Hull City Council
Preliminary Flood Risk Assessment

Draft Report

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Halcrow

Preliminary Flood Risk Assessment

Revision schedule

Date	Document reference	Stage	Author	Reviewer
9.5.2011	PFRA	Working draft v0.2	Phillip Mcloughlin	Donald Daly
28.07.11	PFRA & all annexes	Final amendments and submission	Steve Wragg	Hull City Council

Executive Summary

This report summarises the Preliminary Flood Risk Assessment undertaken for Hull City Council. The PFRA has been undertaken to assist Hull City Council to meet its duties as a Lead Local Flood Authority, with the delivery of the first stage of the Flood Risk Regulations (2009). These regulations implement the EU Floods Directive in the UK.

The PFRA is a high level screening exercise that compiles information on significant local flood risk (any flood risk that does not originate from main rivers, the sea or large reservoirs) from past and future floods, based on readily available and derivable information. The PFRA also includes the identification of flood risk areas where the final two stages of the Flood Risk Regulations apply; stage three delivers Flood Risk Maps and stage four delivers Flood Risk Management Plans.

This study has identified June 2007 as a flood that is considered to have had significant harmful consequences. This is based on the following local definition of harmful consequences: 'Memorable past floods or otherwise registered on a national scale even if only occurring over a relatively small area.' The 2007 flood in Hull affected over 8,000 homes and 1,300 businesses, and more than 90 of the city's schools. The estimated cost of the June 2007 flood damage to Hull City Council's own housing stock was in the order of £41M (with the total cost considerably higher than this figure).

Future flood risk is estimated to be high in the city. Based on the Areas Susceptible to Surface Water Flooding (AStSWF) outputs, it is estimated that approximately 19,557 properties are estimated to be at risk from flooding during a rainfall event with a 1 in 200 annual chance of occurring. This includes 4600 properties within the adjacent East Riding of Yorkshire.

The indicative flood risk areas provided by the Environment Agency have been reviewed based on the local knowledge of past and future floods. The outcome of this review is that the indicative flood risk areas can be used as the flood risk areas for the undertaking of stages three and four of the regulations with some agreed boundary changes between the two LLFA's. The FRA for Hull covers an area of the East Riding of Yorkshire Council, it is intended to rename the area as the Kingston upon Hull and Haltemprice FRA and both authorities will work in partnership to deliver the requirements of the latter stages of the regulations.

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Glossary

Term	Definition
Aquifer	A source of groundwater comprising water bearing rock, sand or gravel capable of yielding significant quantities of water.
AMP	Asset Management Plan is a tactical plan for managing an organisation's infrastructure and other assets to deliver an agreed standard of service.
Area susceptible to groundwater flooding	Coarse scale national mapping showing areas that are susceptible to groundwater flooding.
AStSWF	Areas Susceptible to Surface Water Flooding is the first generation national mapping outlining area of risk from surface water flooding across the country. It is reported with three susceptibility bandings (less, intermediate and more).
CFMP	Catchment Flood Management Plans considered all types of inland 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.
CDA	Critical Drainage Area is an area within Flood Zone 1 which has critical drainage problems and which has been notified to the local planning authority by the Environment Agency.
CIRIA	Construction Industry Research and Information Association.
Civil Contingencies Act	This Act delivers a single framework for civil protection in the UK. As part of the Act, Local Resilience Forums must put into place emergency plans for a range of circumstances including flooding.
CLG	Government Department for Communities and Local Government.
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions.
CSO	Combined Sewer Overflow is a structure that discharges excess wastewater directly to nearby streams, rivers, or other water bodies when the wastewater volume in a combined sewer system exceeds the capacity of the sewer system or treatment plant.
Culvert	A channel or pipe that carries water below the level of the ground.
Defra	Government Department for Department for Environment, Food and Rural Affairs.
DEM	Digital Elevation Model represents the earth's surface and includes all objects on it.
DG5 Register	A water-company held register of properties which have experienced sewer flooding due to hydraulic overload, or properties which are 'at risk' of sewer flooding more frequently than once in 20 years.

Term	Definition
DTM	Digital Terrain Model represents the bare ground surface without any objects like plants and buildings.
EA	Environment Agency is the leading public body for protecting and improving the environment in England and Wales.
Indicative Flood Risk Areas	Areas determined by the Environment Agency as indicatively having a significant flood risk, based on guidance published by Defra and the use of certain national datasets. These indicative areas are intended to provide a starting point for the determination of Flood Risk Areas by LLFAs.
FMfSW	Flood Map for Surface Water is the updated (second generation) national surface water flood mapping which was released at the end of 2010. This database includes two flood events (with a 1 in 30 and a 1 in 200 annual chance of occurring) and two depth bandings (greater than 0.1m and greater than 0.3m).
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood map	Flood map shows the extent of flooding from rivers and the sea for catchments greater than 3km^2.
FMIP	Flood Mitigation Investment Plan is an investment programme for the delivery of solutions that will mitigate flood risk with the greatest integration of actions.
Flood Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra.
Flood Risk Regulations	Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.
Floods and Water Management Act	Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the legislative framework for managing surface water flood risk in England.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a main river.
FRR	Flood Risk Regulations(2009). These regulations implement the EU Floods Directive in the UK.
Historic flood map	Attributed spatial flood extent data for flooding from all sources.
IDB	Internal Drainage Board.
IUD	Integrated Urban Drainage is a holistic approach to managing urban drainage flooding, so that towns and cities across the country are better prepared for the impacts of climate change.
LDD	Local Development Documents is the collective term for development plan documents and supplementary planning documents.

Term	Definition
LDF	Local Development Framework is the name for the portfolio of local development documents. It consists of the local development scheme, a statement of community involvement, development plan documents, supplementary planning documents, and the annual monitoring report. Within Hull this document is referred to as the Hull development framework.
LLFA	Lead Local Flood Authority responsible for taking the lead on local flood risk management.
LiDAR	'Light Detection and Ranging' is an airborne terrain mapping technique which uses a laser to measure the distance between the aircraft and the ground.
LRF	Local Resilience Forum is a multi-agency forum, bringing together all the organisations that have a duty to cooperate under the Civil Contingencies Act, and those involved in responding to emergencies. They prepare emergency plans in a co-ordinated manner.
LPA	Local Planning Authority.
Main River	A watercourse shown as such on the Main River Map and for which the Environment Agency has responsibilities and powers.
NRD	National Receptor Dataset is a collection of risk receptors covering social economic and environmental and cultural receptors produced by the Environment Agency including residential properties, schools, hospitals, transport infrastructure and electricity substations.
Ordinary Watercourse	All watercourses that are not designated Main River, and which are the responsibility of Local Authorities or, where they exist, IDB's.
Partner	A person or organisation with responsibility for the decision or actions that need to be taken.
PFRA	Preliminary Flood Risk Assessment is a high level screening exercise that compiles information on significant local flood risk from past and future floods, based on readily available and derivable information.
Pitt Review	Comprehensive independent review of the 2007 summer floods by Sir Michael Pitt, which provided recommendations to improve flood risk management in England.
Pluvial Flooding	Flooding from water flowing over the surface of the ground; often occurs when the soil is saturated and natural drainage channels or artificial drainage systems have exceeded their drainage capacity.
PPS25	Planning and Policy Statement 25: Development and Flood Risk.
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.
Resistance Measures	Measures designed to keep flood water out of properties and businesses; could include flood guards for example.
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.

Term	Definition
RMA	Risk Management Authority as defined by the Floods and Water Management Act
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SFRA	Strategic Flood Risk Assessment should be carried out by the local planning authority to inform the preparation of its LDDs, having regard to catchment-wide flooding issues which affect the area may contain useful information on historic flooding, including local sources of flooding from surface water and groundwater.
Stakeholder	A person or organisation affected by the problem or solution, or interested in the problem or solution. They can be individuals or organisations, includes the public and communities.
SuDS	Sustainable Drainage Systems. Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Surface water	Rainwater (including snow and other precipitation) which is on the surface of the ground (whether or not it is moving), and has not entered a watercourse, drainage system or public sewer.
SWMP	Surface Water Management Plan.
YW	Yorkshire Water
WaSC	Water and Sewerage Company.
WwTW	Wastewater Treatment Works.

1 Introduction

1.1 What is a Preliminary Flood Risk Assessment?

This report summarises the Preliminary Flood Risk Assessment (PFRA) undertaken for Hull City Council. It has been carried out to assist Hull City Council to meet its duties as a Lead Local Flood Authority (LLFA) with the delivery of the first stage of the Flood Risk Regulations (2009). These regulations implement the EU Floods Directive in the UK.

The PFRA is a high level screening exercise that compiles information on significant local flood risk from past and future floods, based on readily available and derivable information. The PFRA also includes the identification of flood risk areas where the subsequent two stages of the Flood Risk Regulations apply; stage two delivers Flood Risk Maps and stage three delivers Flood Risk Management Plans. The timescales for undertaking the three stages of the flood risk regulations are summarised in Table 1.1.

Table 1.1 – Stages of the Flood Risk Regulations

Stage	Flood Risk Regulations 2009 for LLFAs
1	LLFAs to undertake PFRAs on local flood risk by 22 June 2011, within their administrative boundaries.
	LLFAs or groups of LLFAs to confirm or to propose alternative Flood Risk Areas from indicative flood risk areas already identified in national datasets by 22 June 2011.
2	LLFAs to prepare Flood Hazard and Flood Risk Maps by 22 June 2013 for the flood risk areas and in relation to local flood risk.
3	LLFAs to prepare Flood Risk Management Plans of the identified flood risk areas by 22 June 2015.

Note 1: This table does not cover the tasks undertaken by the Environment Agency to comply with the Flood Risk Regulations in relation to flooding from main rivers, the sea and large reservoirs.

Note 2: Tasks 2 and 3 have not been undertaken as part of this study.

Local flood risk is defined as flood risk originating from sources other than main rivers, the sea and large reservoirs and principally meaning flood risk from surface runoff, groundwater and ordinary watercourses. This main definition of local flood risk requires further clarification:

a) it includes lakes and ponds;

b) it does not consider flooding from sewers unless this is wholly or partly caused by rainwater or other precipitation entering or otherwise affecting the system;

c) it does not include flooding from water supply systems (for example burst water mains); and

d) it considers the interaction with flooding from main rivers, the sea and sewers.

1.2 Background

On 25 June 2007 an unprecedented amount of rain fell on the city of Hull and the surrounding area. All drainage systems were overwhelmed leading to extensive surface water flooding across the city. Over 8,000 homes and 1,300 businesses were flooded and over 90 of the city's schools were affected by floodwaters. Hull City Council believes the cost of the June 2007 flood damage to its own housing stock to be in the order of £41M (ref. Economic Development and Regeneration Project correspondence), with the total cost considerably higher than this figure. The floods have raised awareness of the vulnerability of the city of Hull to flooding from all sources. The actual or perceived threat of further flooding presents uncertainty to all forms of inward investor, these conditions can constrain the development of the city with consequential impacts on the community.

Hull City has appointed Halcrow Group Ltd to undertake a Flood Mitigation Investment Plan (FMIP). The FMIP will provide an investment programme for the delivery of solutions that will mitigate flood risk with the greatest integration of actions. The project will provide a robust and credible framework for longterm delivery of flood risk management infrastructure, but will also identify credible 'quick wins' that will alleviate flooding in known hot spots. This will enable early implementation of works on the ground to restore investor confidence. Halcrow Group Ltd has undertaken the PFRA for Hull City as part of the Flood Mitigation Investment Plan (FMIP).

1.3 Aim and Objectives of the PFRA

The main aim of this study was to undertake stage one of the flood risk regulations (the PFRA) (as shown in Table 1.1). The key objectives for the PFRA are summarised as follows:

- Identify relevant partner organisations involved in future assessment of flood risk; and summarise 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;
- 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 the consequences and impacts of these events;
- Assess the potential harmful consequences of future flood events within the study area;

- Review the provisional national assessment of indicative Flood Risk Areas provided by the Environment Agency and provide an explanation and justification for any amendments required to the Flood Risk Areas;

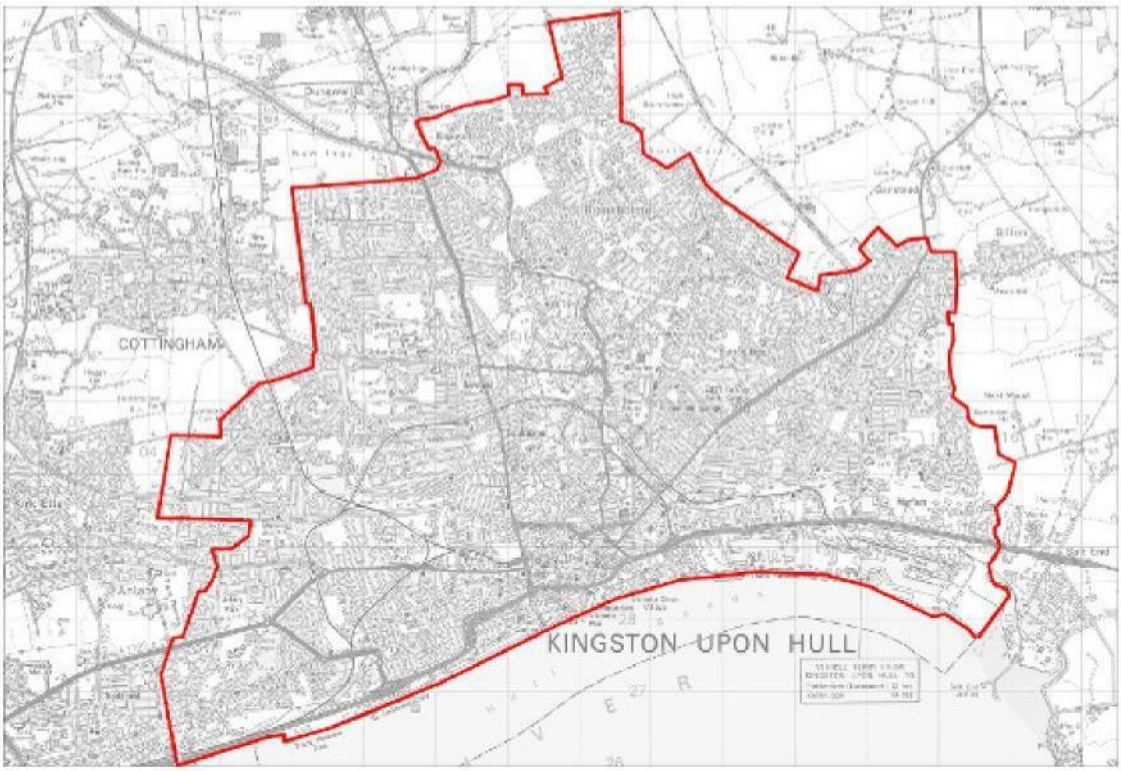
- Provide a summary of the systems used for data sharing and storing, and provision for quality assurance, security and data licensing arrangements;

- Provide advice on the next steps required to ensure that Hull City Council complies with its role as the LLFA – the PFRA is a key input into the Local Flood Risk Management Strategy required as part of the Flood and Water Management Act (2010).

1.4 Study Area

The study area covers the administrative boundary of Hull City Council. It however needs to take account of interactions with adjacent LLFA and in particular if floods are identified as covering more than one LLFA, i.e. the city with the surrounding area of the East Riding of Yorkshire. The city of Hull lies on the north bank of the Humber Estuary and has a population of approximately 250,000 covering a geographical area of 7,150 hectares. The city geographical boundary is defined in Figure 1.1

Figure 1.1 – Extent of Hull City Boundary



The Hull City area is mainly urban and is predominantly built on reclaimed marshland. Outside the boundary of Hull City Council and to the west of the city are the outlying settlements of Cottingham, Willerby and Kirk Ella which are situated on higher ground that drains eastwards towards the city. Hull City is bounded by land administrated by the East Riding of Yorkshire Council. Although the geographical boundary of this project is the area administered by Hull City Council and the focus of this study is principally to understand local flood risk within this area the mechanisms of the Hull and Haltemprice catchments which link the city with the surrounding area of the East Riding of Yorkshire are recognised.

Sewer network flooding, in extreme weather events, is a major concern for the city. Yorkshire Water has invested over £30 million in ensuring that its infrastructure in the city is as robust and resilient as possible and has detailed emergency and escalation procedures during heavy and sustained rainfall events including the use of East and West Hull pumping stations which are capable of pumping vast quantities of water out of the city. Surface water and sewerage in the city is discharged through a complex predominantly combined sewerage system. All foul flows ultimately end up at Hull WwTW located at Saltend (immediately to the east of the Hull CC administrative boundary) where full treatment occurs prior to discharge to the Humber Estuary. The Hull WwTW inlet works also includes facilities for screening storm discharges to the Humber estuary. There are no Combined Sewer Overflows (CSOs) within the Hull CC area and therefore all flows are conveyed to Hull WwTW. In extreme rainfall events, flows can also be discharged direct to the Humber Estuary as an emergency discharge via East and West Hull pumping stations. The Bransholme area of Hull is separately drained and surface water is discharged directly to the River Hull via a surface water pumping station and storage lagoon.

The Environment Agency has extensive flood defence assets within the city along the banks of both the River Hull and the Humber Estuary, consisting of embankments, flood walls, pumping stations and the Hull tidal surge barrier. A smaller network of Hull City Council, Beverley and North Holderness Internal Drainage Board and privately maintained flood defence infrastructure is also present within the city.

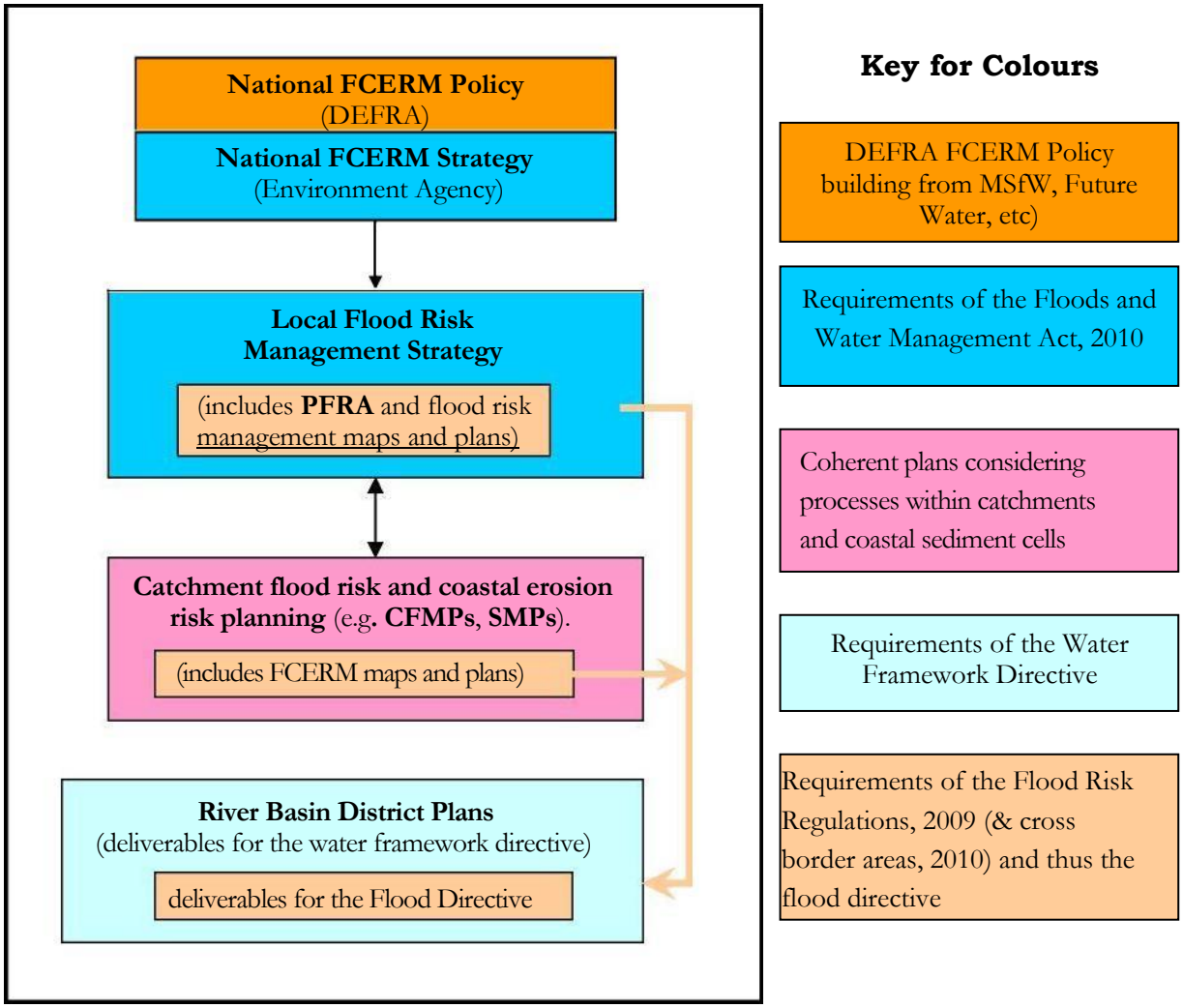
Further information on the rivers, hydrology, geology and topography within Hull City are provided in the level 1 and 2 Strategic Flood Risk Assessments undertaken for Hull City. These can be accessed at the following link: http://www.hull.gov.uk/resident/planning-and-building-control/strategic-flood-risk-assessment

2 Lead Local Flood Authority Responsibilities

2.1 Legislative Background

The legislative background showing how the PFRA fits within this context is summarised in Figure 2.1 below:

Figure 2.1 – Legislative Background



FCERM = National strategy for Flood and Coastal Erosion Risk Management

DEFRA = Department of the Environment of Food and Rural Affairs

MSfW = Making Space for Water

CFMP = Catchment Flood Management Plan

SMP = Shoreline Management Plan

The Floods and Water Management Act was brought into UK law in 2010 to improve flood risk management and support continuity of water supply. A key feature of the Act is the implementation of recommendations from the Pitt Review into the summer 2007 flooding, thus increasing the emphasis on sources of flooding other than fluvial and tidal, in particular surface water which featured heavily in the 2007 flooding.

The Act gives a number of responsibilities and powers to both the Environment Agency and the Lead Local Flood Authorities. As mentioned in Section 1.1, the LLFA are made responsible for local flood risk and main rivers, the sea and large reservoirs are the responsibility of the Environment Agency. The Environment Agency will also be responsible for producing a National Strategy for Flood and Coastal Erosion Risk Management (FCERM) for England.

The PFRA for Hull will inform the future Local Flood Risk Management Strategy and the future update of the Strategic Flood Risk Assessment (SFRA) and other high level documents, such as the River Hull and Coastal Streams Catchment Flood Management Plan (CFMP).

2.2 Leadership and Partnership

As Lead Local Flood Authority, it is the role of Hull City Council to forge effective partnerships with the adjacent LLFA namely East Riding of Yorkshire Council, Yorkshire Water and the Environment Agency as well as other key stakeholders including Network Rail, Beverley and North Holderness Internal Drainage Board and the Highways Agency.

Through a number of previous flood risk projects within the city of Hull (Hull Catchment Flood Management Plan, River Hull Flood Risk Management Strategy, Hull Strategic Flood Risk Assessment, and Hull Surface Water Management Plan & Aqua Green Study), a pro-active flood risk partnership is already in place between key organisations, with protocols for data sharing and best practice already established. The flood risk management partnership and main stakeholders are listed below:

- Hull City Council, Regional Development Service and Street Scene (Land Drainage);
- Environment Agency;
- Yorkshire Water; and
- East Riding of Yorkshire Council, Land Drainage.

Beverley and North Holderness Internal Drainage Board provide drainage to rural areas to the immediate north of the Hull City Council area. Preston Internal Drainage Board also provides land drainage functions to rural areas to the east of Hull City Council around Bilton and Salt End.

2.3 Public Engagement

It is recommended that the best vehicle for engaging the public is by integrating the management of local flood risk with other Hull City initiatives, such as integrating with emerging development proposals and improving the amenity of parks and open spaces. This approach will require a sustained coordinated approach within the City.

It is recognised that members of the public may also have valuable information to contribute to the future stages of the PFRA and to local flood risk management. Stakeholder engagement can be of significant benefit 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.

It is important to undertake some public engagement when formulating local flood risk management plans as this will help to inform future levels of public engagement. It is recommended that Hull City Council follow the guidelines outlined in the Environment Agency's 'Building Trust with Communities' document which provides a useful process of how to communicate risk including the causes, probability and consequences to the general public and professional forums such as local resilience forums.

2.4 Other Responsibilities

Aside from forging partnerships and coordinating and leading on local flood management, there are a number of other key responsibilities that have arisen for Lead Local Flood Authorities from the Flood & Water Management Act and the Flood Risk Regulations. These responsibilities include:

- Investigating flood incidents – LLFAs have a duty to investigate and record details of significant flood events within their area.

- Asset Register – LLFAs also have a duty to maintain a register of structures or features which are considered to have an effect on flood risk, including details on ownership and condition as a minimum. The register must be available for inspection and the Secretary of State will be able to make regulations about the content of the register and records.

- SuDS Approving Body – The Floods and Water Management Act, 2010 establishes a SUDS Approval Body at county or unitary local authority level (in this case Hull City Council) to ensure national standards of sustainable drainage are enforced. Developers will be required to gain approval of their proposed drainage systems before they can begin construction, and the SUDS Approving Body will then be responsible for adopting and maintaining SuDs which serve more than one property (other than on public roads which are the responsibility of the Highways authorities).

- Local Strategy for Flood Risk Management – 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 – LLFAs have powers to undertake works to manage local flood risk, consistent with the local flood risk management strategy for the area.

- Designation powers – LLFAs, as well as 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.

3 Methodology and Data Review

3.1 Data Sources

Most of the required data has been made available from the previous studies (Hull Catchment Flood Management Plan, River Hull Flood Risk Management Strategy, Hull Strategic Flood Risk Assessment, and Hull Surface Water Management Plan & Aqua Green Study). The key information that was obtained is listed in Table 3.1 below:

Table 3.1 – Summary of Key Data

Source	Data/Studies
Environment Agency	Environment Agency Asset Data (NFCDD); Ground level data (LiDAR); Catchment Abstraction Management Strategy; Humber River Basin Management Plan; Humber Strategy Key Issues Assessments (2004/5); Humber Flood Risk Management Strategy (2008); River Hull & Coastal Streams Catchment Flood Management Plan (2010); River Hull Flood Risk Management Strategy (2010); Environment Agency Short, Medium & Long Term Plans (2010); Historic flood data (GIS flood event outlines extracted from NFCDD); Geostore data including Main River details, flood map, and Digital River Network (DRN) data for Hull; Areas Susceptible to Surface Water Flooding (AStSWF); Flood Map for Surface Water (FMfSW); Fluvial and surface water models located in the Hull City area; Local hydrometric data including groundwater level data, rainfall data and river flow data; Details of Flood Warning Areas in Hull.
Hull City Council	OS data; Strategic Flood Risk Assessment (2007, level 1 and 2); Surface Water Management Plan (2010); Historical records of flooding; Identified flood hotspots.

Source	Data/Studies
Yorkshire Water	Foul water and surface water sewer network models in GIS format; Pumping station and manhole locations; Pumping station capacities; Feasibility Study to Investigate Options to Reduce Flood Risk (2007); Humbercare Sewerage Modelling Report (2008).
Other (Local flood groups, Highway Agency, Network Rail, fire brigade, IDB etc.)	Various assets; Flood records; GIS layers for land use types; BGS Susceptibility to Groundwater Flooding.

Additional information has been obtained from the city through an initial site visit followed by a more detailed workshop and virtual site visit of areas at risk of flooding.

The SFRA for the city as the primary document from which local flood risk information has been obtained. The reasoning behind this is that: a) the SFRA (completed in 2007) contained available details on past floods, b) it has been thoroughly reviewed more than once by the city and the Environment Agency, c) it has been formally approved by the city through the LDF planning process and d) it has gathered relevant information from relevant local previous studies (Flood Risk Assessments, etc).

The workshops and virtual site visits have proved to be a highly valuable process which involved 'virtual walks' by technical staff from Halcrow identifying many local flood risk areas, using a GIS environment and the use of Google Street View for 3D images.

The virtual site visits process involved the overlaying of the following GIS layers: a) OS maps, b) the Yorkshire Water pipe network system, c) the river networks, d) the flood zones, e) groundwater incident records, f) surface water flood incident records, g) local flood risk data from strategic data providers (for example the fire brigade), h) the Environment Agency national Areas Susceptible to Surface Water Flooding (AStSWF), i) the Environment Agency national Flood Map for Surface Water (FMfSW), j) a digital terrain model to identify catchment boundaries and terrain gradients, etc.

The virtual site visits assisted in achieving a number of SWMP and PFRA objectives and these are listed in Table 3.2.

Table 3.2 – Objectives of the Virtual Site Visit

No	Objective	Informs the SWMP	Informs the PFRA
1	Identify the source of flooding of past events (from readily available records)	1	1
2	Identify the pathways of past events and better understand the mechanism of flooding	1	1
3	Identify the receptors of past events	1	1
4	Identify which past events had significant consequences to human health, economic activity and/or the environment	1 (to a lesser extent)	1
5	Verify the Areas Susceptible to Surface Water Flooding (AStSWF) or Flood Map for Surface Water (FMfSW) map outputs against past events	1	1 (to a lesser extent)
6	Compare past events against surface water maps originating from: SFRA	1 (to a lesser extent)	1
7	Locally agree surface water information **	1 (to a lesser extent)	1
8	Identify the source of flooding of future events (from modelling outputs)	1	1
9	Identify the pathways of future events and better understand the mechanism of flooding	1	1
10	Identify the receptors of future events	1 (to a lesser extent)	1
11	Confirm which future flooding events are considered to be significant, affecting either or a combination of: a) human health, b) economic activity and c) the environment	1 (to a lesser extent)	1
12	Consider a number of structural and non structural solutions for each flood risk area	1	1 (to a lesser extent)
13	Enhance stakeholder engagement which is considered to be very important for this project	1	1

** This is mainly a requirement of the PFRA as more than one modelling output could be available for local flood risk (this is the case for Hull City in relation to surface water modelling outputs). It was agreed that the AStSWF mapping outputs should be used to inform the PFRA as the AStSWF outputs more closely mirrored historical flooding and the outputs of detailed modelling was not finalised while drafting the PFRA although initial results show a good match.

3.2 Availability

All available data were collected from key strategic data providers. Outputs of detailed modelling being undertaken as part of the FMIP project was not finalised while drafting the PFRA. The output from the FMIP will provide more accurate information on future flood risk in Hull and will form part of the "locally agreed surface water information" once completed.

3.3 Limitations

The data acquired from the strategic providers were all in the required format. The local information provided by Hull Council was in the form of flood incident records in Word format. This information sometimes lacked desirable details such as flood extents. There were some useful GIS datasets supplied from the SFRA however, which were used in the Virtual Site Visits.

3.4 Security, Licensing and Use Restrictions

In addition to the individual organisations licensing agreements, there are three 'Golden rules' which need to be applied:

- Any data received for the PFRA shall not, under any circumstances, be used for any other purpose whatsoever without the explicit written permission of the data owner;
- All rights to the data are reserved by and to the data owner; and
- The right of the data owner to commercially exploit the data must be protected at all times.

Any information provided to Hull City or partners have been through highly secure channels and the management plan for the project has clearly specified a unique location for storing the data.

Table 3.3 overleaf gives an overview of the data restrictions and licensing details for key data outlined in Table 3.1.

Table 3.3 – Data Restrictions and Licensing Details for Strategic Data Providers

Organisation	Restrictions on data and licensing agreements
Environment Agency	The use of some data is restricted to the Local Authorities and their Consultants. Specific data, such as the Indicative Surface Water Flood Risk Areas, are supplied to the consultants via the Local Authorities, as per the Agency's licensing agreement. This data can only be used for surface water management plans, strategic flood risk assessments or preliminary flood risk assessments.
Hull City Council	See 'Golden Rules' outlined under section 3.4
Yorkshire Water	• Necessary precautions must be taken to ensure that all information given to third parties is treated as confidential • The information must not be used for anything other than the purpose stated in the agreement • No information may be copied, reproduced or reduced to writing, other than what is necessary for the purpose stated in the agreement • If Yorkshire Water request, the details of any third party to whom information has been disclosed must sign a confidentiality agreement acceptable to Yorkshire Water • Information is provided without a warranty; therefore Yorkshire Water excludes any liability for any inaccuracy or incompleteness of disclosed information
Other (Local flood groups, Network Rail, Highways Agency, fire brigade, IDB, etc.)	Other organisations hold similar agreements for data supplied to the project. A number of organisations, such as fire brigade and Network Rail have no formal agreement in place.

3.5 Quality Assurance

Data collected were 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 SWMP, Technical Guidance document (March 2010). This system is explained in Table 3.4.

Table 3.4 – Data Quality System from SWMP Technical Guidance (March 2010)

Data Quality Score	Description	Explanations	Example
1	Best available	No better available; not possible to improve in the near future	High resolution LiDAR, river flow data, raingauge data
2	Data with known Deficiencies	Best replaced as soon as new data is 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
4	Heroic assumptions	An educated guess	Ground roughness for 2d models

The use of this system provides a basis for analysing and monitoring the quality of data that is being collected and used in the preparation of the PFRA. As mentioned in Section 3.3 the information provided sometimes lacked in level of detail (an average data quality score of 2 was given) which was however then improved as part of the virtual site visits.

4 Past Flood Risk

4.1 Introduction

This chapter focuses on past floods that had significant harmful consequences to human health, the local economy, local environmental sensitive areas and cultural heritage. It also report floods with no significant harmful consequences. Details are provided for surface water, sewerage, groundwater flooding together with interactions with other flooding sources.

4.2 Surface Water Flooding

Surface water flooding results from rainfall-generated overland flow before the runoff enters any watercourses or sewer. It is usually associated with high intensity rainfall (typically >30mm/hour) resulting in overland flow and ponding in depressions in the topography. Urban underground sewerage/drainage systems and surface watercourses may be completely overwhelmed, preventing drainage. Surface water flooding can also originate from rural areas where high intensity rainfall runs off fields without entering land drainage systems. There have also been events where ordinary watercourses have overtopped causing isolated surface water flooding. Many watercourses were culverted, filled in and turned to public sewers across the city in the 1950's and 1960's due to concerns over safety and hygene, this has led to a complex system of drains, ditches, dykes and watercourses flowing into the sewerage system and this can be overwhelmed leading to surface water flooding as experienced in 2007.

Flooding from surface water is hazardous due to its depth, velocity or flow, and sometimes its sudden appearance in locations, often with very little warning. The new Flood Forecasting Centre, established following the 2007 floods, does provide extreme rainfall event forecasting (http://www.ffc-environment-agency.metoffice.gov.uk/services/era.html), which is now supporting Partners in providing planning for emergency response for such events.

The surface water flood map for Hull (SWMP and ASTSW mapping) shows the whole city is at risk of surface water flooding, however a number of areas have a much higher risk than others. Analysis of the surface water flood map indicates that the two highest risk areas within Hull for surface water flooding are the Derringham and Orchard Park areas which are both situated along the western boundary of the Hull City Council area.

Surface water modelling indicates that the main source of flooding in Derringham is rural run-off from the west through Willerby. The run-off enters Springhead Park Golf Course from Wolferton Road, ponds behind Sands Dyke and subsequently flows along Willerby Road into Derringham. Surface water flooding within the Orchard Park area shows similar characteristics to the flood mechanisms in Derringham in that rural run-off from surrounding fields is the primary risk to the area. Surface water flows from the west and enters Orchard Park adjacent to the police training centre. Once within Orchard Park, surface water is routed northwards affecting numerous streets within the area.

4.3 Sewerage Network Flooding

This section on sewer network flooding draws on data from the Humbercare Sewerage Modelling Report (2008) and actual recorded flooding included on Yorkshire Water's DG5 Register. This model is known to have limitations and cannot accurately predict flood risk. To ensure a completely accurate understanding is obtained YW are currently undertaking a full hydraulic modelling study of the city. The outcomes of this work will be available to the multi agency partnership to review alongside current understanding.

Water and Sewerage Companies are required to record internal property and external flooding incidents arising from the sewer network that are attributed to either a lack of capacity or operational problems. Properties and areas affected by a lack of capacity, i.e. overloaded sewer, are included on the DG5 Register in the appropriate category.

The DG5 Register differentiates between internal and external flooding and categorises the entries into 3 probability bands; twice in 10 years (2 in 10), once in 10 years (1 in 10) and once in 20 years (1 in 20). The probability category is determined by the number of flooding incidents experienced and analysis of the rainfall event that resulted in the flooding incident.

Entries on the Register are based on reported flooding incidents and subsequent investigations rather than predictions based on mathematical modelling. Flooding incidents are not always reported and hence properties affected but not reporting are not included on the Register.

Currently in Hull there are 4 properties on the internal DG5 Register and 12 properties/areas on the external Register as shown in Table 4.1.

Table 4.1 – Summary of DG5 Register for Sewer Flooding in Hull

DG5 Register	2 in 10	1 in 10	1 in 20	Total
Internal	1	3	0	4
External	1	9	2	12

The 4 internal properties are included in Yorkshire Water's current capital investment programme and, subject to affordability, will be removed from the Register on completion of work to address the problem.

4.4 Groundwater Flooding

This section on groundwater flooding principally draws upon data from the Hull SFRA, supplemented by additional desk top study work.

Groundwater flooding may broadly be defined as "the emergence of water originating from sub-surface permeable strata".

Following the floods of summer 2007, Hull City Council mapped secondary flooding in the city, which in some cases was identified as groundwater flooding. However, discussions with the Environment Agency suggest that such water emergence in the city during this period was a relic of surface water flooding interacting with and emerging from local storage in clays and other surface deposits, and was not directly related to local groundwater level rise. Although groundwater levels recorded in boreholes in and around the city during the 2007 floods were very elevated, the Environment Agency believes this related to water entering the boreholes from the surface rather than a response to a regionally raised groundwater level.

On the basis of an evaluation of potential groundwater flood mechanisms and the geological and hydrogeological characteristics of the Hull City Council study area, there are no characteristics that suggest any significant propensity toward groundwater flooding. Overall the risk for groundwater flooding within Hull City is considered to be low.

4.5 Interactions with Other Flooding Sources

Interactions with other flooding sources are shown in the description column of Table 4.2. The interaction with Main River and tidal flooding is managed as the majority of surface water is pumped. All partners concerned with the management of flood risk within Hull have been working together on the Flood Mitigation Investment Plan to understand the interaction between the different sources of flood risk, examining existing strategies and proposals, and developing additional flood mitigation options.

4.6 Summary of Past Floods

Annex 1 of this report contains all historical recorded flooding incidents within Hull City with significant harmful consequences and should be used more as a guide since there is a high level of uncertainty of the data gathering standards (e.g. for maximum flood depths).

Table 4.2 below provides a summary of local past floods, with (highlighted in blue) or without significant harmful consequences, identified by the city through historical records. The information does not always provide dates when the flood events occurred, as many of these have happened more than once at the same location. Figure 6.6 in the Hull City SFRA (2007) shows recorded historical local flooding locations. The June 2007 flood event is the largest recorded flood event. Figure 4.1 provides a visual representation for the events listed in table 4.2. Floods immediately outside of the council boundary are included in the table where they have an impact on the city – connected flow routes, downstream impacts etc – these are not included in the events reported in the Annex.

Table 4.2 – Summary of Past Floods

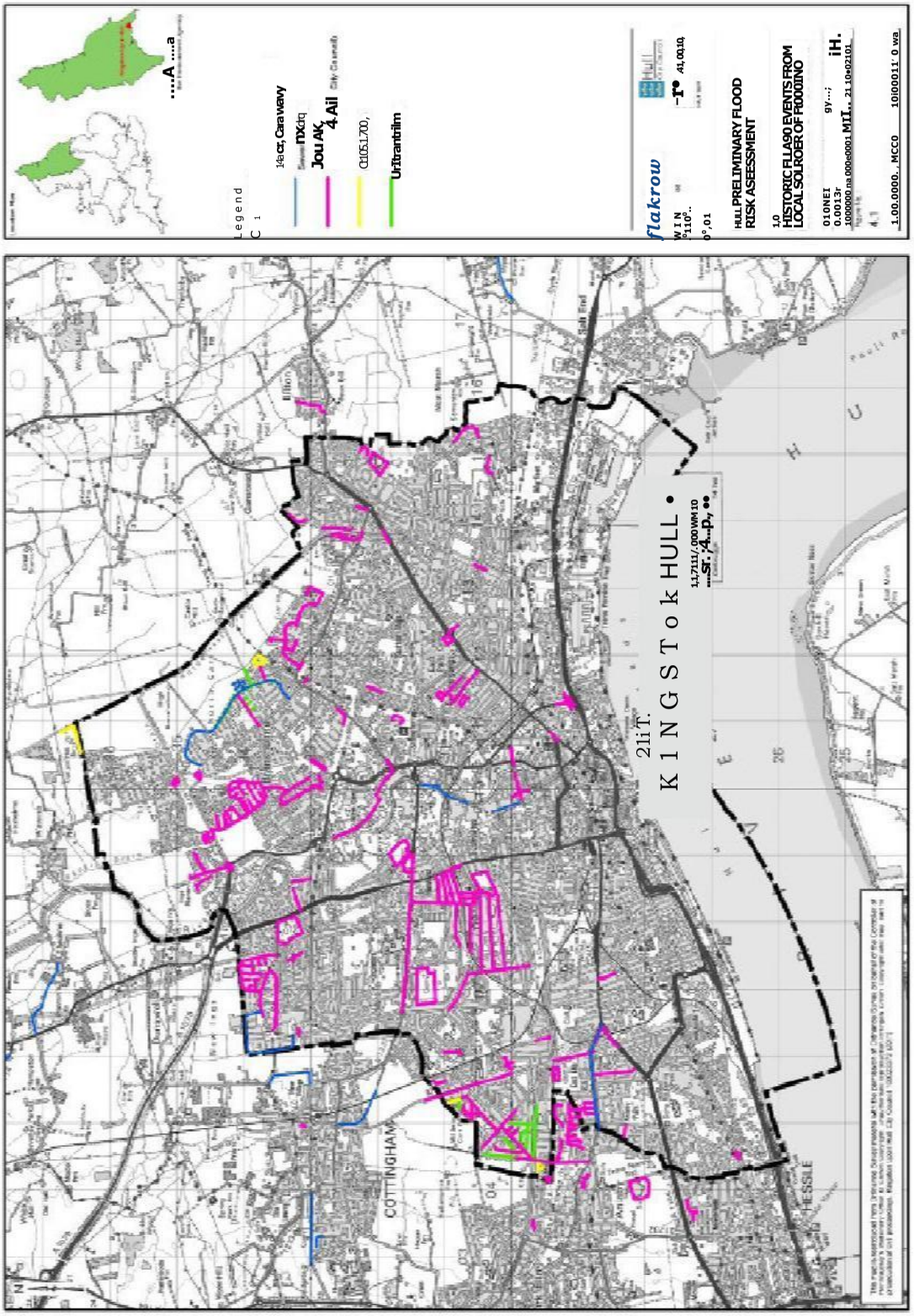
Source / Pathway	**Date** (where known)	**Location** (events with significant harmful consequences are highlighted in blue)	**Cause / Interactions with Other Flooding Sources**
Sutton Cross Drain	unknown	Bransholme, around Noddle Hill Way/ Biggin Avenue/ Castlehill Road adjacent to Sutton Cross Drain.	This area apparently used to flood because the YW pumps couldn't cope.
Setting Dyke	unknown	Willerby Road/Wymersley Road area and around the education centre, Coronation Road North near Setting Dyke.	Lack of maintenance of the trash screens and pumps.
Setting Dyke	Oct 2000	Localised flooding at Coronation Road.	Blocked trash screens.
Western Drain	Oct 2000	Localised flooding at Astral Close.	Blocked trash screens.
Acre Heads Drain	Oct 2000	The Ridings (flooding contained by sand bags).	Rising levels in the drain.
Holderness Drain	Oct 2000	Flooding of land around Carlam Hill.	Overtopping at low points in bank.
Sutton Cross Drain	Oct 2000	Lapwing and Curlew Close on the Brandsholme Estate (flooding contained by sand bags).	High water levels in the flood locked Sutton Cross Drain.
Pluvial/ Drains	15 June 2007	WEST HULL: Boothferry Road, Beverley Road, Anlaby Road, The Paddock, Meadowbank, Priory Road, Willerby Road, Newland Avenue, Cleveland Street, Normanton Rise, Westborough Way, Anlaby Common, Springhead Avenue, Chanterlands Avenue, Nunburnholme Park, Willerby Road (near Yorkshire Water Museum).	Heavy and sustained rainfall overloading drainage system.

Source / Pathway	**Date** (where known)	**Location** (events with significant harmful consequences are highlighted in blue)	**Cause / Interactions with Other Flooding Sources**
Pluvial/ Drains	15 June 2007	EAST HULL: Holderness Road, John Newton Way, Mount Pleasant, Hedon Road, Howdale Road.	Heavy and sustained rainfall overloading drainage system.
Pluvial/ Drains	15 June 2007	NORTH HULL: Kingswood.	Heavy and sustained rainfall overloading drainage system.
Pluvial/ Drains	25 June 2007	WEST HULL: Wymersley Road, Moorhouse Road, Hotham Road South, Hotham Drive, Wold Road, Coronation Road South, Coronation Road North, Meltonby Avenue, Birdsall Avenue, Brantingham Walk, Priory Road, Fern Hill Road, Appleton Road, Sorrel Drive, Celandine Close, Springhead Avenue, Kendal Way, Hawkshead Green, Legarde Avenue, Malham Avenue, Ingleton Avenue, The Paddock, Hessle Road, Belgrave Drive, Calvert Lane, Dunston Road, Boothferry Road, Analby Road, Kirklands Road, St George's Road, Bricknell Avenue, Northern Cemetery, Cottingham Road, Allotment and school playing field in Newland, Newland Avenue, Alexandra Road, Grafton Street, Lambert Street, De Grey Street, Pearson Park, Goddard Avenue, Ella Street, Victoria Street, Park Avenue, Westbourne Avenue, Prince's Road, Chesnut Avenue, Bricknell Avenue, Chanterlands Avenue.	Heavy and sustained rainfall overloading drainage system.
Pluvial/ Drains	25 June 2007	EAST HULL: Swan Street, Chapman Street, Lincoln Street, Holderness Road, Hedon Road (at A1033 roundabout), The Oval and Elm Avenue, Laburnam Avenue, Westcott Street and School, Marlowe	Heavy and sustained rainfall overloading drainage system.

Source / Pathway	**Date** (where known)	**Location** (events with significant harmful consequences are highlighted in blue)	**Cause / Interactions with Other Flooding Sources**
		Street, East Park sports centre, Stockholme Road, West Carr Lane, Peppleton Close, Corona Drive, Dorchester Road, Holwell Road, Southcoates Avenue, Exeter Grove, Biggin Avenue, Kestrel Avenue, Church Street, Robson Way, Howdale Road, Mallyan Close, Ramsgate Close, Dunvegan Road, Gleneagles Park, Frome Road, Waveney Road, Western Gailes Way, Shannon Road (south), Salthouse Road and Holderness Road (near Holderness Drain), Jervis Road, School off Barham Road, Bradford Avenue, Ecclesfield Avenue.	
Pluvial/ Drains	25 June 2007	NORTH HULL: Courtway Road, Hall Road, Orchard Park Road, Thorpepark Road, Ilthorpe, Homethorpe, Gorthorpe, Easethorpe, Dodthorpe, 14th and 8th Avenue, Princess Elizabeth Playing Fields, Parkstone Road, Welwyn Park Drive, Knightly Way, Chevening Park, Runnymede Way, Bushey Park, Rouundabouts on Wawne Road, Hemble Way, Parcevall Drive, John Newton Way, Ashworthy Close, Cookbury Close, Bude Road, School off Bude Road, Bodmin Road, Tiverton Road, Blisland Close, Soffham Close, Hartland Close, Whitstone Close, Davidstow Close, Langtree Close, Cheltenham Avenue, Newtondale, Littondale, Stonesdale.	Heavy and sustained rainfall overloading drainage system.
Sewer Flooding	Known Risk	Bankside, Hull.	Overloaded sewer system.

Source / Pathway	**Date** (where known)	**Location** (events with significant harmful consequences are highlighted in blue)	**Cause / Interactions with Other Flooding Sources**
Sewer Flooding	Known Risk	Cleeve Road, Hedon.	Overloaded sewer system.
Sewer Flooding	Known Risk	Dane Park Road.	Overloaded sewer system.
Sewer Flooding	Known Risk	Downhill Drive, Bransholme.	Overloaded sewer system.
Sewer Flooding	Known Risk	Eppleworth Road, Cottingham.	Overloaded sewer system.
Sewer Flooding	Known Risk	Leadhills Way, Bransholme.	Overloaded sewer system.
Sewer Flooding	Known Risk	Middle Dike Lane, Cottingham.	Overloaded sewer system.
Sewer Flooding	Known Risk	Northumberland Avenue.	Overloaded sewer system.
Sewer Flooding	Known Risk	Peckforten Close, Bransholme.	Overloaded sewer system.
Sewer Flooding	Known Risk	Snuff Mill Lane, Cottingham.	Overloaded sewer system.
Sewer Flooding	Known Risk	Analby Road, Analby.	Overloaded sewer system.
Sewer Flooding	Known Risk	Noddle Hill Way, Bransholme.	Overloaded sewer system.
Sewer Flooding	Known Risk	Sancton Close, Cottingham.	Overloaded sewer system.

Figure 4.1 – Historic Flood Events from Local Sources of Flooding



4.7 Significant Harmful Consequences

Hull Council has one past flood with significant harmful consequences to report to the EU, based on the following definition of significance:

'Memorable past floods or otherwise registered on a national scale (such as the Easter 1998 event) even if only occurring over a relatively small area.'

This is reported in Annex 1

The above definition of significant harmful consequence has been defined locally by the LLFA and it is based on a recent Environment Agency briefing paper on reporting information on past floods (Feb 2011). The following event meets the defined criteria for "significant harmful consequences";

In June 2007 the City of Hull experienced extensive surface water flooding effecting approximately 8700 homes. This event was characterised by unusually unsettled weather and above average rainfall through the month of July, peaking on 20 July, when an active frontal system deposited more than 100 millimetres (3.9 in) of rain in parts of England in a 24 hour period (see rows highlighted blue in Table 4.2 above).

5 Future flood risk

5.1 Summary of Future Flood Risk

Future flood risk is estimated to be high in the city.

Table 5.1 summarises the number of properties at risk of surface water flooding based on the Environment Agency's AStSWF & FMfSW model outputs (some of this information has been copied in Annex 2 for reporting to the EU).

Table 5.1 – Number of Residential Properties at Risk of Flooding

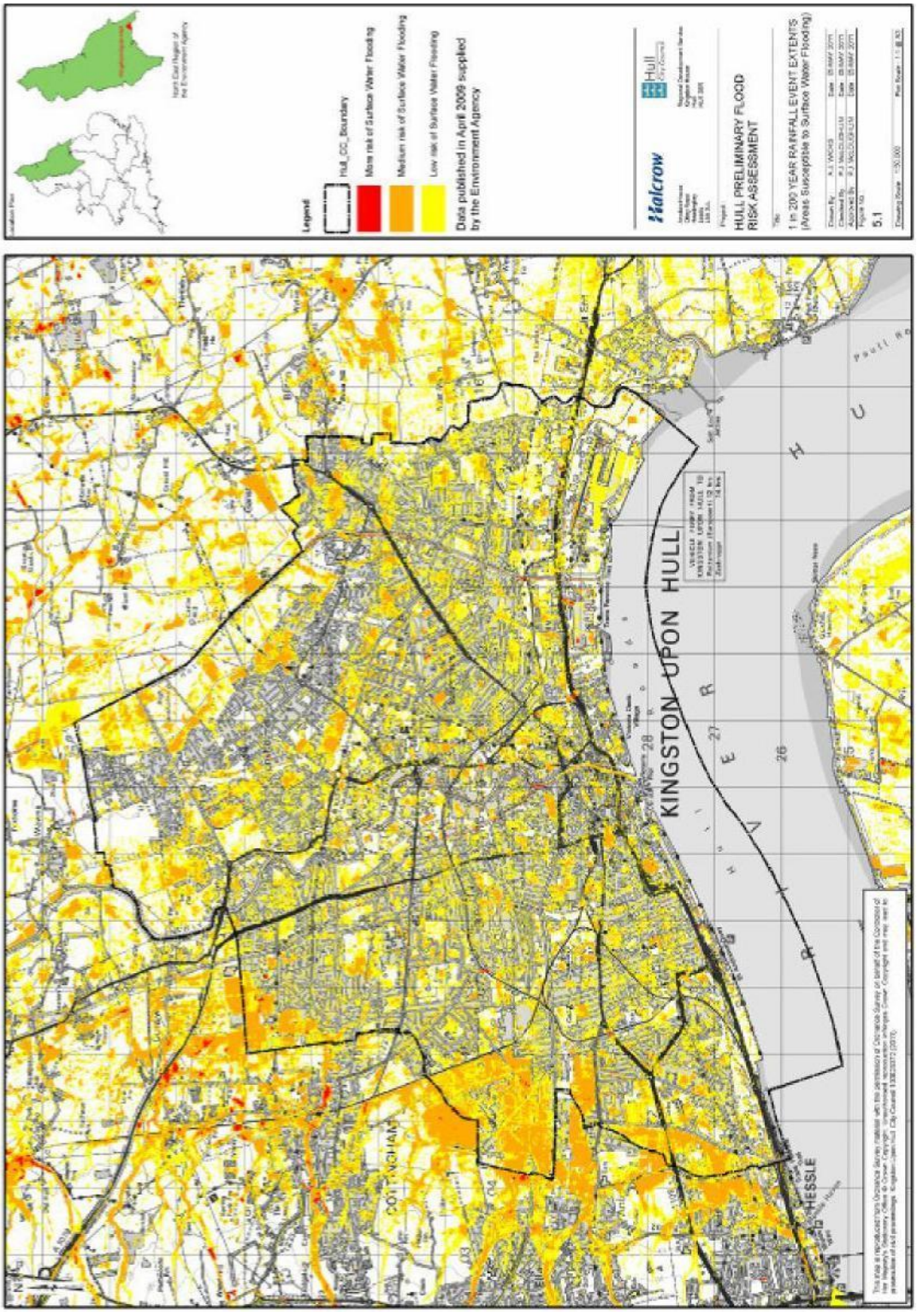
Location	AStSWF Less Susceptible	AStSWF Intermediately Susceptible	FMfSW 200 year event (greater than 0.1m deep)	FMfSW 200 year event (greater than 0.3 deep)
Hull City	57,000	14,952	17,700	500
East Riding of Yorkshire	Not determined	4605	Not determined	Not determined
Kingston upon Hull (total)		19,557		

In particular, as no significant schemes have been undertaken at the locations of past floods unless identified in Table 4.2 all these locations can be considered as areas where similar floods could still occur. Much of the flooding of the locations identified in Table 4.2 is confirmed by the two Environment Agency national datasets. These national datasets are the Areas Susceptible to Surface Water (AStSWF) and the Flood Map for Surface Water (FMfSW). Outputs of detailed modelling being undertaken as part of the FMIP project were not finalised while drafting the PFRA although initial results show a good match to historical flooding. Five hot spots have been identified in Hull, namely; Orchard Park; Sutton Ings; Newlands; Derringham; and East Ella.

5.2 Locally Agreed Surface Water Information

A comparison of surface water model outputs from the sources identified in Section 5.1 was undertaken as part of the virtual site visit. The principal characteristics of drainage in Hull are the low gradient and reliance on pumping. To reflect these local drainage characteristics the agreed conclusion was that the AStSWF outputs were most representative of the study area available at the time of writing – the outputs of which correlate well with the SFRA and SWMP. Figure 5.1 provides information of the 1 in 200 year rainfall event depths. Please note that there is a Flood Mitigation Investment Plan underway for Hull. The output from this will provide more accurate information on future flood risk in Hull and will form part of the "locally agreed surface water information" once completed.

Figure 5.1 – 1 in 200 year rainfall event extents (Areas Susceptible to Surface Water Flooding)



5.3 Ground Water Flooding

General information relating to groundwater flooding in the area has been obtained from the Hull River and Coastal Streams CFMP as well as the CAMS (Catchment Abstraction Management) report. Groundwater flooding most commonly occurs in the areas which lie on the edge of the Wolds, to the west of Hull City Council, as these are the locations where the major aquifers come to the surface. Occasional and sporadic elevated groundwater levels in the Cottingham area have caused flooding in the past, though this is just outside of Hull City Council. The Environment Agency is not aware of any recent examples of groundwater flooding within Hull City Council. As noted in section 4.4 overall the risk for groundwater flooding within Hull City is considered to be low.

5.4 Potential Consequences of Future Flooding

The Environment Agency has used the Flood Map for Surface Water mapping, Areas Susceptible to Surface Water mapping and the National Receptors Database to identify a number of areas across England that exceeds a given threshold as below:

- 200 people flooded to a depth of 0.3m during a rainfall event with a 1in200 annual chance of occurring.
- 20 businesses to a depth of 0.3m during a rainfall event with a 1in200 annual chance of occurring.
- 1 critical service to a depth of 0.3m during a rainfall event with a 1in200 annual chance of occurring.

The assessment was carried out based on 1km^2 national grid squares and the grid squares that exceed the above criterion were identified. Mapping has been made available by the EA showing the grid squares which exceed this criterion for the Areas Susceptible to Surface Water. The Flood Map for Surface Water is widely recognised to under represent flood risk in lowland or pumped catchments and it is recommended by the EA that the Areas Susceptible to Surface Water mapping product is used.

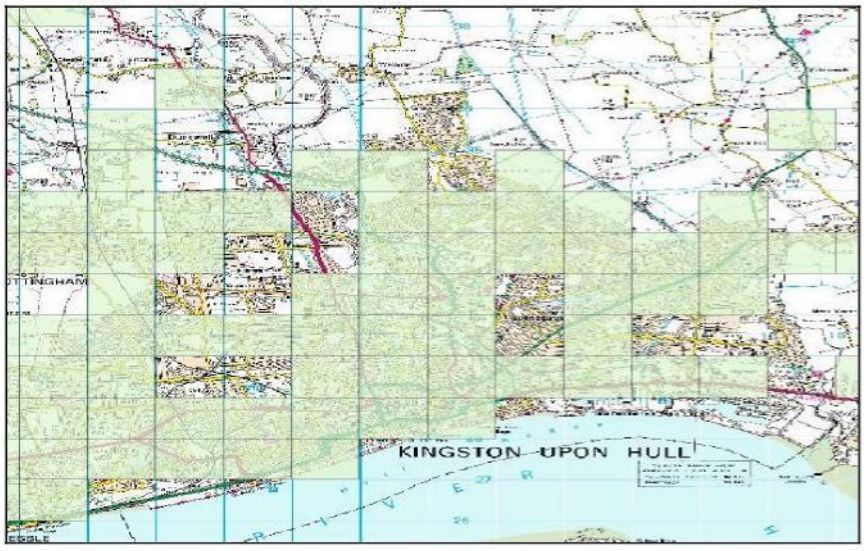


Fig 5.4 – Squares above threshold using the Areas Susceptible to Surface Water Mapping

5.5 Impact of Climate Change

There is clear and scientific evidence that climate change is happening now. It cannot be ignored.

Over the past century around the UK we have seen sea level rise and more of our winter rain failing 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 levels in the atmosphere are likely to cause higher winter rainfall in future. Past Greenhouse gas 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 2080s.

We have enough confidence in the large scale climate models to say that we must plan for change. There is more uncertainty at a local scale but model results can still help us plan to adapt. For example we understand rain storms may become more intense, event if we can't be sure 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%.

Key Projections for Humber River Basin District

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

- Winter precipitation increases of around 12% (very likely to be between 2 and 26%)
- Precipitation on the wettest day in winter up by around 12% (very unlikely to be more than 24%)
- Relative sea level at Grimsby very likely to be up between 10 and 41cm from 1990 levels (not including extra potential rises from polar ice sheet loss)
- Peak river flows in a typical catchment likely to increase between 8 and

14% ***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 of this rain falling in wet spells may increase river flooding. 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 we need to be prepared for the unexpected.

Drainage systems in the district have been modified to manage water levels and could help in adapting locally to some impacts of future climate on flooding, but may also need to be managed differently. 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. Even small rises in sea level could add to very high tides so as to affect places a long way inland.

Where appropriate, we need local studies to understand climate impacts in detail, including effects from other factors like land use. Sustainable development and drainage will help us adapt to climate change and manage the risk of damaging floods in future.

Adapting to Change

Past emissions means some climate change is inevitable. It is essential we respond by planning ahead. We can prepare by understanding our 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, we have to make local decisions uncertainty. We will therefore consider a range of measures and retain flexibility to adapt. This approach, embodied within flood risk appraisal guidance, will help to ensure that we do not increase our vulnerability to flooding.

5.6 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, 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), but should be recorded here so that they can be reviewed in the future.

Hull City Council have developed Flood Risk Standing Advice in agreement with the Environment Agency, flood hazard mapping from the SFRA and a matrix derived from this hazard lists flood mitigation measures expected from developments associated with development use types. Raised floor levels, resilient construction and a place of safety are required to be identified through the flood risk assessment and implemented.

There is a Supplementary Planning Document "Flood Mitigation Plan for New Developments" to inform prospective developers and applicants of Kingston upon Hull City Council's requirements for the management of flood water in new developments across Hull This was originally produced for the Surface Water Management Plan and is being updated as part of the Hull Flood Mitigation Investment Plan**.** A Development and Flood Risk SPD will be developed to further advice and steer developers, the Flood Risk Standing Advice documentation will be incorporated into the draft documents detailed above.

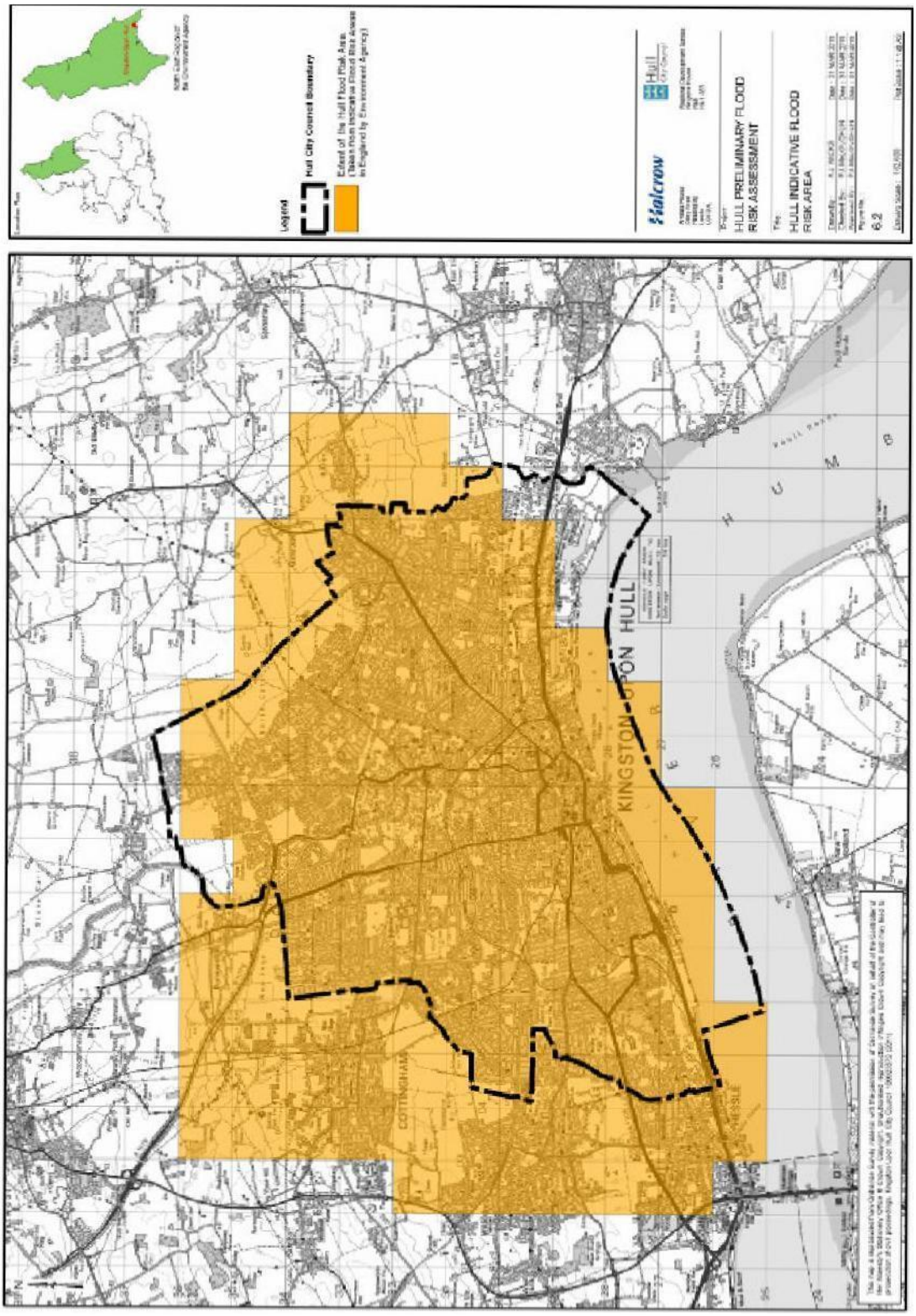
6 Review of Indicative Flood Risk Areas

6.1 Extent of Indicative Flood Risk Areas

The Environment Agency map showing the indicative flood risk areas in England which includes Hull is provided in Figure 6.1. The indicative flood risk is referred to as the Kingston upon Hull indicative flood risk area and is shown in more detail in Figure 6.2.

Figure 6.1 – Indicative Flood Risk Areas in England

Figure 6 . 2 – Kingston Upon Hull Indicative Flood Risk Areas



The indicative flood risk areas have been obtained as a result of adopting a consistent and proportionate approach at the national level, taking account of: a) the number of people (based on property numbers x 2.34), b) the number of critical services and c) the number of non-residential properties. The national datasets used were: a) the FMfSW, b) the AStSWF, c) the National Receptor Database (NRD) and d) the Areas Susceptible to Groundwater Flood Map.

An important principle of the method is that the assessment of significance is based on flooding in the order of a 1 in 100 chance in any given year. For the purposes of the PFRA process the rainfall event with a 1 in 200 chance of occurring in any year scenario is the most appropriate as this is equivalent to the chance of flooding on the ground in the order of a 1 in 100 chance in any given year.

The grid squares identified as exceeding the local thresholds, section 5.4, were collated where more than 5 grid squares were found to be touching on a 3km by 3km ($9km^2$) grid and considered as clusters. All clusters were ranked nationally based on the number of properties, critical services and none residential properties affected, a threshold was set above which the clusters would be considered as indicative flood risk areas and reported to Europe, this was set as 30,000 people at risk of flooding.

6.2 Review Comments

The indicative flood risk area has been reviewed within the city area. The area covers a large number of the past and future floods identified in Chapters 4 and 5 notably the 2007 flooding. There is no reason therefore to doubt the indicative flood risk area.

7 Identification of Flood Risk Areas

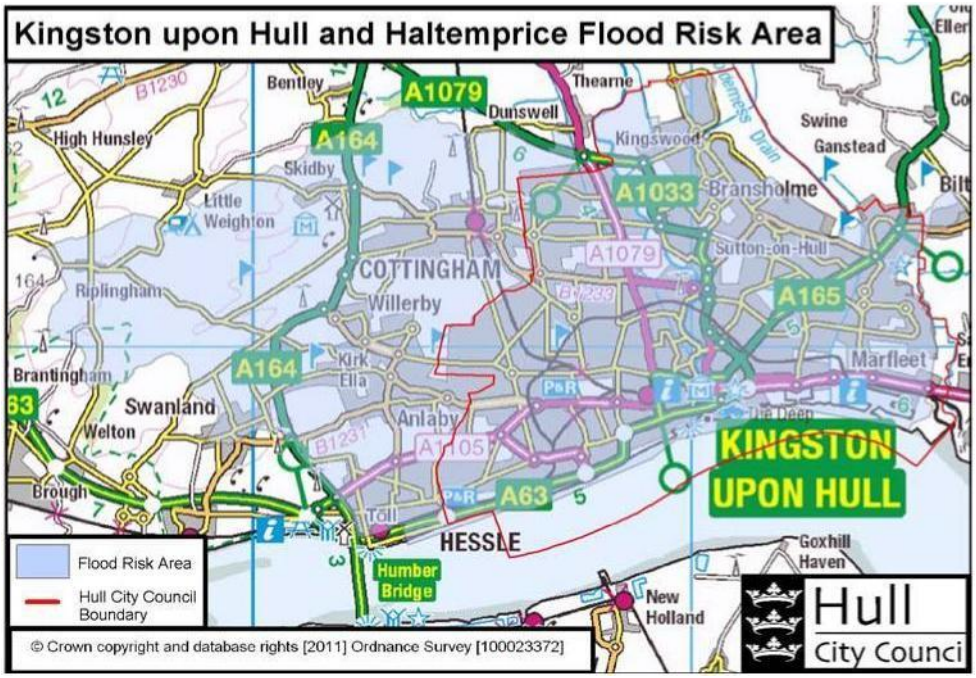
7.1 Amendments to FRA

The Kingston upon Hull Flood Risk Area (FRA) is proposed to be changed in name and geographic coverage to reflect the cross boundary nature of the watershed and contributing catchment. The indicative flood risk area is recommended to be renamed as the Kingston upon Hull and Haltemprice Flood Risk Area.

The amended FRA is shown in Annex 5 and reproduced below as figure 7.1, the geographic changes reflect the full watershed that would be modelled in the latter stages of the Flood Risk Regulations requirements, the increased geographic area was originally proposed by the East Riding of Yorkshire Council, the area has been approved by the Environment Agency and Hull City Council as a relevant and important change to the original iFRA.

Information relating to the Kingston upon Hull and Haltemprice FRA is reported in the Annexes of both authorities PFRA reports, agreed and consistent data and wording is used in both submissions.

Figure 7.1 – Kingston upon Hull and Haltemprice Flood Risk Area



7.2 New FRA

No new FRA are proposed.

8 Next Steps

8.1 Scrutiny and Review

The scrutiny and review procedures that must be adopted when producing a PFRA are set out by the European Commission. 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 flood risk areas are identified. Another important aspect of the review procedure is to ensure that the guidance is applied consistently; a consistent approach will allow all partners to understand the risk and manage it appropriately.

The scrutiny and review procedure will comprise two key steps:

The first part of the review procedure is through an internal Local Authority review of the PFRA, in accordance with appropriate internal review procedures. Internal approval should be obtained to ensure the PFRA meets the required quality standards, before it is submitted to the Environment Agency.

The second part of the review procedure is through the Environment Agency. Under the Flood Risk Regulations, 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 Flood Risk Areas have been amended and ensure the format of these areas meets the provided standard. If satisfied, they will recommend submission to the relevant Regional Flood Defence Committee (RFDC) for endorsement. RFDCs will make effective use of their local expertise and ensure consistency at a regional scale. Once the RFDC has endorsed the PFRA, the relevant Environment Agency Regional Director will sign it off, before all PFRAs are collated, published and submitted to the European Commission.

The first review cycle of the PFRA will be led by Hull City Council and must be submitted to the Environment Agency by the 22nd of June 2011. They will then submit it to the European Commission by the 22nd of December 2011 using the same review procedure described above.

8.2 Data Collection and Management

Data gaps that will require future collection activities are listed as follows:

1) A systematic approach to recording local flood risk is recommended, in particular for locations where there are interactions with other sources of flooding and locations where significant hazards have been identified.

There is an opportunity to work with the Environment Agency in developing an integrated system for collecting and managing data, based on the systems that are already in place for fluvial and tidal flooding.

2) A better understanding of how the drainage system operates will be gained by obtaining and interrogating the relevant Yorkshire Water models. These models will be critical for the further stages of the FMIP which will also benefit the PFRA.

8.3 Incident Recording

An action plan for the recording of incidents for Hull could be delivered using a secure website, which could be developed to assist in the logging of information consistently.

It is recommended that the recording of flood incidents should follow the principles given in the INSPIRE European Directive (these are listed in the final guidance document for PFRA). The use of a spreadsheet similar to the PFRA spreadsheet (the spreadsheet that will be used for reporting significant flood risk to the EU) is proposed to the city council for consideration as the vehicle for recording flood incidents. The reason is that this format are fully aligned to the INSPIRE directive.

8.4 Other Flood Risk Regulation Requirements

Other planned actions that will be required to comply with the Flood Risk Regulations are:

1) Development of an action plan on how the city will perform its duties as the SuDs approval body (approval, adoption and maintenance of SuDs which serve more than one property).

2) Links with Flood Risk Assessments and SuDs approvals to be developed as an integrated approach to the approval of SuDs proposals.

9 References

Brown, S. Beswick, M. et al. (2008) Met Office Submission to the Pitt Review - Executive Summary, The extreme rainfall of Summer 2007 and future extreme rainfall in a changing climate

Defra (2006) Flood and Coastal Defence Appraisal Guidance, FCDPAG3 Economic Appraisal, Supplementary Note to Operating Authorities – Climate Change Impacts. October 2006. Available from http://www.defra.gov.uk/environment/flooding/documents/policy/guidance/fcdpag/fcd3cl

Defra / WAG (2010) Selecting and reviewing Flood Risk Areas for local sources of flooding – Guidance to Lead Local Flood Authorities. Available from http://www.defra.gov.uk/environment/flooding/documents/research/flood-risk-method.pdf

Defra (2010) Surface Water Management Plan Technical Guidance

Environment Agency (2009) River Hull and Coastal Streams Catchment Flood Management Plan

Environment Agency (2010) Preliminary Flood Risk Assessment - Final Guidance (Report – GEHO1210BTGH-E-E). Available from http://publications.environment-agency.gov.uk/pdf/GEHO1210BTGHe-e.pdf

Environment Agency (2010) Preliminary Flood Risk Assessment – Annexes to the Final Guidance (Report – GEHO1210BTHF-E-E). Available from http://publications.environment-agency.gov.uk/pdf/GEHO1210BTHFe-e.pdf

Environment Agency Building Trust with Communities

Miller, H.L. (eds.). Summary for Policymakers. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 9. Available for download from http://www.ipcc.ch/ipccreports/ar4-wg1.htm

The Pitt Review (2008) Learning lessons from the 2007 floods

Annex 1 – Records of past floods and their significant consequences (Preliminary Assessment Spreadsheet)

Please refer to Annex 1 of the Preliminary Assessment Spreadsheet which has been supplied alongside this report.

Annex 2 – Records of future floods and their significant consequences (Preliminary Assessment Spreadsheet)

Please refer to Annex 2 of the Preliminary Assessment Spreadsheet which has been supplied alongside this report.

Annex 3 – Records of Flood Risk Area and its rationale (Preliminary Assessment Spreadsheet)

Please refer to Annex 3 of the Preliminary Assessment Spreadsheet which has been supplied alongside this report.

Annex 4 – Review Checklist

Please refer to Annex 4 spreadsheet which has been supplied alongside this report.

Annex 5 – GIS Layer of Flood Risk Area(s)

The GiS layer for the amended Kingston upon Hull and Haltemprice Flood Risk Area is the shared submission with ERYC, a .pdf version of this submission is supplied with this report.