rating
United Utilities	Flooding Register	Registers logs and records of sewer flooding incidents for each area.	2
	Modelling Information	Models of drainage systems operated and maintained by United Utilities.	2
	Asset Register	Asset register available to Warrington Borough Council on request.	2
	Telemetry	Information regarding sewer performance	2
Fire & Rescue	Incident Response Register	Issue logs of all events recorded by Cheshire Fire and Rescue Service. This includes internal floods such as burst pipes and sewerage problems	2
Other Sources	Media Records	Information obtained from online media – news websites / social media etc.	2

4.3.4 Data Limitations

The first edition of the PFRA identified a number of issues during the data collection process. Whilst a number of processes have since been improved a number of limitations still remain.

Inconsistent Recording Systems

Previously the lack of a consistent flood data being captured within one central recording system within Warrington Borough Council had led to inconsistencies in the recording of flood event data. The Council addressed this issue as part of undertaking Sections 19 and 21 of the FWMA 2010. Only sections of the study area that have recently been flooded have been scrutinised for consistency, the limitation of inconsistent recording still applies for those sections of the study area that have only experienced flooding historically.

Incomplete Datasets

Some of the datasets collated are not exhaustive. Warrington Borough Council along with the other stakeholders, has strived to reduce the number of incomplete datasets since 2011. Records for recent flooding locations are now comprehensive, however knowledge gaps still remain in sections of the study area that have only experienced flooding historically and therefore hinder the identification of accurate FRAs.

Varied Quality of Data

Depending upon stakeholder objectives, when collecting information there has been varied quality in historic flood records. This has made it difficult to accurately assess the consequences of historic local flooding.

Records of Consequences of Flooding

It is not always possible to clearly identify and compartmentalise flooding, particularly from engineered systems that are typically interconnected, which results in flooding from a combination of sources.

Data records provided by the other partner organisations were not always comprehensive for specific past flood events. Since 2011 there has been increased co-operation with stakeholders to

standardise the recording procedure to become more aligned and comprehensive, increasing confidence to identifying flooding source and consequence.

Quality Assurance

Data collected was subject to quality assurance measures to monitor and record the quality and accuracy of acquired information and datasets. A data quality score was given, which is a qualitative assessment based on the Data Quality System provided in the Surface Water Management Plans (SWMP) Technical Guidance document (March 2010). This system is explained in Table 6. A confidence rating for the dataset was then determined as summarised in Table 5.

Table 6: Recording the Quality of Data

Data Quality Score	Description	Explanations	Example
1	Best possible	No better available; not possible to improve in the near future	High resolution LIDAR River/sewer flow data Rain gauge data
2	Data with known deficiencies	Best replaced as soon as new data are available	Typical sewer or river model that is a few years old
3	Gross assumptions	Not invented but based on experience and judgement	Location, extent and depth of surface water flooding Operation of un-modelled highway drainage 'future risk' inputs e.g. rainfall, population
4	Heroic assumptions	An educated guess	Ground roughness for 2D models

4.4 Phase 2 – Data Review and Analysis

4.4.1 Assessing Historic Flood Risk

Existing datasets, reports and anecdotal information from the stakeholders have been collated and reviewed to identify details of major past flood events which had locally significant harmful consequences. The analysis included an assessment of economic damage, environmental and cultural consequences and impact on the local population.

For further information on historical flooding please refer to Section 5 of this PFRA.

4.4.2 Assessing Future Flood Risk

The identification of FRAs through the PFRA should also take into account future floods, defined as any flood that could potentially occur in the future. This definition includes predicted floods extrapolated from current conditions in addition to those with an allowance for climate change. The assessment of future flood risks will primarily rely on a technical review of the Environment Agency's Risk of Flooding from Surface Water (RoFSW) maps first published in 2013 and updated annually.

The previous PFRA relied upon a technical review of surface water flood depth maps (1 in 200 annual chance of flood with 180 minute duration) produced for the Surface Water Management Plan (SWMP) as the best available information. For areas not covered by the SWMP modelling the Environment Agency's Areas Susceptible to Surface Water Flooding Map was used. Both datasets

have been superseded by the RoFSW which when compared to observe actual flooding better represents the flood extents.

In January 2017 the PFRA guidance, first published in 2011, was revised due to increased understanding of the FWMA 2010 requirements, data collection and recording methods, completion of flood alleviation schemes, and technological advances to produce more accurate model predictions. Table 7 summarises the main differences between the guidance documents.

Table 7: Differences between assessment criteria

Description	2011 PFRA	2017 PFRA
Rainfall Return Period for analysis	1 in 30 year (3.3%) 1 in 200 year (0.5%)	1 in 30 (3.3%) 1 in 100 (1%) 1 in 1000 (0.1%)
Number of "blue squares" formed within a 3x3 km square grid to create a cluster. Refer to Section 4.1 for further information	5	5

RoFSW maps were generated using 'direct rainfall' modelling (the application of rainfall to all cells in a 2D model, and runoff is routed within the hydraulic model). RoFSW maps do not take into account any non-surface water influences such as rivers, sea, sewers or groundwater.

Table 8: Risk Categories for RoFSW maps

Banding	Return Period
High	>1 in 30 years (3.3%).
Medium	Between 1 in 100 (1%) and 1 in 30 years (3.3%).
Low	Between 1 in 1000 (0.1%) and 1 in 100 years (1%).
Very Low	<1 in 1000 years (0.1%).

Risk categories, to depth and velocity of flood waters, have been assigned based on the information provided by the Environment Agency. **Even though it is based as an annual chance of the event occurring, there is no limit on the event taking place at multiple times throughout the year.**

Table 9: Information contained in the RoFSW banding.

Predicted Depth (mm) Banding	Predicted Velocity (m/s) Banding
>900 300 to 900 <300	>0.25 <0.25

Further information regarding the Risk of Flooding from Surface Water Maps (formerly known as the updated Flood Map for Surface Water - uFMfSW) is available at the following webpage:

https://www.gov.uk/government/publications/flood-maps-for-surface-water-how-they-were-produced

The following factors were considered when assessing the future flood risk across the study area:

- Topography.
- Location, and type, of drainage systems.
- Characteristics of watercourses (lengths, modifications).

- Location of Ordinary Watercourses and Flood Plains that retain water.
- Residential / economical areas.
- Effectiveness of any works constructed for the purpose of flood risk management.
- Current and predicted impact of climate change.
- Proposals for future development.

For further information on future flooding please refer to Section 6 of this PFRA.

4.5 Phase 3 – Reviewing Indicative Flood Risk Areas

Information on historic and future flood risk has been used to formally review FRAs. Flood risk indicators have been used to determine the impacts, and consequences, of flooding on human health, economic activity, environment and cultural heritage.

The flood risk indicators have been selected and analysed by DEFRA and the Environment Agency in order to identify areas where flood risk and potential consequences exceed a pre-determined threshold. The areas that have been identified using this methodology, and exceed 30,000 people at risk, have been identified as Indicative FRAs.

Table 10: Key Flood Risk Indicators and Impacts

Impact of flooding on:	Flood Risk Indicators
Human Health	Number of residential properties. Critical services (Hospital, Police / Fire / Ambulance Stations, Schools, Nursing, Homes, etc.). The number of critical services can be identified using the National Receptor Dataset (NRD).
Economic Activity	Number of non-residential properties. Principal road that is flooded for longer than 5 hours. Area of agricultural land.
Environment	Designated sites (SSSIs, SACs, SPAs, etc.) and BAP habitat. It also identifies the flooding consequences around pollution (PPC, COMAH) and Contaminated land.
Cultural Heritage	Cultural heritage sites (World Heritage Sites), Scheduled Ancient Monuments, Listed Buildings, Conservation Areas, Registered Parks and Gardens.

4.5.1 The Criteria

Table 11 sets out for people, services, properties and communities, the level of flood risk which LLFAs should consider to be significant for the purposes of the Regulations. These indicators and criteria relate to the risk of surface water flooding from a rainfall event with a 1% (or 1 in 100) chance of occurring in any one year.

Table 11: Indicators and criteria for assessing whether the risk of local flooding is significant for the purposes of identifying FRAs

<table>
<tr><th>Method for determining indicative Flood Risk Areas</th><th>Definition</th><th>Indicator</th><th>Criteria</th></tr>
<tr><td rowspan="5">1. Cluster method</td><td rowspan="5">1km grid squares are "blue squares" if at least one of the flood risk indicators is above the criteria threshold.

A cluster is formed where, within a 3x3 km square grid, at least 5 of the 1km squares meet the criteria for one or more of the indicators. Where multiple overlapping grids meet the requirement, these are unified to form a larger cluster.

All of the clusters (both small and large) have been identified as indicative flood risk areas.</td><td>Number of people at risk of surface water flooding</td><td>200 people or more per 1km grid square

Number of people taken as 2.34 times the number of residential properties at risk.</td></tr>
<tr><td colspan="2">or</td></tr>
<tr><td>Number of key services at risk of surface water risk* e.g. utilities, emergency services, hospitals, schools</td><td>2 or more per 1km grid square</td></tr>
<tr><td colspan="2">or</td></tr>
<tr><td>Number of reportable properties (residential and non-residential) properties at risk*</td><td>20 or more per 1km grid square</td></tr>
<tr><td>2. Communities at risk method</td><td>Community areas, as defined by the Office for National Statistics built-up areas (BUAs) and built-up areas sub-divisions (BUASD), where there is a large number of properties at risk.</td><td>Number of reportable properties (residential and non-residential) properties at risk*</td><td>3,000 or more reportable properties (residential and non-residential) within a BUA/BUASD.</td></tr>
</table>

The Environment Agency has provided a set of indicative FRAs for LLFAs to consider. LLFAs are only required to do this in relation to local flood risks, including risks of flooding from surface water, groundwater and ordinary watercourses. They do not need to consider risks of flooding from the sea, main rivers or reservoirs, except where these may affect flooding from another source.

The Environment Agency has used two methods to derive these indicative areas. The methods are:

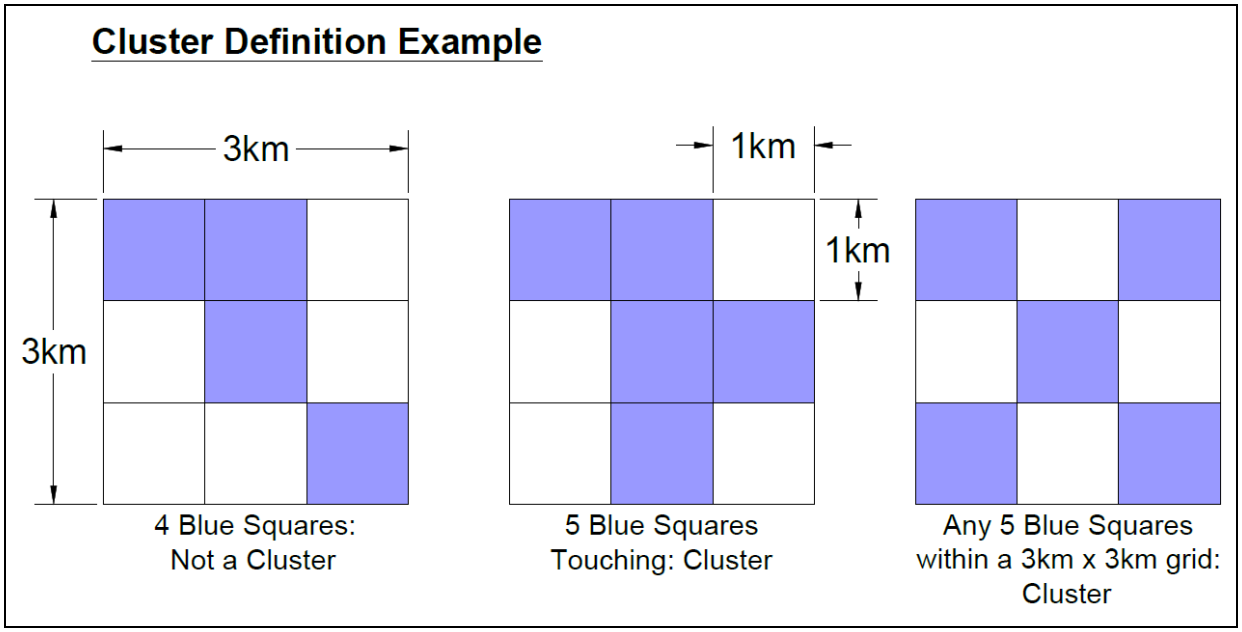
1. The Flood Risk Areas cluster method

As used in the first cycle to identify high concentrations of risk. The country was divided into 1km squares and national information used to identify the squares meeting one or more of the cluster method related criteria in Table 11. A cluster is formed wherever, within a 3x3 km square grid, there are at least 5 squares meeting the criteria are touching. Often multiple grids that meet this requirement will overlap. Overlapping grids are unified to form a larger cluster. All clusters, large and small are identified as indicative FRAs.

A rainfall event with a 1% chance (1 in 100 year return period) of occurring in any year has been utilised to generate the clusters rather than 0.5% chance (1 in 200 year return period) as in 2011

PFRA. This is because current surface water risk products do not include the assessment of a 0.5% chance rainfall event.

Figure 4: Cluster Definition Example



2. The Environment Agency's Communities at Risk method

Developed since 2010 which complements and validates the cluster method by identifying built up areas where total flood risk is considered high. Indicative FRAs are identified wherever there are 3,000 or more reportable properties (residential and non- residential) at risk within a built-up area (BUA) or built-up area sub-division (BUASD) as defined by the Office for National Statistics.

As with method 1, this is for a rainfall event with a 1% chance of occurring in any year.

When determining their FRAs, Warrington Borough Council began with the Environment Agency's indicative FRAs and used its local knowledge and information to provide confidence with reference to Table 5.

The Environment Agency has suggested some additional indicators and criteria to consider in relation to Table 5 at the local level which may be sufficient for a flood risk to be considered significant factors to identify a change from the indicative FRAs:

- Flood risk from other local sources e.g. groundwater, local watercourses
- The combined impact of flooding from multiple sources.
- Areas susceptible to more frequent, less extensive flooding, that could over time result in significant damages.
- Vulnerable local sites, such as caravan parks or camp sites.
- Consequences of flooding for agricultural land.
- Consequences of flooding for roads, rail or other infrastructure.
- Consequences of flooding for internationally or nationally designated environmental sites or internationally or nationally important cultural heritage features, and
- Location of sites subject to Integrated Pollution Prevention and Control or Control of Major Accident Hazard regulation.

There is no national criterion for these local factors, but when considering whether a local factor related risk is significant, it should be assessed whether the magnitude of risk in relation to a local factor, or a combination of local factors, is comparable to the scale of the risk presented by the criteria in Table 11.

Additional information to the methods used by the Environment Agency to develop indicative FRAs for this PRFA review is contained in Appendix B.

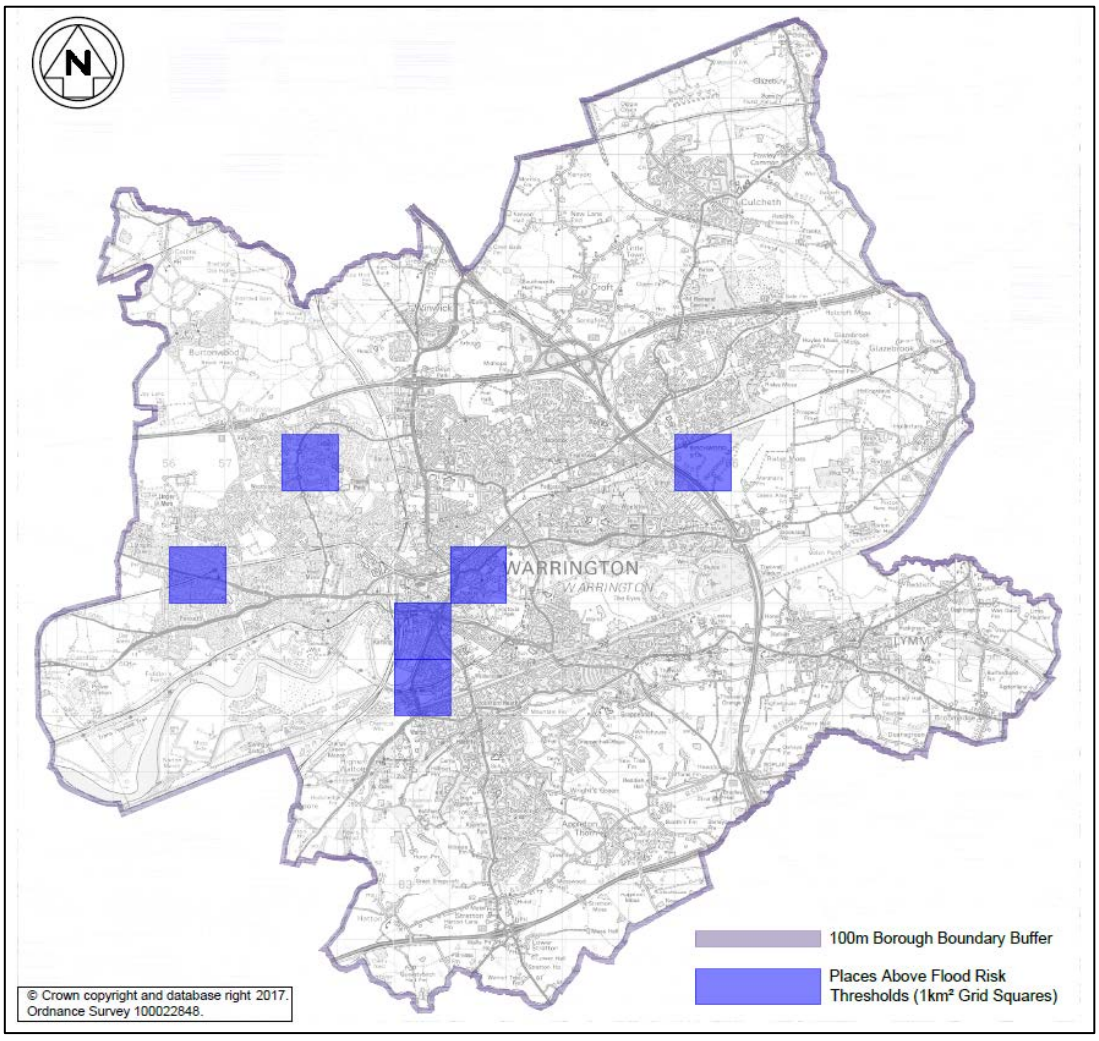
4.5.2 Review

Method 1 - The Flood Risk Areas cluster method

There are 6 “blue squares” (1km grid squares) identified within the Warrington Borough Council. Only 3 of these are contained within a 3x3 km square grid, the remaining 3 squares are in isolated areas of the borough. No cluster identified.

The DEFRA / EA identified 1km^2 Squares Above Flood Risk Threshold (Blue Squares) for Warrington is shown in Figure 2 of Appendix A and below.

Figure 5: DEFRA / EA identified 1km^2 Squares Above Flood Risk Threshold (Blue Squares) for Warrington



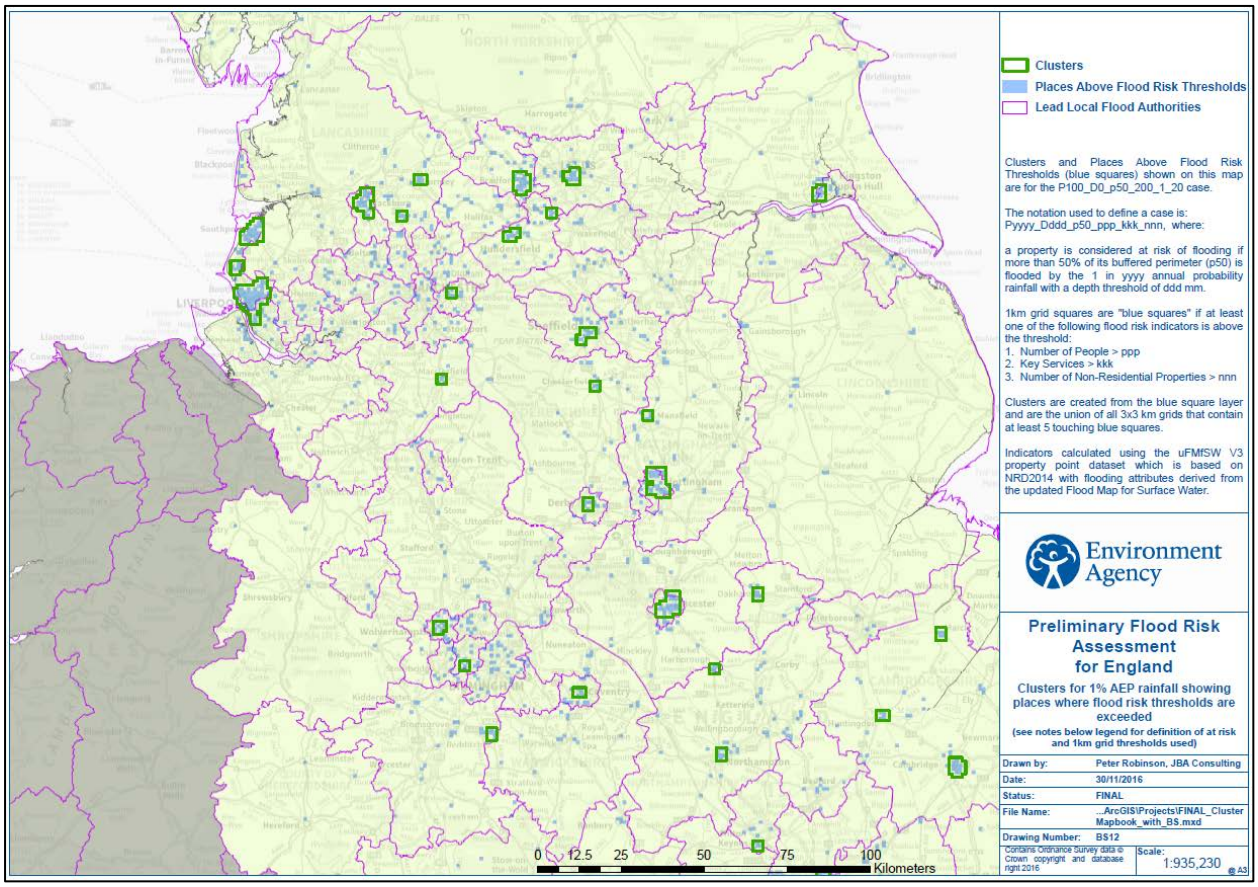
Method 2 - The Environment Agency's Communities at Risk method

There were no Communities at Risk identified within the Warrington Borough Council boundary.

4.5.3 Conclusion

There are no indicative FRAs or Clusters identified within the Warrington Borough Council administrative area.

Figure 6: Clusters for 1% AEP rainfall showing places where flood risk thresholds are exceeded



5 Historic Flood Risk – Assessment of Past Flooding

5.1 Introduction

This section summarises the readily available and relevant information on historic floods. The PFRA guidance requires floods identified with "significant harmful consequences" to be reported in the spreadsheet in Annex 1 of this report.

"Significant harmful consequences" are considered to be impacts of flooding that may have negative consequences for human health, the social and economic welfare of individuals and communities, infrastructure, and the environment (including cultural heritage).

The definition of a past flood with "significant harmful consequences" is determined by the LLFA. The level of significance is chosen so that only relatively harmful flood events are included in the PFRA. Such flood events are those that would be deemed significant when considered from a national perspective.

For the purposes of this PFRA, the definition of "significant" has been defined by Warrington Borough Council as followed:

Table 12: Historically Significant Harmful Consequences

Impact of flooding on:	Category	Consequence
Human Health	Number of individuals	≥ 200
Economic Activity	Number of critical services	≥ 2
	Number of residential properties	≥ 83
	Number of non-residential properties	≥ 20
Environment	-	-
Cultural Heritage	-	-

Using the definition above, Warrington Borough Council has 1 record of a local flood with historically significant harmful consequences. This is listed in Annexe 1.

Irrespective of "significance", Warrington Borough Council considers that all flood events that affect property or people justify consideration. Therefore, where known, information on all flood events has been gathered. A summary of the information specific to each source of flooding relevant to the PFRA is included in this chapter. Other floods that do not meet the criteria, or for which the consequences are not known, are not included in Annexe 1, as per the PFRA guidance, but their locations are plotted on the relevant figures.

It is noted that flooding can be the result of complex interactions between the different sources (e.g. main river and surface water) and the degree of influence from other sources are not always fully understood.

The Warrington Borough Council Local Flood Management Strategy, first published in June 2014, addressed these issues from the first publication of the PFRA. The strategy is to be reviewed by June 2021.

5.2 Overview

5.2.1 Surface Water Flooding (Overland Flow)

Surface water flooding, also known as pluvial flooding, results from overland flow before the runoff enters a watercourse or drainage system. It is usually the result of high intensity rainfall exceeding the hydraulic capacity of the receiving system. However it can also occur with lower intensity rainfall when the land has a low permeability and/or is already saturated, frozen or developed.

Surface water flooding within the United Kingdom is becoming a regular issue due to the high rate of developments creating large impermeable surfaces. There are certain locations within the study area where this flooding mechanism is more prominent due to the increased urban nature of the catchment, combined with the complex hydraulic interactions between the tidal River Mersey, urban watercourses, surface water drainage systems, and combined sewer systems at overflow locations.

Some records do not identify the number, and duration, of properties flooded. This has led to low confidence as often only street names have been reported, regularly from local media, and do not specifically identify the nature of the flooding, possible causes, or exact locations.

Figure 7: Warrington Borough Council Spatial Distribution of Historic Flood Records

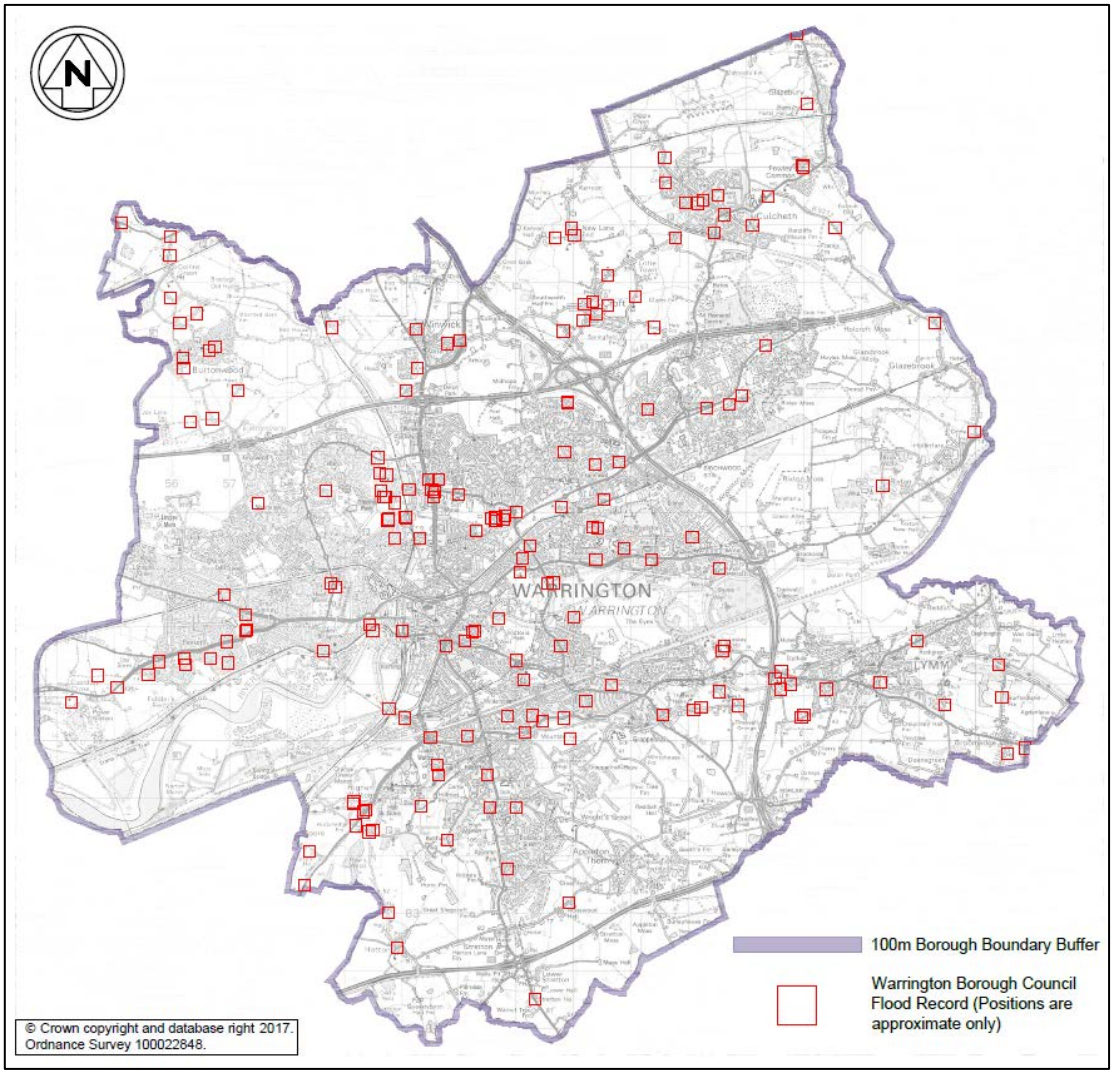


Figure 3 in Appendix A shows the locations of historic flood events held by Warrington Borough Council. There are a total of 197 recorded historical surface water flooding events of varying significance and type.

Information was provided by Cheshire Fire and Rescue regarding incidents of flooding to which they responded. The information was filtered to remove incidents internal to property such as bust water pipes leaving those relevant to the PFRA, there was 26 incidents recorded between August 2004 and December 2015.

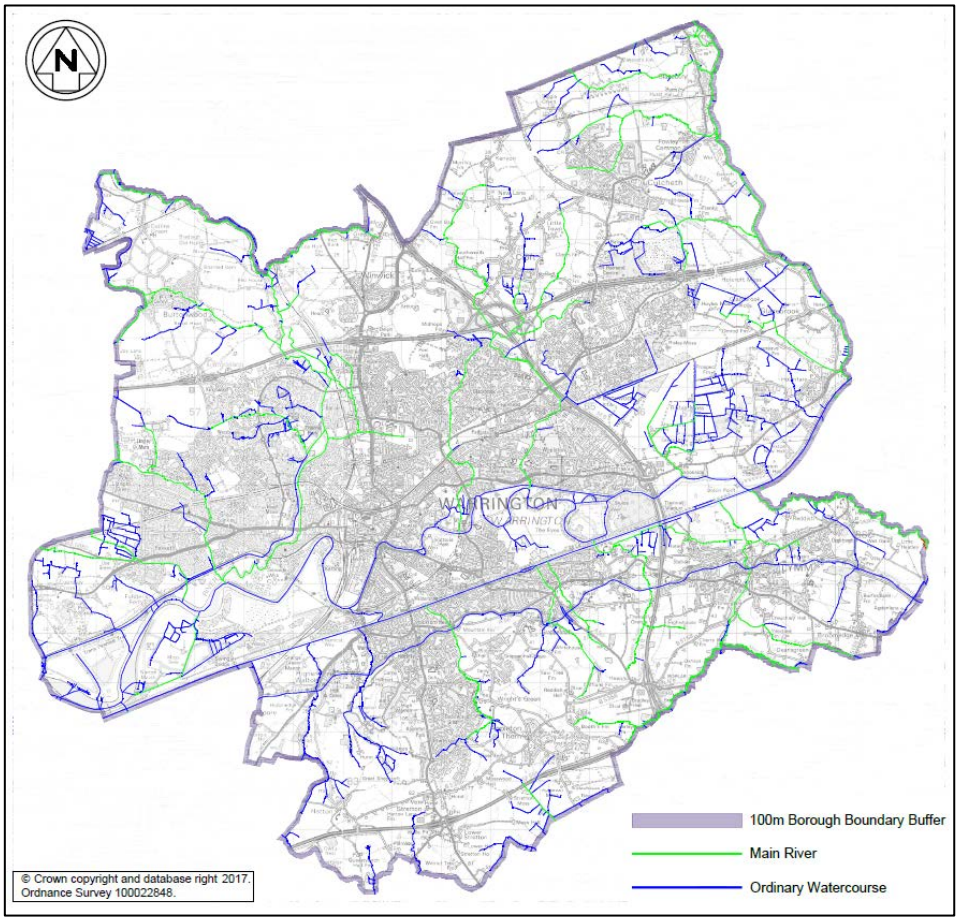
Warrington Borough Council has identified no incidents of historically significant harmful consequences for surface water flooding. Areas affected by surface water flooding which have not been classified as having significant harmful consequences will be reviewed as part of Warrington's longer-term strategy.

5.2.2 Ordinary Watercourse Flooding (Fluvial)

Flooding from any type of watercourse, also known as fluvial flooding, occurs when intensive or prolonged rainfall causes a watercourse to exceed hydraulic capacity. The additional inflow causes the water to rise above its banks or retaining structures and subsequently flows onto the land.

All watercourses within the study area have been identified using the Environment Agency's Detailed River Network (DRN) and are classified as either Main River or Ordinary Watercourse. These are indicated in Figure 4 within Appendix A and an extract is shown below.

Figure 8: Classification of Watercourses within the Administrative Boundary of Warrington BC



Main rivers are usually larger rivers and streams. Other rivers are called Ordinary Watercourses. The Environment Agency carries out maintenance, improvement or construction work on main rivers to manage flood risk under the Water Resources Act 1991. Environment Agency powers to carry out flood defence work apply to main rivers only. Lead local flood authorities, district councils and internal drainage boards carry out flood risk management work on ordinary watercourses. The Environment Agency decides which watercourses are main rivers. It consults with other risk management authorities and the public before making these decisions. The main river map is then updated to reflect these changes. Inclusion of main rivers is beyond the scope of this PFRA.

Ordinary Watercourses are any watercourses that are not designated a main river by the Environment Agency and therefore come under the powers of Warrington Borough Council. These include every river, stream, ditch, drain, cut, dyke, sluice, sewer (other than a public sewer) and passage through which water flows and which does not form part of a main river.

Ordinary Watercourses with known flood risks associated to them (limited channel capacity, channel constrictions or a poor maintenance regime) were previously designated Critical Ordinary Watercourses (COWs). In 2006/7, the Environment Agency reclassified all COWs as main rivers and took over responsibility for their maintenance and management, in a process known as enmainment.

Although there are several recorded incidents of localised flood events related to ordinary watercourses that were not enmained, none of these have had 'significant harmful consequence'.

Warrington Borough Council has identified no historically significant harmful consequences for fluvial flooding from Ordinary Watercourses. Areas affected by fluvial flooding which have not been classified as having significant harmful consequences will be reviewed as part of Warrington's longer-term strategy.

5.2.3 Sewer Flooding

Sewer flooding is often caused when drainage systems exceed their hydraulic capacity during periods of intensive, or prolonged, rainfall. However, sewer flooding can also be caused when a blockage occurs on the network restricting flows. These drainage systems are owned and maintained by the sewage undertaker (United Utilities). There are 3 types of sewer:

- Foul only flows;
- Surface water flows;
- Both foul and surface water flows (combined system).

Combined sewerage systems are mostly associated with sections of the study area developed during the Victorian era. To maintain hydraulic efficiency the combined system contains a number of relief structures to divert excess flows to adjacent watercourses to reduce the risk of sewer flooding from manholes. These structures are known as Combined Sewer Overflows (CSOs). The operation of these increases the risk of fluvial flooding, as well as pollution of the watercourse. Each CSO has a permit from the Environment Agency which outlines the conditions in which the asset can discharge. Developments from the late 1970s / early 1980s have been constructed using individually separate foul and surface water systems.

There are some housing developments from the early 20th century that utilise the principles of the separate system where both foul and surface water flows are routed in the one manhole. These dual

manholes operate in a similar manner to CSOs and are normally situated at the head of the sewerage network, whereas CSOs are situated in the main body of the system. Dual manholes can cause major pollution problems from storm sewage discharges or dry weather discharges via surface water sewers as a result of foul sewer blockages.

Some of the sewers across Warrington BC date back to Victorian times and includes the areas of Penketh and Great Sankey. The population and size of Warrington has grown as the community around Warrington expanded. More houses and businesses mean an increase in the amount of drainage systems and discharges and less permeable surfaces for rainwater to drain into. Climate change is also leading to longer, heavier periods of rain. These two factors can result in the existing sewers and drains not being able to cope at certain times during heavy rainfall.

United Utilities have provided an incident register for locations that have experienced internal (i.e. flooding within a property) and external flooding from a number of sources. The register has been filtered to identify hydraulic issues, such as overloading of the sewerage system or restriction at outfall locations caused by high level in the receiving watercourse. “Other” causes of flooding, for example blockages, asset failure or other operational issues, have been discounted from this PFRA.

Figure 9: Approximate locations of flooding caused by Hydraulic Issues (United Utilities)

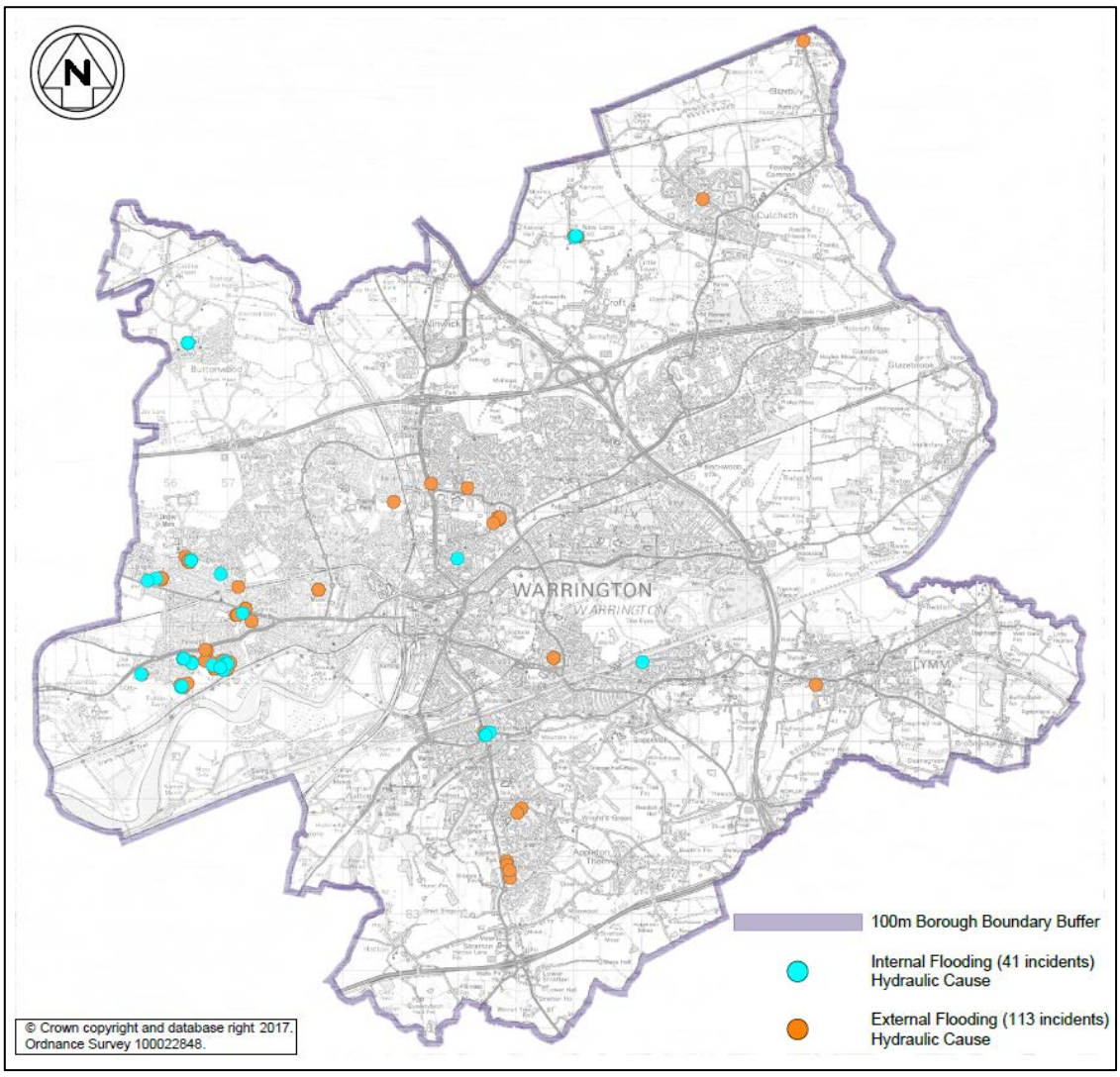


Figure 5 in Appendix A (extract above) presents the historic sewer flooding information provided by United Utilities. There have been a total of 154 flooding incidents (113 external and 41 internal) across the study area.

Warrington Borough Council has identified no historically significant harmful consequences due to flooding from the sewerage system. Areas affected by sewer flooding which have not been classified as having significant harmful consequences will be reviewed as part of Warrington's longer-term strategy.

5.2.4 Groundwater Flooding

Groundwater flooding occurs when the water table rises above normally expected and anticipated levels and emerges at the ground surface. Groundwater flooding occurs in response to a combination of already high groundwater levels (regularly during mid or late winter) and intense or unusually prolonged periods of rainfall. Other mechanisms which produce groundwater flooding including:

- Artificial structures;
- Groundwater rebound (which occurs when abstraction, typically for drinking water, industrial or mine dewatering purposes, stops and water levels return to pre-abstraction levels);
- Mine water rebound;
- High in-bank river levels.

The occurrence of groundwater flooding is usually localised and, unlike flooding from watercourses, does not generally pose a significant risk to life due to the slow rate at which the water level rises but can last several months and can cause significant social and economic disruption to the affected areas.

There are known locations with high groundwater within Warrington however, there are no specific records or reported incidents of groundwater flooding. Therefore it is considered currently that there are no groundwater flood incidents that would result in 'significant harmful consequences' as defined by the PFRA threshold.

5.2.5 Canals

There are three canals operated by subsidiary companies on behalf of Peel Ports Group within Warrington, they are:

- Bridgewater Canal operated by the Bridgewater Canal Company Ltd,
- Manchester Ship Canal operated by Manchester Ship Canal Company Ltd,
- New Cut Canal operated by Manchester Ship Canal Company Ltd.

Warrington Borough Council owns and maintains parts of the St Helens Canal within the Warrington Borough Council boundaries.

These engineered systems are heavily controlled and are unlikely to respond in the same manner during periods of rainfall as natural watercourses. The probability of flooding is more associated with residual risks, such as overtopping of canal banks, breaching of embanked reaches or asset (e.g. gate) failure. Each canal also has significant interaction with other sources of flood risk, such as the main rivers and the minor watercourses that feed them, or drains that cross beneath them.

There are no assets owned or maintained by the Canal & Rivers Trust, formerly British Waterways, in the Warrington administrative area.

Warrington Borough Council has identified one historical flood event as a result of flooding from canals which resulted in significant harmful consequences as defined by the PFRA threshold.

Details of the above flood event are included in Annex 1: Past Floods.

5.2.6 Interaction with Main Rivers

It is identified in the Mersey Estuary Catchment Flood Management Plan (CFMP) and the Environment Agency Warrington Flood Risk Management Strategy that there is a long history of fluvial and tidal flooding in central Warrington dating back to 1767.

Fluvial flooding is associated more with the River Mersey tributaries and main watercourses, such as Dallam, Sankey, and Whittle Brooks, rather than the River Mersey itself. The Environment Agency is responsible for managing these main tributaries. Warrington has benefited from the Manchester Ship Canal which transfers a significant flow of water past Warrington and reduces the risk of fluvial flooding along the River Mersey.

High water levels in the River Mersey are common due to tidal and fluvial events. Although flooding from main rivers does not need to be included in the PFRA, it is thought that there is a strong link between surface water flooding, sewer flooding incidents and flooding from ordinary watercourses and water levels on the River Mersey and its tributaries such as Dallam Brook and Sankey Brook. There is evidence to suggest that surface water flooding is exacerbated in some areas, during high tidal cycles when gravity drains and outfalls are blocked with high tidal waters. However, due to the incomplete nature of the information available at present, the degree of influence on local flood risks cannot be determined.

Table 13: Warrington BC Significant Fluvial & Tidal Flooding Incidents

Date	Event
1697	Fluvial event along Dallam Brook.
April 1967	Fluvial flooding along Whittle Brook where 50 properties were flooded
February 1990	Tidal flooding along the River Mersey where 17 properties, 8000m³ of commercial floor space and a public school were flooded
October 2000	Fluvial flooding along Dallam Brook where 15 houses in the Dallam area were flooded

Information about historical flooding will often be due to an unknown source, or because of interactions between sources. This interaction will be difficult to identify without detailed flood risk studies.

5.3 Summary

Warrington Borough Council has reviewed the best available information and identified that there has been one nationally significant or historically local significant flood event within the study area.

Details of the above flood event are included in Annex 1: Past Floods.

6 Future Flood Risk

6.1 Introduction

Whilst analysis of past flooding provides valuable information on the nature and extents of flooding that have occurred in Warrington in the past, it does not necessarily inform us about how and where flooding may occur in the future.

Predictions of future flood risk are produced using combinations of hydrological and hydraulic modelling and analysis of past hydrological records to make future predictions. The following sections of this PFRA discuss the potential sources of flooding within the study area. The following sources of flooding have been considered in subsequent sections of this report:

- Ordinary watercourses (fluvial);
- Surface water;
- Groundwater;
- Canals.

6.2 Overview

6.2.1 Surface Water Flooding

As identified in Table 5 there are a number of national and local level surface water flooding datasets available for the study area.

Since 2008 The Environment Agency has produced a series of surface water flood maps to aid local authorities in determining areas at risk of flooding. The latest incarnation of the maps is the Risk of Flooding from Surface Water (RoFSW) maps. This has been previously discussed in Section 4.4.2 of this report.

Environment Agency guidance on using surface water flood risk information recommends that Warrington Borough Council, as an LLFA, should: review, discuss, agree and record, with the Environment Agency, United Utilities, and other interested parties, what surface water flood data best represents their local conditions, known as “locally agreed surface water information”. Whilst this is not a requirement under the Regulations, it does inform the PFRA process as this information should play an important role in identifying FRAs.

Warrington Borough Council has agreed with all interested parties that the Risk of Flooding from Surface Water (RoFSW) mapping is the most appropriate dataset that represents the risk of flooding from surface water within the study area at a high level.

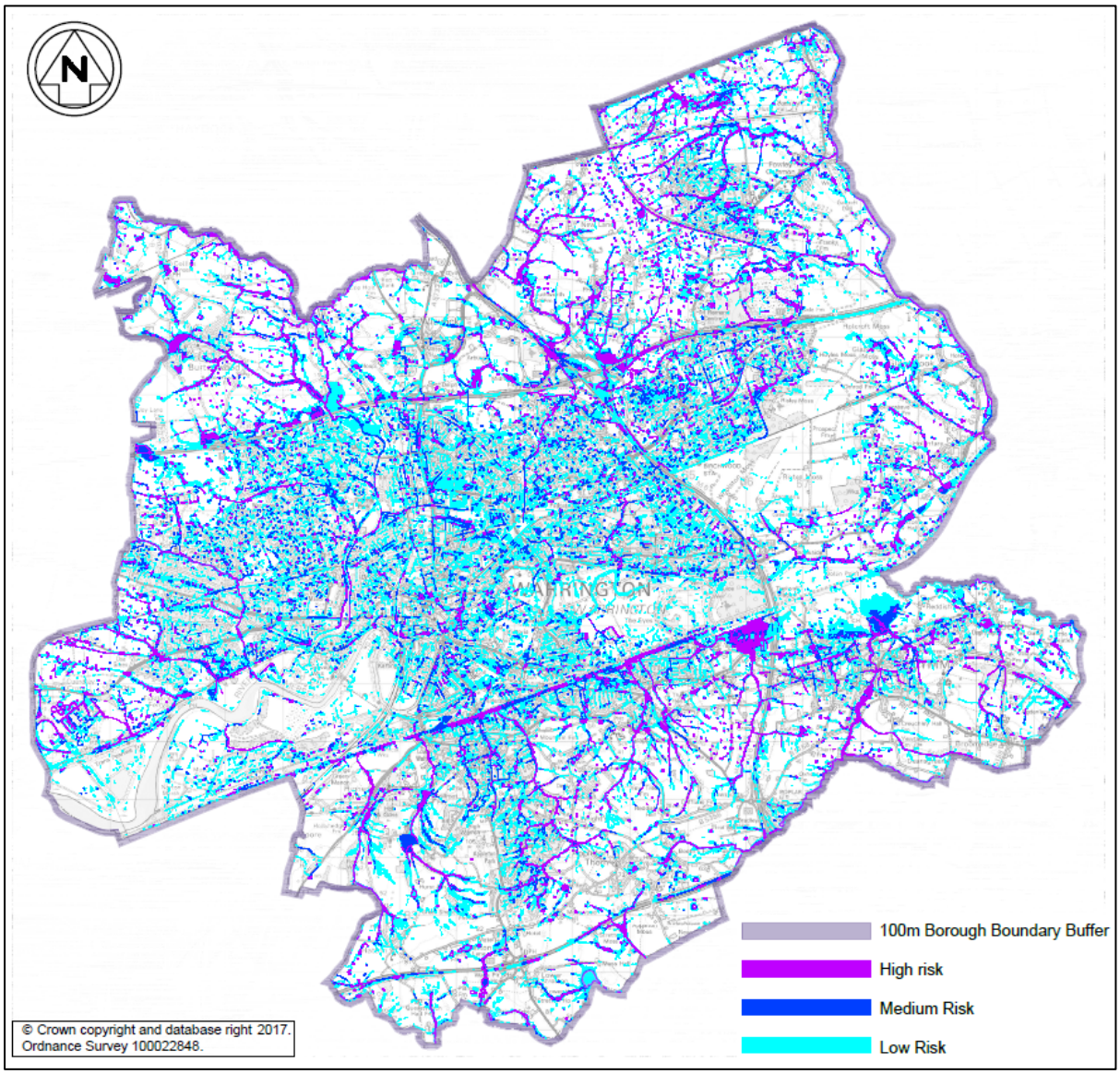
Figure 6 in Appendix A and Table 14 identify areas within Warrington potentially at risk of surface water flooding.

It should be noted that the RoFSW dataset, the successor to uFMfSW, does contain the following limitations:

- In urban areas, rainfall is reduced to 70% to represent infiltration, then a rainfall reduction of 12mm/hr is applied to represent the effects of the drainage system.

- Large subsurface drainage elements, such as flood relief culverts and flood storage, are not included. These assumptions can affect the modelled extent and pattern of flooding. Modelled flood extents are particularly sensitive to the drainage rate used.
- At the national scale there is limited recorded surface water flood data that exists for LLFAs to perform validation, so in many places no validation has been carried out yet.
- As with many other flood models the input information, model performance and modelling that were used to create the RoFSW vary for different areas; these affect the reliability of the mapped flood extents and, in turn, the suitability for different applications.
- RoFSW does not take individual property threshold heights into account.
- The flood extents show predicted patterns of flooding based on modelled rainfall. In reality, no two storms are the same, and so two floods of similar rarity may result in different patterns of flooding and consequently these maps cannot definitively show that an area of land or property is, or is not, at risk of flooding.
- It does not show future scenarios, for example climate change.

Figure 10: Extract of the EA Risk of Flooding from Surface Water Dataset (December 2013)



This dataset has been used to assess the potential surface water flood risk to properties across the study area, summarised in Table 14.

Table 14: Numbers of Properties Potentially at Risk from Surface Water Flooding in the Future

Property Type	Susceptibility to surface water flooding banding		
	Low	Medium	High
All	8897	1032	Not available
Residential	7298	890	201*
Non-Residential	855	117	Not available
Key Services	142	25	Not available

* Property count information provided by EA with the exception of high risk surface water banding.

Data Verification

In order to verify information provided by Environment Agency, Warrington Borough Council undertook an internal review to assess confidence in the data.

The method employed by Warrington Borough Council is based upon PFRA FAQ guidance (April 2017) which states that the "The definition for "At Risk" is as described in the technical report for the Updated Flood Map for Surface Water (uFMfSW*) property points dataset (Environment Agency, 2014) i.e. depth of >0mm for >50% of wetted perimeter.

*uFMfSW is now referred to as the Risk of Flooding from Surface Water (RoFSW) map.

The results are summarised in Table 15 below.

Table 15: Data Verification Analysis

	Susceptibility to surface water flooding banding (Residential Property)		
	Low	Medium	High
Environment Agency	7298	890	Not available
Warrington Borough Council	7181	871	201
Difference	117	19	-
Discrepancy	1.60%	2.13%	-

The minimal discrepancy between the Environment Agency and Warrington Borough Council property counts maybe due to the different methods used when trimming the data to the Warrington Borough boundary (Actual boundary vs 1km^2 grid square).

Warrington Borough Council considers that the figures provided by Environment Agency are acceptable for the purpose of the PFRA as a strategic level document.

The level of future flood risk and the estimated associated consequences are provided in the spreadsheet in Annex 2.

Further information to background and limitations to risk of surface water mapping by the Environment Agency can be obtained via the following link.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/297432/LIT_8988_0bf634.pdf

6.2.2 Sewer Flooding

Hydraulic (1D) sewer models have been created which cover the majority of the sewerage network maintained by United Utilities. These have been verified against a flow survey to provide an accurate representation of network performance during both dry weather and storm conditions. A suite of design storm events of differing return periods, durations, and inclusive of the effects of climate change, are then applied to the models to assess hydraulic performance. The outputs include a range of predicted surcharge levels and flood volumes at individual node locations. Clusters of flooding nodes are then grouped based upon the common hydraulic deficiencies and / or geographic location and are checked against historical records to confirm existing flooding locations, as well as a tool to predict future flooding locations.

Whilst this data allows a high-level analysis of sewer flood risk, there are a number of limitations with the data:

- Not all sewer networks are modelled.
- Model confidence is low in sections of the network that were not covered by flow monitor during the survey period.
- The models are calibrated for a particular period and conditions the flow survey was installed and may not fully take into consideration the effects of seasonality.
- 1D models do not represent the flow path unlike 2D and Integrated Catchment Modelling (ICM) models. Predicted flood volume in 1D models departures and returns to the system at the same node location, in truth this may not be the case.
- Not all models accurately represent interaction watercourses at outfall locations. A number of 1D models are to be upgraded to include representation of watercourses, Integrated Catchment Modelling (ICM) which includes the 2D element, during the coming years. This will enable increased understanding of hydraulic interactions of all systems, in particular the operational performance of CSOs and flood routing paths of surfaces waters.

Figure 5 in Appendix A presents the historic sewer flooding information provided by United Utilities. There have been a total of 154 flooding incidents (113 external and 41 internal) across the study area. These known flooding locations are coherent with predictions from the hydraulic sewer model, therefore providing confidence to sections of the study area where flooding is predicted but has gone unreported.

Based on information readily available on their website in their “Strategic Direction Statement” United Utilities are proposing to address a significant number of sewer flooding problems by 2020. Based on figures from 2015, this will include a 40% reduction to the number of properties experiencing internal foul flooding. This is to be achieved through investment in the completion of a number of studies and capital works projects.

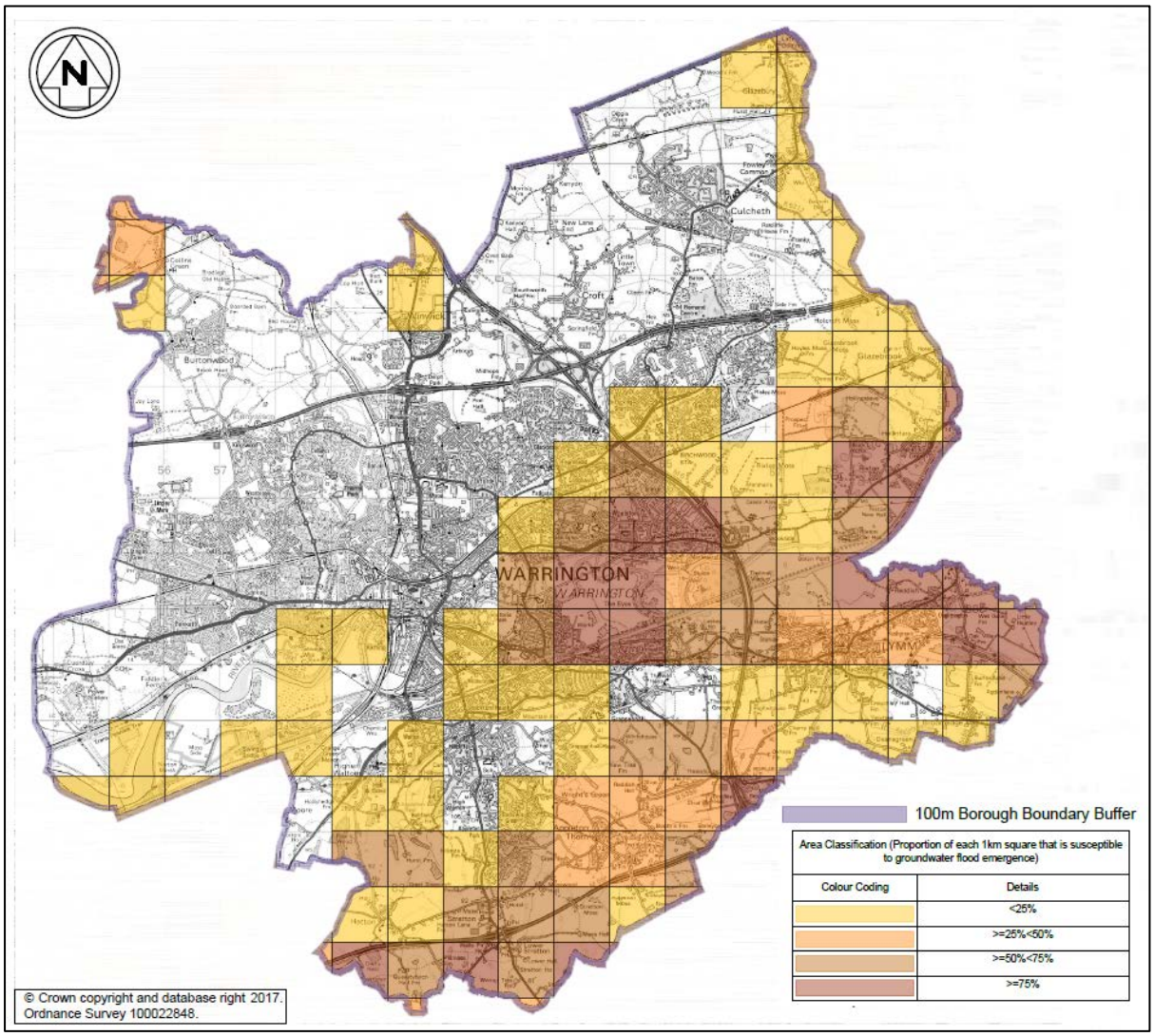
6.2.3 Groundwater Flooding

The Environment Agency’s national dataset, Areas Susceptible to Groundwater Flooding (AStGWF) provides the main dataset used to assess the future risk of groundwater flooding.

The AStGWF map (Figure 7 in Appendix A) uses four susceptible categories to show proportion of each 1km grid square where geological and hydrogeological conditions show that groundwater might emerge. It does not show the likelihood of groundwater flooding occurring. In common with

the majority of datasets showing areas which may experience groundwater emergence, this dataset covers a large area of land, and only isolated locations within the overall susceptible area are actually likely to suffer the consequences of groundwater flooding. Unless an area identified as "susceptible to groundwater flooding" is also identified as "at risk from surface water flooding", it is unlikely that this location would actually experience groundwater flooding to any appreciable depth, and therefore it is unlikely that the consequences of such flooding would be significant.

Figure 11: Extract of the EA Areas Susceptible to Groundwater Flooding Dataset



The AStGWF dataset was derived using the British Geological Society (BGS) 1:50,000 scale Groundwater Flood Susceptibility Map produced in 2010, utilising the top two susceptibility bands. Two hydrogeological conceptual models have been used in the development of the susceptibility dataset. These are:

- Permeable Superficial Deposit (PSD) flooding - Associated with shallow unconsolidated sedimentary aquifers which overly non-aquifers. These aquifers are susceptible to flooding as the storage capacity is restricted. Direct rainfall recharge can be relatively high and the sediments may be very permeable thus creating a good hydraulic connection with adjacent watercourses. Intense rainfall can cause a rapid response in groundwater levels; rising river

levels. As the upstream catchment responds to the rainfall, this can create increased heads that drive water into the aquifer.

- Clearwater flooding - caused by the water table in an unconfined aquifer rising above the land surface in response to extreme rainfall. Occurs when antecedent conditions of high groundwater levels and high unsaturated zone moisture content combine with intense rainfall

The Groundwater Flood Susceptibility Map does not incorporate anomalous discharge from springs or flooding associated with urban groundwater rebound, mine water discharge, urban drainage, or any other flooding associated with changes in the engineered environment.

Figure 7 in Appendix A shows the AStGWF map and indicates that extensive areas in the eastern part of the borough are at risk from rising groundwater levels. However, it is not backed up by historical evidence and high groundwater levels are known to exist in other areas not highlighted by the dataset.

As well as the national Groundwater Flood Map, there are a number of other national and more local datasets and studies which contain some details about possible groundwater flooding in Warrington.

The Environment Agency's CFMPs identified a number of locations in Warrington, including significant areas of the River Glaze and Sankey Brook that are at risk of groundwater flooding using DEFRA's Groundwater Study and Groundwater Emergence Maps (GEMs). These maps do not necessarily imply flooding of properties, only that groundwater would emerge at the surface first within the indicated areas.

The Environment Agency prepared the Lower Mersey and North Merseyside Water Resources Study in 2009 (Final Report 6588R4), which has some details about possible groundwater flooding in Warrington. As well as a number of locations outside of Warrington, the study focuses on areas surrounding the River Mersey, Glaze Brook and Sankey Brook where most groundwater would naturally discharge.

6.2.4 Ordinary Watercourses

There is at present no specific Borough wide modelling for ordinary watercourses however the Environment Agency have produced Flood Zone Maps which shows the results of coarse modelling of catchments over 3km2 (Figure 8 in Appendix A). The Environment Agency Flood Map does not provide information on flood depth, speed or volume of flow.

In order to better understand the risk of flooding from ordinary watercourse, Warrington Borough Council in 2012 commissioned JBA Consulting to assist the Council with development of an asset database and also to determine the flood risk associated with the assets collated.

JBA Consulting simulated flooding caused by 100% blockage scenario in pipes, culverts or bridges using JScreen software. JScreen defined the extent of flood, and analysed its consequences highlighting the different property types that are vulnerable to flood if a culvert or any other flood risk asset were to fail.

In 2014/15, Warrington Borough Council as part of the Cheshire Mid-Mersey Partnership (CMMP) undertook a project to improve the knowledge of flood risk from the ordinary watercourse network across the partnership area by undertaking asset inspections, topographical surveys and modelling

works on ordinary watercourses which had been identified using the best available information at the time as potentially high risk. This project was considered to build upon the previous work completed by JBA due to the increase in collection of information.

CH2M Hill was appointed in November 2014 under the Water and Environment Management (WEM) Framework to undertake appropriate assessment of more than 30 km of non-main watercourse across the CMMP areas. Three separate surveys were outlined to capture the required data for the proposed study outputs;

- T98 Conditional Asset Assessment.
- CCTV survey.
- Topographical survey.

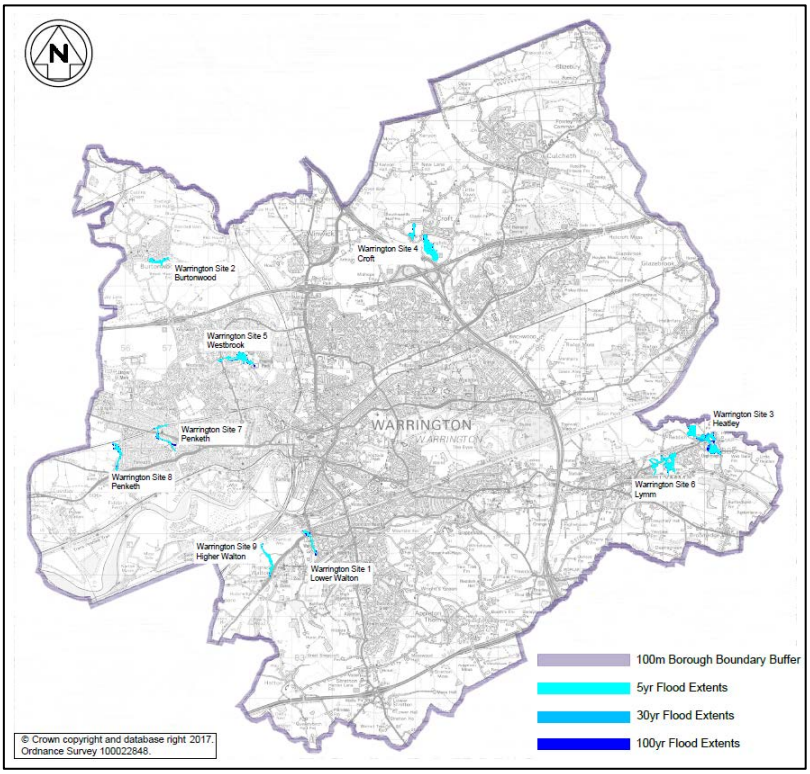
Catchment wide modelling and mapping was undertaken by CH2M following the completion of the survey investigations enabling visualisation of possible implications of events with return periods of 1 in 5 year, 1 in 30 year and 1 in 100 year. The modelled flood risk mapping represents the current situation of assets on the ground using the surveyed data to populate model data. (Flood Outline mapping shown in Figure 9, Appendix A)

Model results have been used to produce depth grids, flood outlines and property counts based on properties from the Nation Receptor Database (NRD) to identify properties at risk.

The small size of the watercourses considered within this study means there were no observed flow data sets available, therefore best practice outlined by the Environment Agency was followed:

- Catchments delineated using GIS and FEH CDROM.
- Catchment descriptors from FEH CDROM used within ReFH analysis to calculate inflows for required return periods.

Figure 12: Extract of Ordinary Watercourse Model Outputs



Summary of property counts (locations extracted from NRD) within flood outline for modelled reach as part of CH2M Hill study are shown in Table 16 below:

Table 16: Numbers of Properties Potentially at Risk from Modelled Ordinary Watercourses Flooding in the Future

Location	Description	Property Count 1 in 5yr	Property Count 1 in 30yr	Property Count 1 in 100yr
Warrington Site 1	Lower Walton	4	4	4
Warrington Site 2	Burtonwood	21	23	26
Warrington Site 3	Heatley	0	10	32
Warrington Site 4	Croft	0	0	0
Warrington Site 5	Westbrook – Ladywood Road	8	10	12
Warrington Site 6	Lymm	47	53	60
Warrington Site 7	Penketh – Penketh High School	7	9	13
Warrington Site 8	Penketh - Stocks Lane	0	0	0
Warrington Site 9	Higher Walton	0	0	0

Although it appears that flooding may occur, at the above sites. Property counts do not achieve the threshold to be determined as having “significant harmful consequences“. Lymm (Warrington Site 6) is predicted to be the most vulnerable area within the administrative district of Warrington Borough Council.

The level of future flood risk and the estimated associated consequences are provided in the spreadsheet in Annex 2.

Note – The River Mersey

The Environment Agency do not classify the reach of the River Mersey through Warrington as main river, as it is a heavily modified river system as extensive re-sectioning and embankment works were carried out in the 1960s. Although not classified as a main river, the Environment Agency does manage the river, with the River Mersey and its five main tributaries forming the focus of the Environment Agency's Flood Risk Management Strategy for Warrington.

6.2.5 Canals

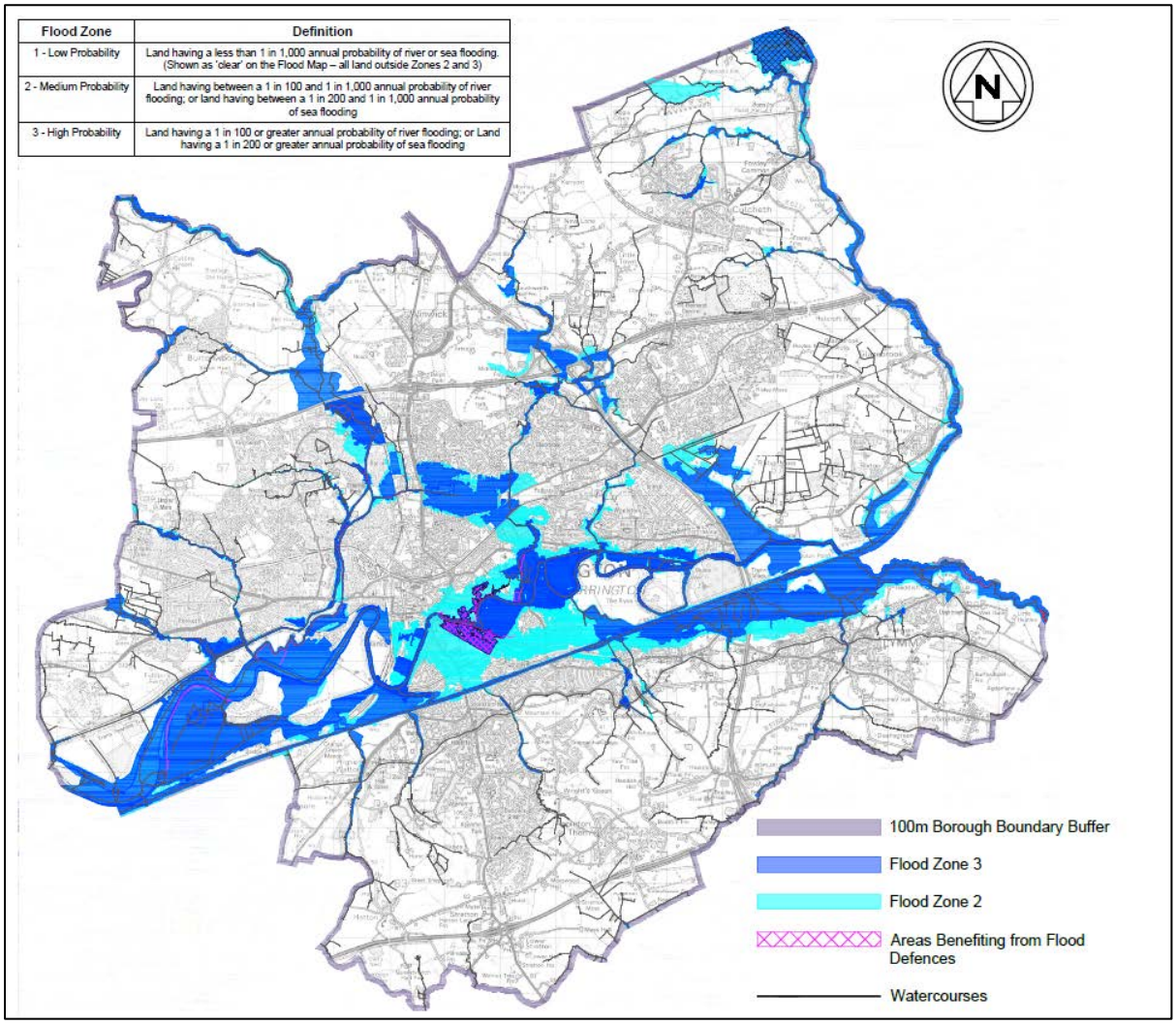
The Environment Agency’s Flood Zone Mapping includes flood risk from the Manchester Ship Canal and is shown in Figure 8 in Appendix A. Due to the Ship Canal being such a large body of water which is fed directly by main rivers it is not considered to be a ‘local’ flood issue. Warrington has and continues to benefit from the Manchester Ship Canal which transfers a significant flow of water past Warrington and reduces the risk of fluvial flooding along the River Mersey.

Despite the construction of the Manchester Ship Canal, the River Mersey is at potential risk of tidal flooding, with the most significant recent flood events occurring in February 1990 and October/November 2000. Any mitigation for this risk and interactions between the canals and the main rivers is being managed by the Environment Agency.

The Environment Agency therefore provides a major role in management of the flood risks from the canals and its interactions with the River Mersey.

At present the Flood Mapping of the Manchester Ship Canal in Warrington may be subject to revision as a result of further work needed to establish the level of risk if any from the Manchester Ship Canal and this is being led by the Environment Agency.

Figure 13: Extract of Environment Agency Flood Map for Planning



7 Climate Change and Long Term Development

Generally, preliminary assessment reports in 2011 described only the broad implications of climate change at river basin district level, based on UK Climate Projections, 2009 (UKCP09).

The next set of climate projections is due in 2018 (UKCP18). Until then UKCP09 is still a valid tool to aid decision-makers to assess the full range of risks from the changing climate and advise to adapt.

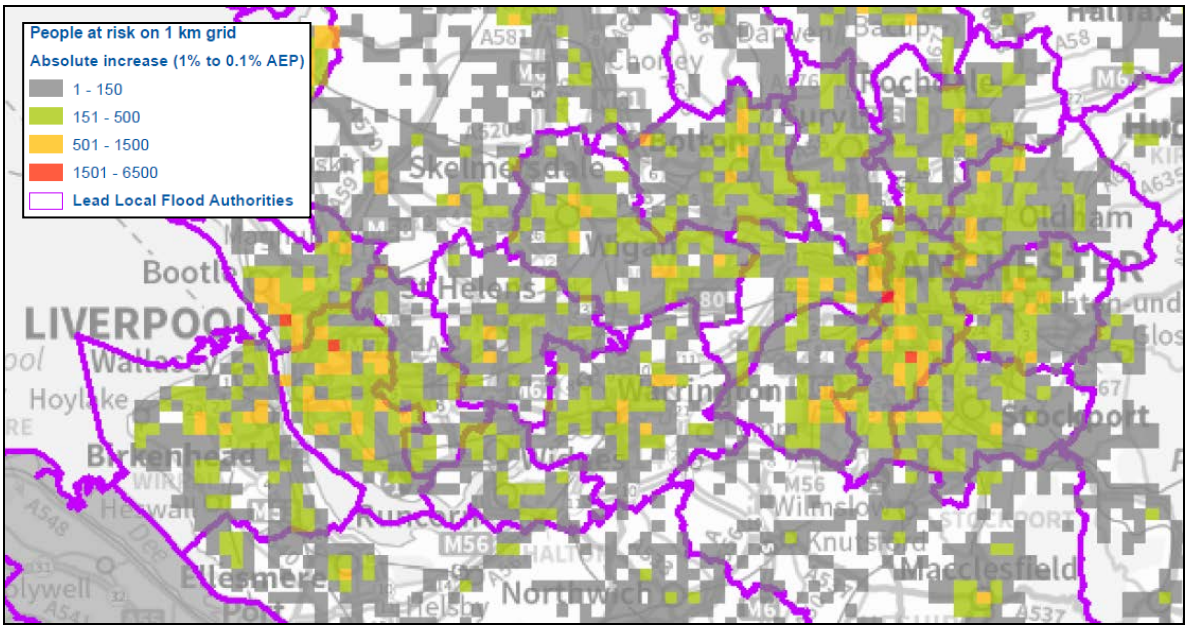
7.1 Initial Review

Whilst a significant amount of work has been completed since the introduction of the PFRA in 2011 it is still recognised that the implications of climate change for local flood risk are still not well understood.

The Environment Agency have carried out a simple analysis at the national level to compare the number of people at risk from surface water flooding for a rainfall event with a 1% chance (1 in 100 year return period) of occurring in any year with the number at risk from an event with a 0.1% chance (1 in 1000 year return period) of occurring in any year. The numbers of people at risk are counted per 1 kilometre grid square across England. The resulting 'heat map' shows how the absolute number of people at risk increases between these two rainfall events for each 1km grid square.

This method is not based on climate projections, and it does not account for future population growth. It does provide a simple way, however, of identifying areas that could be susceptible to increased rainfall intensity as a proxy for climate change. It is a reasonable proxy for an upper end climate change scenario for the end of the century, both in the pattern of change across the country and the percentage increase in intensity compared to the current climate. Figure 14 shows an extract from the 'heat map'. Red and orange squares indicate the highest increase in numbers of people at risk, and green and grey indicate lower increases.

Figure 14: Extract from the 'heat map' illustrating absolute increase in numbers of people at risk from surface water flooding for a 0.1% (1000 year) rainfall event compared to a 1% event (100 year)



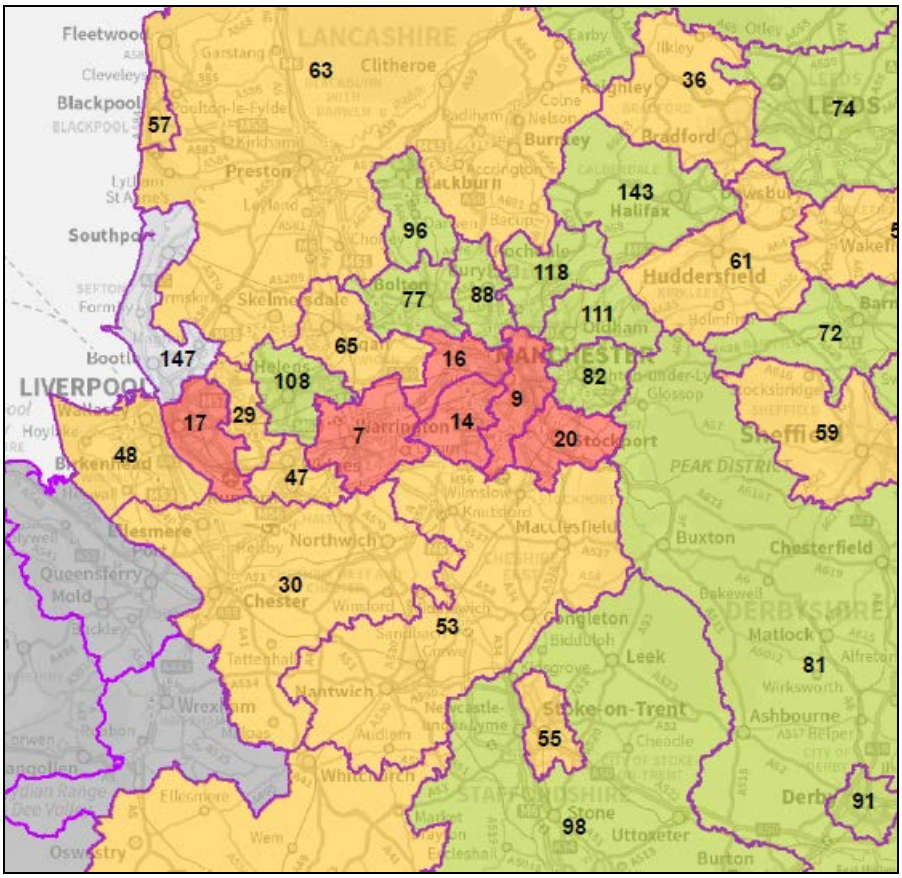
This 'heat map' provides an initial understanding of how climate change may affect local flood risk in the future, and helpful when considering the indicative FRAs as part of this PFRA review.

At the national scale the administrative area of Warrington Borough Council is positioned 7th out of 152 LLFAs when reviewing the percentage increase in people at risk of flooding in LLFAs for the 0.1% rainfall event compared with the 1% event.

Table 17: Absolute and percentage Increase in the number of people at risk of flooding by LLFA for 0.1% (1000 year) rainfall event compared with 1% (100 year) event

Rank	LLFA Name	Residential properties (1 in 100 year)	Residential properties (1 in 1000 year)	Non residential properties (1 in 100 year)	Non residential properties (1 in 1000 year)	Number of People (1 in 100 year)	Number of People (1 in 1000 year)	Absolute increase between 1 in 100 and 1 in 1000 year	Percentage increase in people at risk
1	City of Portsmouth (B)	392	5,452	98	617	917	12,758	11,841	1291
2	Newham London Boro	1,463	14,514	109	1,154	3,423	33,963	30,540	892
3	North East Lincolnshire (B)	1,021	9,874	71	688	2,389	23,105	20,716	867
4	City of Peterborough (B)	845	7,369	246	1,144	1,977	17,243	15,266	772
5	York (B)	520	4,530	33	340	1,217	10,600	9,383	771
6	Merton London Boro	1,777	15,077	201	1,056	4,158	35,280	31,122	748
7	Warrington (B)	890	7,298	117	855	2,083	17,077	14,994	720
8	Tower Hamlets London Boro	2,133	16,405	233	1,686	4,991	38,388	33,397	669
9	Manchester District (B)	2,151	15,865	271	1,985	5,033	37,124	32,091	638
10	Barking and Dagenham London Boro	918	6,371	124	645	2,148	14,908	12,760	594

Figure 15: Extract from percentage increase in the number of people at risk of flooding by LLFA for 0.1% (1000 year) rainfall event compared with 1% (100 year) event



*Label in LLFA boundary indicates the rank of the LLFA in order of largest to smallest percentage increase in number of people at risk.

7.2 The Impacts of Climate Change – The Evidence

Over the past century around the UK sea level rises have occurred and more of our winter rain falls in intense wet spells. Seasonal rainfall is highly variable. It seems to have decreased in summer and increased in winter, although winter amounts changed little in the last 50 years. Some of the changes might reflect natural variation; however the broad trends are in line with projections from climate models.

Greenhouse gas (GHG) levels in the atmosphere are likely to cause higher winter rainfall in future. Past GHG emissions mean some climate change is inevitable in the next 20-30 years. Lower emissions could reduce the amount of climate change further into the future, but changes are still projected at least as far ahead as the 2080's.

There is enough confidence in large scale climate models to say that Warrington Borough Council and the UK must plan for change. There is more uncertainty at a local scale but model results can still help to plan to adapt. For example it is now understood that rain storms may become more intense, even though there are still uncertainties about exactly where or when. By the 2080s, the latest UK climate projections (UKCP09) are that there could be around three times as many days in winter with heavy rainfall (defined as more than 25mm in a day). It is plausible that the amount of rain in extreme storms (with a 1 in 5 annual chance, or rarer) could increase locally by 40%.

7.3 Key Projections for North West River Basin District

If emissions follow a medium future scenario, UKCP09 projected changes by the 2050s relative to the recent past in the North West are:

- Winter precipitation increases of around 14% (very likely to be between 4 and 28%)
- Precipitation on the wettest day in winter up by around 11% (very unlikely to be more than 25%)
- Relative sea level at Morecambe very likely to be up between 6 and 36cm from
- 1990 levels (not including extra potential rises from polar ice sheet loss)
- Peak river flows in a typical catchment likely to increase between 11 and 18%

Increases in rain are projected to be greater near the coast than inland.

7.4 Implications for Flood Risk

Climate changes can affect local flood risk in several ways. Impacts will depend on local conditions and vulnerability.

Wetter winters and more rain falling in wet spells may increase river flooding especially in steep, rapidly responding catchments. More intense rainfall causes more surface runoff, increasing localised flooding and erosion. In turn, this may increase pressure on drains, sewers and water quality. Storm intensity in summer could increase even in drier summers, so Warrington needs to be prepared for the unexpected.

Rising sea or river levels may also increase local flood risk inland or away from major rivers because of interactions with drains, sewers and smaller watercourses.

Where appropriate, Warrington will be involved in local studies to understand climate impacts in detail, including effects from other factors like land use. Sustainable development and drainage will help with adaptation to climate change and manage the risk of damaging floods in future.

7.5 Adapting to Change

Past emission means some climate change is inevitable. It is essential Warrington and the UK respond by planning ahead. Warrington can prepare by understanding current and future vulnerability to flooding, developing plans for increased resilience and building the capacity to adapt. Regular review and adherence to these plans is key to achieving long-term, sustainable benefits.

Although the broad climate change picture is clear, Warrington Borough Council has had to make local decisions with less certainty. A range of measures therefore will need to be considered to retain the flexibility to adapt. This approach, embodied within flood risk appraisal guidance, will help to ensure that Warrington does not increase the vulnerability to flooding.

7.6 Long Term Developments

It is possible that long term developments might affect the occurrence and significance of flooding. However current planning policy aims to prevent new development from increasing flood risk.

In England, Section 10 of National Planning Policy Framework (section of relevance formally Planning Policy Statement 25 - PPS25) on development and flood risk aims to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at highest risk. Where new development is,

exceptionally, necessary in such areas, policy aims to make it safe without increasing flood risk elsewhere and where possible, reducing flood risk overall.

Adherence to Government policy ensures that new development does not increase local flood risk. However, in exceptional circumstances the Local Planning Authority may accept that flood risk can be increased contrary to Government policy, usually because of the wider benefits of a new or proposed major development. Any exceptions would not be expected to increase risk to levels which are "significant" (in terms of the Government's criteria).

At the time of writing, the Strategic Flood Risk Assessment Level 2 and Local Plan Core Strategy are currently under review and as such a full assessment cannot be undertaken.

Warrington Borough Council will continue to ensure new developments will where possible manage surface water at source and ensure developments do not contribute to flooding problems elsewhere. Where possible, new developments may relieve existing problems by improved management of surface water flows.

8 Review of Indicative Flood Risk Areas

8.1 Overview

As described in Section 4 in order to ensure a consistent national approach, DEFRA have identified significant criteria and thresholds to be used for defining FRAs.

Guidance on applying these thresholds has been released in the Environment Agency's "Review of preliminary flood risk assessments (Flood Risk Regulations 2009): Guidance for lead local authorities in England" (25th January 2017) which superseded DEFRA's "Selecting and reviewing Flood Risk Areas for local sources of flooding" (first published September 2013, withdrawn February 2017). This guidance document sets out agreed key risk indicators and threshold values which must be used to determine FRAs.

The methodology is based on using national flood risk information to identify 1km grid squares where local flood risk exceeds a defined threshold. Where a cluster of these grid squares leads to an area where flood risk is most concentrated and over 30,000 people are predicted to be at risk of flooding, this area has been identified as an Indicative FRA.

None of the clusters shown affect more than 30,000 people across the study area and therefore there are no Indicative FRAs within the Warrington Borough Council boundary as defined by the PFRA criteria.

Warrington Borough Council has accepted the current proposed indicative significant FRAs. However, it is recognised that Warrington has many locally significant flood risk issues.

9 Next Steps

9.1 Future Data Management Arrangements

9.1.1 Investigation

In order to continue to fulfil the role of Local Lead Flood Authority Warrington Borough Council is required to investigate future flood events and ensure continued collection, assessment and storage of flood risk data and information. The central flood data collection spreadsheet will be updated with each flood event.

9.1.2 Policy for Investigation and Recording

All flood events will be subject to investigations and recording. The local threshold for formal investigation leading to publication is a flood event with significant consequences.

A flood event with significant consequences is one that has had, or could have had if action had not been taken, one or more of the following impacts:

- Resulted in major disruption to the flow of traffic.
- Posed, or could have posed, a risk to human health.
- Adversely affected the functioning of critical infrastructure.
- Caused harmful impacts to environmentally and socially important assets.
- Caused internal flooding to a property used for residential or commercial purposes.

It is crucial that all records of flood events are documented consistently and in accordance with the INSPIRE Directive (2007/2/EC), European Directive transposed into UK Law in December 2009. The centralised database will be kept up to date by Warrington Borough Council, who has the overall responsibility to manage flood data throughout the administrative area. This can be used as an evidence base to inform future assessments and reviews and for input into the mapping and planning stages.

9.1.3 Asset Register

Section 21 of the FWMA 2010 states that LLFAs have a duty to maintain a register of structures or features which, in the opinion of the authority, are likely to have a significant effect on a flood risk in its area, and a record of information about each of those structures or features, including information about ownership and state of repair. Warrington Borough Council is continuing to develop this database.

The Councils register is available to view at the following web address:

http://www.jbamap.co.uk/map/la/warringtonassetregister/

9.2 Review Procedures

Meeting quality standards is important in order to ensure that the appropriate sources of information have been used to understand flood risk and the most significant FRAs are identified.

The review procedure will comprise two key steps, namely, Local Authority Review and Environment Agency Review. The Review Checklist in Annex 4 of this document is used by all LLFA's and the Environment Agency to review and ensure a consistent review process is applied.

9.2.1 Local Authority Review

The first part of the review procedure is through internal Local Authority review of the PFRA in accordance with appropriate internal review procedures, quality assurance and resilience. The Council will then take it for approval in accordance to Corporate Procedures before being delivered to the Environment Agency to ensure national consistency.

The review of the PFRA for Warrington Borough Council will be undertaken by the Engineering and Flood Risk Manager and the Portfolio Holder for Highways, Transportation and Public Realm.

The PFRA must be reviewed and updated every 6 years. The first edition of the PFRA was submitted to the Environment Agency on 22nd June 2011. This report (the second edition) is the first review and is to be submitted to the Environment Agency on 22nd June 2017 under Sections 10 and 17 of FRR 2009.

9.2.2 Environment Agency Review

Under Section 10 of FRR 2009 the Environment Agency has been given a role in reviewing, collating and publishing all of the PFRAs once submitted.

The Environment Agency will undertake a technical review (area review and national review) of the PFRA, which will focus on instances where FRAs have been amended and ensure the format of these areas, meets the required standard. Once satisfied, the Environment Agency will then recommend submission of the PFRA to the North West Regional Flood and Coastal Committee (RFCC) for endorsement if satisfied. The RFCC will make effective use of their local expertise and ensure consistency at a regional scale. Once the RFCC has endorsed the PFRA, the relevant Environment Agency Regional Director will sign it off.

All PFRAs obtained by the Environment Agency will then be collated, published and submitted to the European Commission by 22nd December 2017 under Section 16 of FRR 2009.

Future review cycles, of no more than 6 years, will use the same procedure described above.

Appendix A: Figures

Appendix B: Methods used to develop indicative FRAs for the second cycle

Extract from Review of preliminary flood risk assessments (Flood Risk Regulations 2009): guidance for lead local flood authorities in England (25th January 2017 – produced by the Environment Agency)

We used two methods to identify areas of potentially significant risk as the basis for the indicative FRAs. In each case we used national information from the current (2016) Risk of Flooding from Surface Water (RoFSW) map - previously known as the updated Flood Map for Surface Water (uFMfSW) - and a rainfall event with a 1% chance of occurring in any year.

Method 1 - Cluster analysis for concentrations of people/property at risk

In this method, 1km grid squares of places where surface water flood risk is an issue ("blue squares") were identified wherever at least 200 people or 20 non-residential properties or more than 1 key service might be flooded.

In some areas these blue squares are densely packed together representing a concentration of high consequences from surface water flooding and providing a way of identifying areas where flood risk could be significant. Where many grid squares are close together (clustered) and the risk is most concentrated, these clusters form indicative FRAs.

All clusters contain at least 5 adjacent blue squares. The flood risk indicators used in the identification of indicative FRAs are summarised in the table below. These are similar to those used to develop indicative FRAs in 2011, but using a rainfall event with a 1% chance of occurring in any year rather than 0.5% chance as in 2011. This is because current surface water risk products do not include the assessment of a 0.5% chance rainfall event.

Table B-1: Definition of flood risk indicators used in cluster analysis

Indicator	Definition	Threshold
People	Number of people at risk taken as 2.34 times the number of residential properties at risk of flooding	200 people or more per 1km grid square
Key Services	Number of key services at risk, for example utilities, emergency services, hospitals, schools	2 or more per 1km grid square
Non-residential Properties	Number of non-residential properties at risk from flooding	20 or more per 1km grid square

Method 2 - Communities at risk (C@R)

Method 1 identifies locations where the density of flood risk is highest across the country. There are other locations where the total flood risk is high but not as concentrated as those areas identified in method 1. So, to complement method 1, we have used information from our C@R work.

For C@R we have analysed the surface water flood risk for communities according to Office for National Statistics built-up areas (BUAs) and built-up areas sub-divisions (BUASDs).

Built-up areas (BUAs) are characteristic of settlements including villages, towns or cities. In 2011 across England and Wales 95 per cent of the usually resident population lived in BUAs. They include areas of built-up land with a minimum of 20 hectares (200,000m2). Any areas with less than 200 metres between them are linked to become a single BUA, with BUASDs identified.

Where available, we have used BUASDs to provide greater granularity of communities in large urban areas. Where this approach identifies 3,000 or more reportable properties at risk of surface water flooding, the BUA/BUASD forms an indicative FRA. As with method 1, this is for a rainfall event with a 1% chance of occurring in any year.

The National Receptor Database (NRD2014) property point dataset with the uFMfSW Property Point v3 attributes was used to classify a property as 'at risk' of flooding from surface water. 'At risk' properties were counted by BUASD boundary (to exclude non-reportable property points e.g. telephone boxes, advertising hoardings).

Combining method 1 and method 2 and identifying indicative FRAs

In some locations, clusters of blue squares from method 1 and BUA/BUASDs from method 2 overlap. Where this is the case, the indicative FRA is the total extent of the two areas combined.

Appendix C: Limitations to the Methods used to develop indicative FRAs for the second cycle

Method 1 - Cluster analysis for concentrations of people/property at risk

Grid-based approach

Warrington Borough Council had two main concerns regarding the approach taken by the Environment Agency.

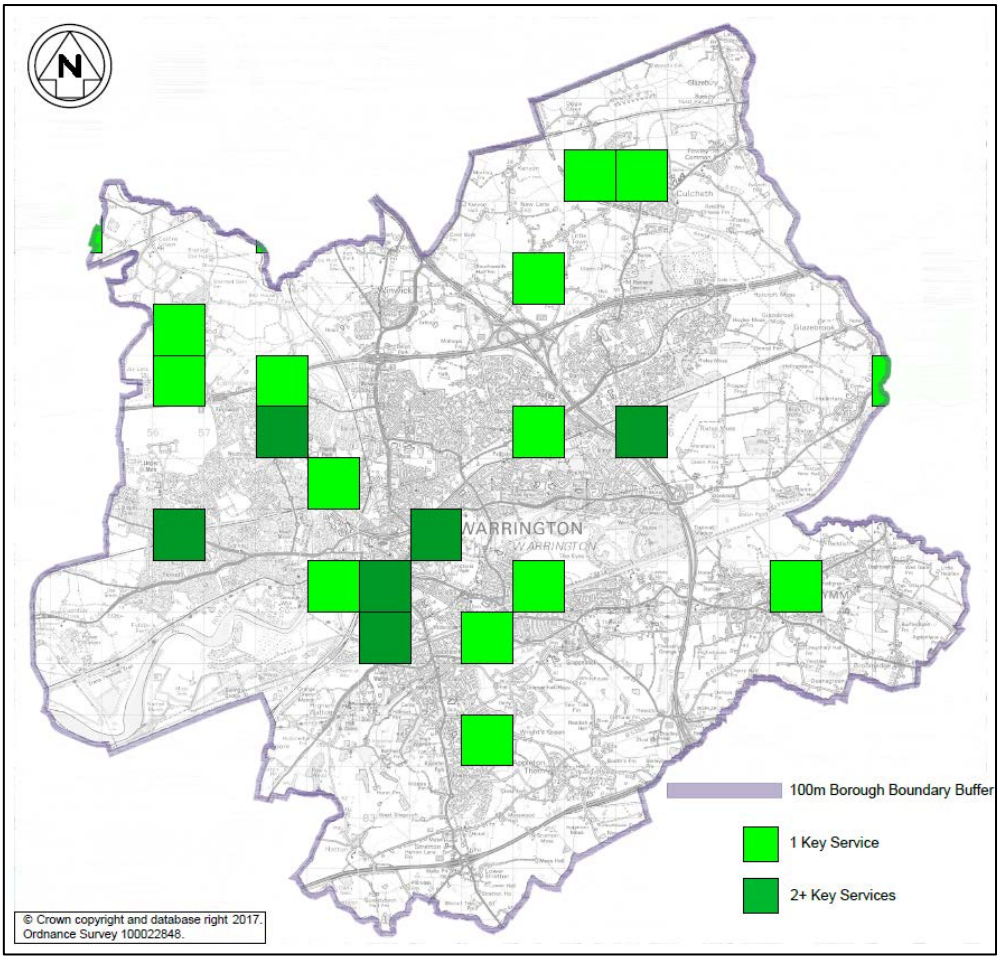
1. The requirement for two critical services to be within the threshold may be misrepresentative of the importance of those critical services. For example:

    - Two nursing homes would outrank a hospital or;
    - Two electricity sub-stations would outrank a school.

    Whilst these issues can be followed up on an individual basis, the standard procedure would not pick up a grid square containing a single, but vital, critical service.

    Warrington Borough Council under took an internal review of the dataset to identify all critical services with the Borough and are illustrated in figure C-1 below.

Figure C-1: Review of Critical Services at Risk of Flooding from Surface Water

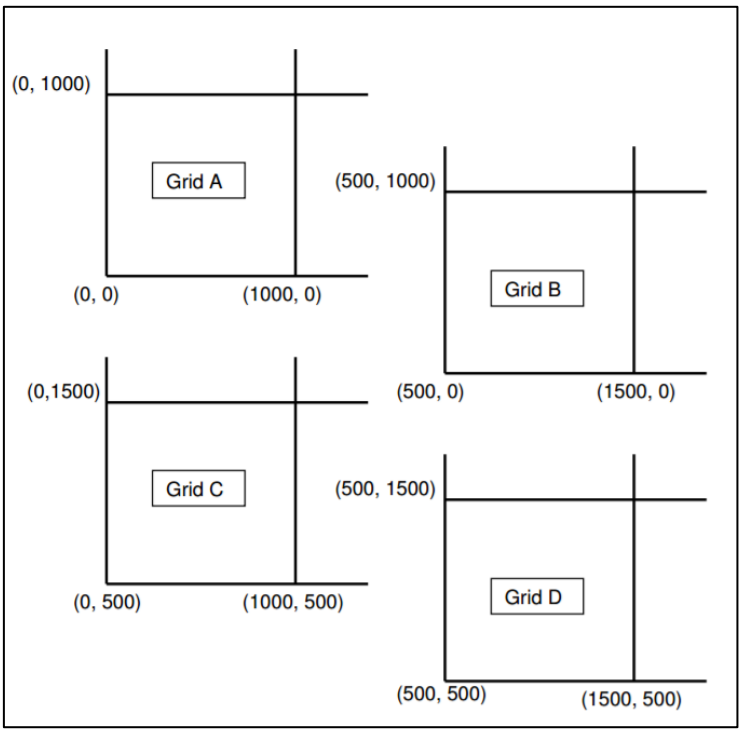


Warrington Borough Council agrees with all the critical service locations identified by the Environment Agency at risk of flooding, including those which are above the threshold. There were no locations identified that resulted in outranking as in the aforementioned example.

2. The grid-based approach contains an arbitrary reference. The geographical location of each grid square depends upon the grid origin, which is set by the Ordnance Survey grid system. If for example the grid square was repositioned by 500m, as illustrated in Figure C-2, then the number of critical services within a 1km^2 may alter and thus may / may not adhere to the desired threshold.

   Warrington Borough Council did not undertake any further analysis to a shift in the grid system as the Ordnance Survey grid system is considered to be a national standard.

Figure C-2: Variation to shift in grid system



Allocation of Critical Services

The National Receptor Dataset (NRD) contains a property categorisation code that links to methods in the Multi-Coloured Manual (MCM) for estimating flood damages based on flood depth. NRD links individual property types in the property points dataset (known as OS BaseFunction property types) to MCM codes, to facilitate flood damage estimation. Each MCM code is therefore a broad category (such as 'hospital') containing a number of detailed property types. In defining the detail of flood risk indicators the Environement Agency based indicators on MCM codes where suitable, and used more detailed OS BaseFunction property types where the property classification was not suitable.

For the purpose of the PFRA, critical services are defined by the Environment Agency in Table C-1.

Table C-1: Critical Services

Critical Service	MCM Code	Description
Schools	Not used	Initially MCM code 610 was considered (described as School, College, University, Nursery). However this includes some OS Base Function property types that are not critical services, such as 'vehicle driver training' and 'training'. Instead the Environment Agency chosen a set of OS Base Function types: Education First School Further education college High School Higher Education Infant School Junior School Middle School Nursery Primary School Private School School School for the Deaf Secondary School Special School Technical School University Pre-school Education Etc....
Hospitals	660	-
Nursing/Care/Retirement Homes	625	Predominately comprises nursing homes and rest homes, but also covers a number of other institutions, including prisons.
Police Stations	651	-
Fire and Ambulance Stations	650	-
Prisons	625	Predominately comprises nursing homes and rest homes, but also covers a number of other institutions, including prisons.
Sewerage Treatment Works	840	-
Electricity Installations	960	-

Warrington Borough Council undertook a sensitivity analysis as part of the PFRA review. Whilst the methodology utilised by the Environment Agency is considered acceptable, caution was required to the sub-classification of these and their relevance. Reviewing the 2013 Multi-Coloured Manual (Chapter 5: Flood damage to non-residential properties) a number of NRD codes were incorrect,

duplicated, or categorised as generic within the Warrington area. An example of this is illustrated in Table C-2.

Further information to the classification of NRD to MCM codes can be obtained from the following location:

http://www.mcm-online.co.uk/wp-content/uploads/2015/05/Ch5-Matching-NRD-to-MCM-Codes.pdf

Table C-2: Example of Critical Services Discrepancy within Warrington

Environment Agency Review		Warrington Borough Council Review	
Critical Service	**MCM Code**	**Critical Service**	**MCM Code**
Hospitals	660	Hospice	6
		Hospital	6
		Hospital / Hospice	6
		Medical	6
		Professional Medical Service	6

The internal review process identified no additional critical services at risk of flooding with respect to the Environment Agency review. However, it did provide an overview to critical services which are beyond the threshold but may be vulnerable to future flooding

Number of people at risk of surface water flooding

In order to verify information provided by Environment Agency, Warrington Borough Council undertook an internal review to assess confidence in the data.

The population per household for the PFRA assessment has been set by the Environment Agency as 2.34. The 2.34 multiplier is based on the Office for National Statistics General Household Survey, 2006. According to the Office for National Statics Census information, the average household size in the UK was 2.30 people per household, compared to 2.40 in 2001. The average population with the 22 wards of Warrington is 2.30 (2011 census). Whilst the population factor used for the PFRA is considered acceptable for Warrington at the national level, caution is required due to the population distribution at the local level which may result in a $1km^2$ exceeding the $\geq$200 people threshold.

Table C-3: Populations per household within Warrington

Warrington	Population per Household (2011 census)*
Appleton	2.5
Bewsey and Whitecross	2.2
Birchwood	2.2
Burtonwood	2.4
Culcheth	2.4
Fairfield and Howley	2.0
Grappenhall	2.4

Warrington	Population per Household (2011 census)*
Great Sankey North	2.4
Great Sankey South	2.4
Hatton, Stretton and Walton	2.6
Latchford East	2.2
Latchford West	2.1
Lymm	2.4
Orford	2.4
Penketh and Cuerdley	2.4
Poplars and Hulme	2.3
Poulton North	2.3
Poulton South	2.4
Rixton and Woolston	2.4
Stockton Heath	2.3
Westbrook	2.6
Whittle Hall	2.6

*Values have been rounded to one decimal place

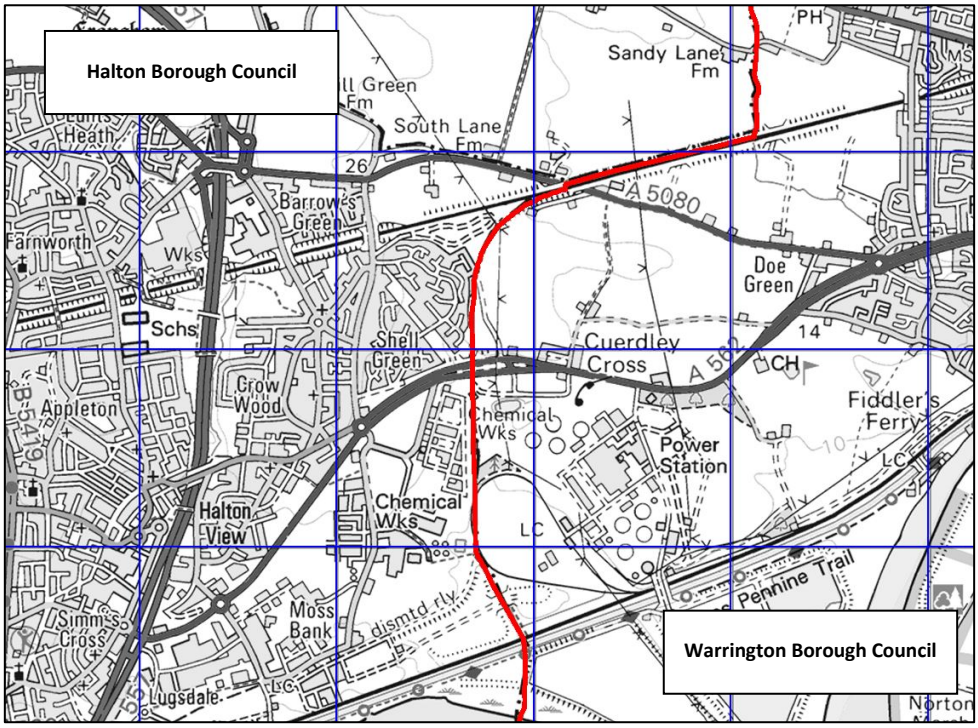
In relation to Point 2 of the grid-based approach, any amendment to the positioning the grid square may result in exceedance of the >200 people threshold.

Council Boundary - 1km^2 grid vs Actual Boundary

The outputs of calculating critical services, residential and non-residential properties within the Warrington area is contained within the 1km^2 grid square provided by the Environment Agency. As illustrated in Figure C-3 the administrative boundary divides the square, thus a discrepancy is created between the Council's dataset and that provided by the Environment Agency.

Warrington Borough Council was in regular consultation with neighbouring authorities to confirm the correct definition of the administrative boundary, identify any areas of cross broader developments, and confirm which grid squares may skew the results of data analysis (i.e. double counting). Only minimal discrepancies where identified thus enabling to increase confidence in the dataset provided by the Environment Agency.

Figure C-3: Example of Administrative Boundary dividing 1km^2 Grid Square



Annexes

Annexe 1	**Past Floods**
Annexe 2	**Future Floods**
Annexe 3	**Flood Risk Areas**
Annexe 4	**PFRA Checklist**