



Redcar and Cleveland BC Preliminary Flood Risk Assessment

Final Report

May 2011

**Redcar and Cleveland
Borough Council,
Belmont House,
Guisborough,
TS14 7FD.**



JBA Office

JBA Consulting
 Bank Quay House
 Sankey Street
 Warrington
 WA1 1NN

JBA Project Manager

Sam Wingfield BSc MRes

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Contract

This report describes work commissioned by Alan Smuk, on behalf of RCBC, by an email dated 08/03/11. RCBC's representative for the contract was Alan Smuk of Highway Maintenance & Drainage. Sam Wingfield of JBA Consulting carried out this work.

PAR prepared by Sam Wingfield BSc MRes
 Analyst

Maps prepared by Peter Grace
 Analyst

Reviewed by Sam Willis BSc MSc TIPENZ
 Analyst

Purpose

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Acknowledgments

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Executive Summary

This report has been prepared to assist Redcar and Cleveland Borough Council (RCBC) meet their duties, as a Lead Local Flood Authority (LLFA), to manage local flood risk and deliver the requirements of the Flood Risk Regulations (2009). It is part of the Preliminary Flood Risk Assessment (PFRA) process.

The Regulations require LLFAs, through the PFRA process, to determine whether there is a significant risk in their area based on local flooding (surface water, groundwater, ordinary watercourses and canals) and to identify the part of the area affected by these risks. This is then known as the Flood Risk Area. The PFRA comprises this document, known as the Preliminary Assessment Report (PAR), and the supporting spreadsheet. Together they form the first of the two stages the requirements of the Regulations.

As a LLFA, RCBC must submit their PFRA to the Environment Agency for review by 22nd June 2011. The methodology for producing this PFRA is based on the Environment Agency's Final PFRA Guidance and Defra's Guidance on selecting Flood Risk Areas, both published in December 2010.

In order to ensure a consistent national approach, Defra and WAG identified significance criteria and thresholds to be used for defining flood risk areas. The Environment Agency then used these criteria with their own national datasets to determine indicative Flood Risk Areas. Ten national Indicative Flood Risk Areas were identified; however none fall within the North East of England.

In order to develop a clear overall understanding of the flood risk across Redcar and Cleveland, this report collates and reviews all available local flood risk information of past and future flood risk. The majority of this data was sourced from Redcar and Cleveland's Strategic Flood Risk Assessments and directly from RCBC.

Based on the evidence that was collected, no past flood events were considered to have had 'significant harmful consequences'. Therefore, the decision was made to not include any records of past flooding in Annex 1 of the Preliminary Assessment Spreadsheet.

However, it must be noted that there are a number of locations across Redcar and Cleveland that are subject to frequent flooding from local sources, particularly from surface water. Based on the Environment Agency's national surface water modelling approximately 4,200 properties are estimated to be at risk from flooding to a depth of 0.3m during a rainfall event with a 0.5% annual probability (a.p.). This does not meet the Environment Agency threshold of 30,000 people within a cluster of significant areas required to identify a Flood Risk Area.

It was concluded that RCBC does not have the evidence (through additional analysis) to justify the identification of a Flood Risk Area in their administrative area.

By not having a Flood Risk Area covering RCBC, the next stage of the PFRA process is not triggered. This means the Council does not have to produce flood hazard maps, flood risk maps and flood risk management plans for that area. RCBC will still have to produce a local flood risk management strategy for their area. Some recommendations and next steps for this are made at the end of this report. Whilst this strategy does not have to be done to prescribed deadlines in the Regulations a strategic approach will be required to assessing and developing solutions to reduce flood risk.

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Glossary

Term or Abbreviation	Definition
Act	A Bill approved by both the House of Commons and the House of Lords and formally agreed to by the reigning monarch (known as Royal Assent)
Assets	Structures, or a system of structures used to manage flood risk
AStGWF	Areas Susceptible to Groundwater Flooding
AStSWF	Areas Susceptible to Surface Water Flooding
BAP	Biodiversity Action Plan
Catchments	An area that serves a river with rainwater. Every part of land where the rainfall drains to a single watercourse is in the same catchment.
CFMP	Catchment Flood Management Plan
CSOs	Combined Sewer Overflows
Cultural heritage	Buildings, structures and landscape features that have an historic value. These are also known as heritage assets
Defences	A structure that is used to reduce the probability of floodwater or coastal erosion affecting a particular area (for example a raised embankment or sea wall)
Defra	Department for Environment, Food and Rural Affairs
DTM	Digital Terrain Model
FCERM	Flood and coastal erosion risk management
Flood	The temporary covering by water of land not normally covered with water
FMfSW	Flood Map for Surface Water
Flood Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG
FWMA	Flood and Water Management Act
GHG	Greenhouse Gas
Groundwater	Water which is below the surface of the ground and in direct contact with the ground or subsoil
HSWGW	Historic Surface Water and Groundwater
Indicative Flood Risk Areas	Areas determined by the Environment Agency as indicatively having a significant flood risk, based on guidance published by Defra and WAG 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
LLFA	Local Lead Flood Authority
Local flood risk	Flood risk from sources other than main rivers, the sea and reservoirs, principally meaning surface runoff, groundwater and ordinary watercourses
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 – a collection of risk receptors produced by the Environment Agency
NWL	Northumbrian Water Ltd
Ordinary watercourses	All watercourses that are not designated Main River, and which are the responsibility of Local Authorities or, where they exist, IDBs
Preliminary assessment report	A high level summary of significant flood risk, based on available and readily derivable information, describing both the probability and harmful consequences of past and future flooding
Preliminary assessment spreadsheet	Reporting spreadsheet which LLFAs need to complete. The spreadsheet will form the basis of the Environment Agency's reporting to the European Commission
PFRA	Preliminary Flood Risk Assessment
PPS25	Planning Policy Statement 25
Receptor	Something that may be harmed by flooding
Regulations	The Flood Risk Regulations

Resilience	The ability of the community, services, area or infrastructure to withstand the consequences of an incident
Risk	Measures the significance of a potential event in terms of likelihood and impact
River basin district	There are 11 river basin districts in England and Wales, each comprising a number of contiguous river basins or catchments. The Environment Agency is responsible for collating LLFA reports at a river basin district level
SFRA	Strategic Flood Risk Assessment
Source	The origin of a hazard (e.g. heavy rainfall, strong winds, surge etc)
Surface runoff	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
UKIP09	UK Climate Change Projections 2009
WAG	Welsh Assembly Government

1. Introduction

1.1 Preliminary Flood Risk Assessment

This document reports the findings of research undertaken by JBA Consulting on behalf of Redcar and Cleveland Borough Council (RCBC) towards the preparation of a Preliminary Flood Risk Assessment (PFRA) for their administrative area.

The chief drivers behind this research and preparation of the PFRA report are two sets of new legislation: the Flood Risk Regulations (the Regulations), which came into force on the 10th December 2009, and the Flood & Water Management Act (FWMA) which gained Royal Assent on the 8th April 2010. Under these pieces of legislation, all Unitary Authorities (RCBC) and in two-tier systems (all County Councils) are designated as a Local Lead Flood Authority (LLFA) and have formally been allocated a number of key responsibilities with respect to local flood risk management. A full description of these responsibilities is provided in Chapter 2.

The purpose of the Regulations was to transpose the European Floods Directive (Directive 2007/60/EC on the assessment and management of flood risk) into domestic law in England and Wales. The aim of the Directive is to reduce the likelihood and consequence of flooding by establishing a common framework for understanding and managing flood risk across Europe. It establishes four stages of activity within a six year flood risk management cycle.

The Regulations also implement the requirements of the European Floods Directive; in particular it places duties on the Environment Agency and LLFAs to prepare a number of key documents including:

- Preliminary Flood Risk Assessments (PFRA);
- Flood hazard and flood risk maps; and
- Flood Risk Management Plans

Table 1-1 shows the elements of work required from RCBC under the Regulations, along with the timescales of their respective delivery.

Table 1-1: Work Required under the Flood Risk Regulations 2009

Timescale	Assessment or Plan	Description
22nd June 2011	Prepare a preliminary assessment report	The PFRA should focus on local flood risk from surface water, groundwater, ordinary watercourses and canals .
22nd June 2011	Determination and identification of flood risk areas	Flood Risk Areas are areas of significant risk identified on the basis of the findings of the PFRA, national criteria set by the UK Government Secretary of State and guidance provided by the Environment Agency.
22nd June 2013	Prepare flood hazard maps and flood risk maps in relation to each relevant flood risk area	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 2015	Prepare a flood risk management plan in relation to each relevant flood risk area	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.

This Preliminary Assessment Report (PAR) is the first of the two stages in the process. This report also provides the evidence and appraisal for the second stage of identifying Flood Risk Areas. The identification of Flood Risk Areas will establish where the final two stages of preparing hazard and risk maps and flood risk management plans are required.

The PFRA (and any subsequent maps and plans) will form part of the local flood risk management strategies that LLFAs are required to prepare under the FWMA. Local

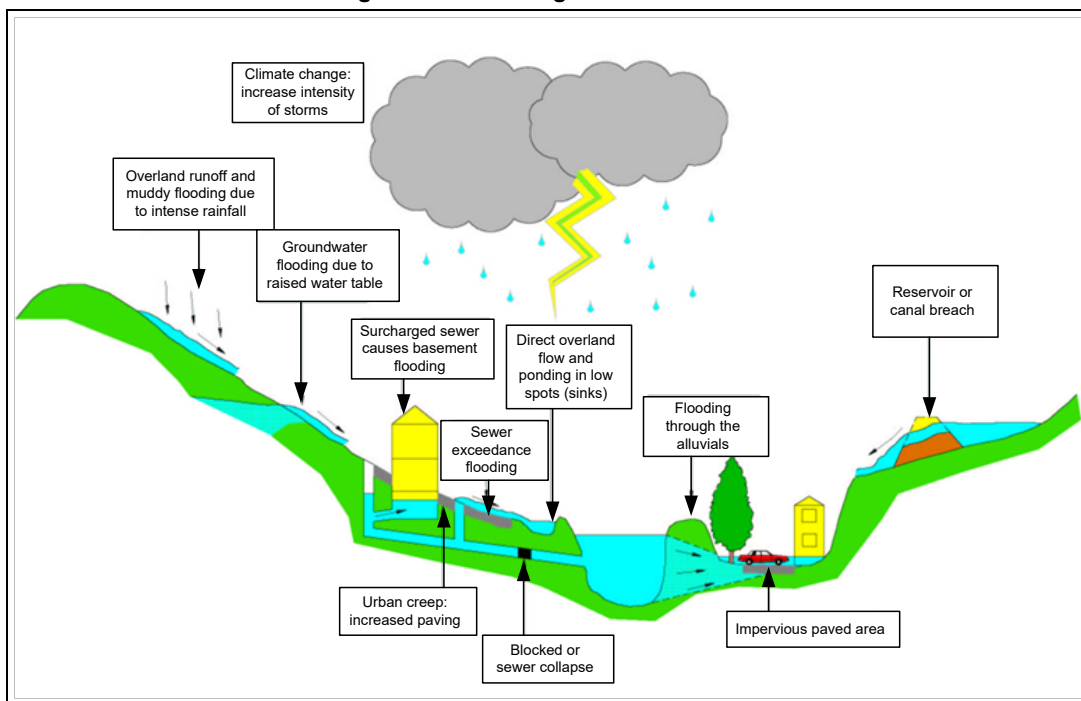
strategies will set out how LLFAs will manage the local flood risks in their areas and will also cover areas not identified as being at significant flood risk under the Regulations.

1.2 Sources of flooding

As described in the Regulations, flooding associated with the sea, main rivers and reservoirs is the responsibility of the Environment Agency.

LLFAs are responsible for assessing risk from sources of flooding other than main rivers, the sea and reservoirs. In particular this includes surface runoff, groundwater and ordinary watercourses and any interaction these have with drainage systems and other sources of flooding including sewers. The interaction of flooding from main rivers, the sea and reservoirs with local sources will need to be taken into account.

Figure 1-1: Flooding from all Sources



Descriptions of relevant sources in relation to Redcar and Cleveland are provided below:

1.2.1 Surface water flooding

Flooding of land from surface water runoff is usually caused by intense rainfall that may only last a few hours. The resulting water follows natural valley lines, creating flow paths along roads, through and around developments and ponding in low spots, which often coincide with fluvial floodplains in low-lying areas. Surface water flooding also occurs when heavy rainfall exceeds the capacity of local drainage networks and water flows across the ground.

1.2.2 Groundwater and mine water flooding

Groundwater flooding occurs as a result of water rising up from the underlying aquifer or from water flowing from abnormal springs. This tends to occur after long periods of sustained high rainfall, and the areas at most risk are often low-lying where the water table is more likely to be at shallow depth.

There are several mechanisms which produce groundwater flooding including prolonged rainfall raising groundwater levels, high in bank river levels, artificial obstructions and groundwater and mine water rebound.

In the past, there was significant ironstone mining across Redcar and Cleveland especially in the Skinningrove and Eston area. In total there were eighty four mines in the area.

1.2.3 Sewer flooding

Combined sewers and surface water drainage systems are spread extensively across the urban areas of Redcar and Cleveland with various interconnected systems discharging to treatment works and into local watercourses. Many of the trunk sewers within the older urban areas (e.g. Eston and Redcar) are combined and it is only more recently since the late 1960s that a separate system of sewers has evolved at the periphery of urban areas.

Typically, foul systems will comprise a network of drainage sewers, sometimes with linked areas of separate and combined drainage, all discharging to sewage treatment works. Combined Sewer Overflows (CSOs) provide an overflow release from the drainage system into local watercourses or surface water systems during times of high flows. Surface water systems will typically collect surface water drainage separately from the foul sewerage and discharge directly into a watercourse.

A major cause of sewer flooding is often due to large rainfall events causing sewers to surcharge leading to highway and external curtilage flooding and sometimes internal sewer flooding to properties.

1.2.4 Canal and ordinary watercourse flooding

There are no canal systems within Redcar and Cleveland. There are a number of ordinary watercourses in Redcar and Cleveland. The majority of these have been identified in the RCBC SFRA.

Flooding of these watercourses is either due to exceedance of channel capacity or exceedance of culvert capacity/blockage during high flows. The process of flooding on watercourses depends on a number of characteristics associated with the catchment including; geographical location and variation in rainfall, steepness of the channel and surrounding floodplain and infiltration and rate of runoff associated with urban and rural catchments.

1.2.5 Interaction with main rivers

Flooding is often the result of water from more than one source, or water building up because another source (such as a river, or the sea) has prevented it from discharging normally. Information about past flooding will often be about an unknown source (i.e. it is not clear where the water came from), or flooding because of interactions between sources (in which case two or more sources may be recorded).

1.3 Study area

The study area for this PFRA is defined by the administrative boundary of RCBC. Redcar and Cleveland is located in north east of England and is one of five borough councils in the Tees Valley. The geographical extent of the study area is illustrated in Figure 1-2.

The study area falls across the Northumbria River Basin District and is served by one water company, Northumbrian Water. The study area is also currently served by the Environment Agency North East region.

Redcar and Cleveland is bordered to the north by the North Sea coast, to the south and east by North Yorkshire County Council and to the west by the Tees Estuary and Middlesbrough.

1.4 Aims and objectives

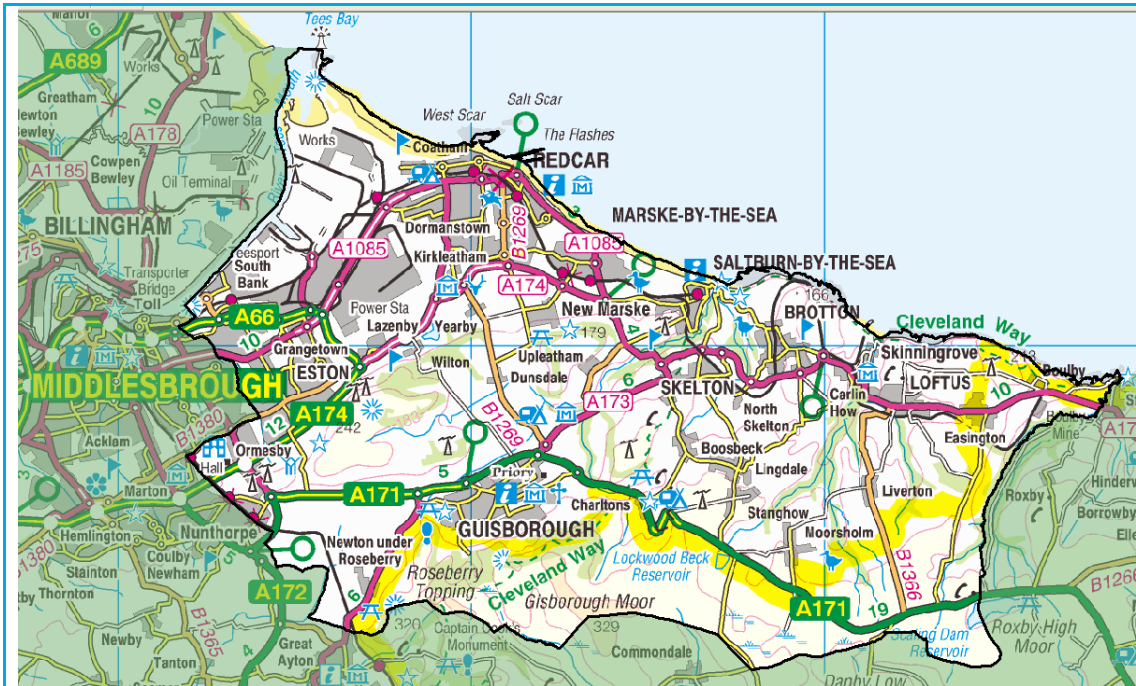
The PFRA is a high level screening exercise to locate areas in which the risk of surface water and groundwater flooding is significant and warrants further examination through the production of maps and management plans. The aim of this PFRA is to provide an

assessment of local flood risk across the study area, including information on past floods and the potential consequences of future floods.

The key objectives can be 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;
- Provide a summary of the systems used for data sharing and storing, and provision 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 the consequences and impacts of these events;
- Establish an evidence base of historic flood risk information, which will be built up on in the future and used to support and inform the preparation of Redcar and Cleveland's Local Flood Risk Strategy;
- 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 explanation and justification for any amendments required to the Flood Risk Areas.

Figure 1-2: RCBC Administrative Area



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2. Lead Local Flood Authority Responsibilities

2.1 Introduction

The Regulations define new responsibilities for flood risk management based on the recommendations of the Pitt Review. The preparation of a PFRA is just one of these responsibilities. This section provides a brief overview of other responsibilities RCBC are obliged to fulfil under their new role as a Lead Local Flood Authority (LLFA).

2.2 Governance and partnership arrangements

Sir Michael Pitt's review of the flooding in 2007 stated, "*The role of local authorities should be enhanced so that they take on responsibility for leading the co-ordination of flood risk management in their areas*". The Act provides for this through the new role of the Lead Local Flood Authority (LLFA), of which RCBC has been designated, and is therefore responsible for leading local flood risk management across their administrative area.

Sir Michael Pitt's Review recommended that the LLFA should bring together all relevant bodies to help manage local flood risk. The important roles played by district councils, highways authorities, water companies are also recognised in the Act, and these bodies, together with the Environment Agency, are identified as risk management authorities.

The Act enables effective partnerships to be formed between the LLFA and the other relevant authorities who retain their existing powers (with some enhancement). It requires the relevant authorities to co-operate with each other in exercising functions under the Act and they can delegate to each other. It also empowers a LLFA to require information from others needed for their flood risk management functions.

Ideally, these working arrangements should be formalised to ensure clear lines of communication, mutual co-operation and management through the provision of Level of Service Agreements (LoSA) or Memorandums of Understanding (MoU).

Partnership working is essential in the management of local flood risk. RCBC should ensure that appropriate partnerships are in place, which will help the collection and sharing of data, and the effective management of the PFRA process. The importance of working together is reflected in Regulation 35 of the Regulations and Section 13 of the Act that requires relevant authorities to cooperate with one another.

The Tees Valley local authorities have set up a Tees Valley Flood Group. This group was initially set up to oversee the production of the SFRA updates. In the future this group will be used to coordinate activities and responsibilities that come from the Flood and Water Management Act.

2.2.1 Stakeholder engagement

As part of the PFRA, RCBC has sought to engage stakeholders representing the following organisations, authorities and various sector/department leads within RCBC:

- Environment Agency
- Northumbrian Water (NWL)
- Tees Valley Flood Group
- RCBC Emergency Planning (which also covers Cleveland Fire Brigade)
- Highways Agency
- RCBC Spatial Planning
- RCBC Highway Maintenance & Drainage

RCBC do not currently have a stakeholder engagement plan. This is likely to be formed by the Tees Valley Flood Group to meet the requirements of the Flood and Water Management Act.

Some early engagement has already been made with Planning, Highway Maintenance and Emergency Planning. This was initiated during the updated of RCBC's SFRA. This will need to be developed further and cover other functions in RCBC including Neighbourhoods and Regeneration.

2.2.2 Public engagement

It is recognised that members of the public may also have valuable information to contribute to the PFRA and to local flood risk management more generally across Redcar and Cleveland. Stakeholder engagement can afford 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.

It is important to undertake some public engagement when formulating local flood risk management plans (if a Flood Risk Area has been identified) as this will help to inform future levels of public engagement. If no Flood Risk Area has been identified, RCBC should still engage with the public during the formulation of local flood risk management strategies.

It is recommended that RCBC 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.

RCBC currently undertake some public engagement with residents that have been directly affected by flooding. This is currently quite limited and there is no public engagement plan at present.

2.3 Further responsibilities

Aside from forging partnerships, coordinating, and leading on local flood management, there are a number of other key responsibilities that have arisen for LLFAs from the FWMA and the Regulations. These responsibilities are included in Table 2-1 below.

The commencement date of some of these responsibilities has been extracted from a recent letter from Defra to LLFAs date 8th March 2011.

Table 2-1: Further Key LLFA Responsibilities under the FWMA

LLFA Responsibility	Description	Legislation Commencement
Local Strategy for Flood Risk Management	RCBC, as a LLFA is required to develop, maintain, apply and monitor a local strategy for flood risk management in its area. The local strategies will build on information such as national risk assessments and will use consistent risk based approaches across different local authority areas and catchments. The local strategy will not be secondary to the national strategy; rather it will have distinct objectives to manage local flood risks important to local communities.	October 2010

LLFA Responsibility	Description	Legislation Commencement
Investigating Flood Incidents	RCBC, as a LLFA has a duty to investigate and record details of significant flood events within their area. This duty includes identifying which risk management authorities have relevant flood risk management functions and how they intend to exercise, or is proposing to exercise those functions in response to the flood. The responding risk management authority must publish the results of its investigation and notify any relevant risk management authorities.	April 2011
SuDS Approving Body	The Act establishes each LLFA as a SuDS Approving Body (the "SAB"). The SAB would have responsibility for the approval of proposed drainage systems in new developments and redevelopments, subject to exemptions and thresholds. Approval must be given before the developer can commence construction. The SAB would also be responsible for adopting and maintaining SuDS which serve more than one property, where they have been approved. Highways authorities will be responsible for maintain SuDS in public roads, to National Standards.	Expected April 2012
Works Powers	The Act provides RCBC, as a LLFA, with powers to do works to manage flood risk from surface runoff, groundwater and on ordinary watercourses, consistent with the local flood risk management strategy for the area.	Implementation is planned to follow the national strategy coming into force later in the year
Designation Powers	The Act provides RCBC, as a LLFA, with powers to designate structures and features that affect flooding or coastal erosion. The powers are intended to overcome the risk of a person damaging or removing a structure or feature that is on private land and which is relied on for flood or coastal erosion risk management. Once a feature is designated, the owner must seek consent from RCBC to alter, remove, or replace it.	Implementation is planned to follow the national strategy coming into force later in the year
Asset Register	RCBC, as a LLFA has 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.	April 2011

3. Methodology and Data Review

3.1 Introduction

The PFRA is a high level screening exercise used to identify areas of significant risk, based on available and readily derivable information, describing both the probability and harmful consequences of past and future flooding. The PFRA involves:

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

Under the Regulations, Flood Risk Areas will require further examination and management through the production of flood risk and flood hazard maps and flood risk management plans.

This Preliminary Assessment Report (PAR) provides the evidence for identifying Flood Risk Areas. It also includes the information and decisions made by RCBC in identifying Flood Risk Areas allowing one reference document to be produced. Although not a requirement of the Regulations, a PAR will also provide a useful reference point for all local flood risk management and so inform local strategies.

The approach for producing this PFRA was based upon the Environment Agency's PFRA Final Guidance, which was released in December 2010. The following methodology has been used to undertake the PFRA.

3.2 Methodology

To prepare this PAR, RCBC has gathered information on past and future floods from a range of available or readily derivable sources. This data collection process has mainly been carried out during the preparation of the Redcar and Cleveland Level 1 and Level 2 Strategic Flood Risk Assessments (SFRA) and through meetings with RCBC highways and drainage engineers.

Some of this information will be limited to specific locations, and available locally, whilst other information will be part of large national datasets obtained from the Environment Agency.

3.2.1 Assessing historic flood risk

Existing datasets, reports and anecdotal information from a range of stakeholders was collected during the Redcar and Cleveland SFRA. This was provided for the purpose of the review of historic flooding and to identify any events with significant harmful consequences. These events should be entered in the PFRA spreadsheet, which is used to provide details of past flood events and associated consequences including economic damage, environmental and cultural consequences and impact on the local population.

Each historical flood record was geo-referenced making 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.

Where there is no information about the consequences of a past flood, it has not been considered to have had significant harmful consequences and as such has not been recorded in the preliminary assessment report spreadsheet. However, as the PFRA process was seen as an opportunity to provide a summary of all the information readily available on past floods, not just those with significant consequences, all historical records have been included in the summary maps, table and description of past flooding. Although not required by the Regulations, this will be useful for RCBC's future local strategy.

3.2.2 Assessing future flood risk

If a location does not have a recorded history of past floods, it does not mean that there is no risk of flooding. To ensure flood risk is assessed objectively, the PFRA should consider where flooding might occur in the future, rather than only reacting to floods in the past.

Future floods, or future flood risk, are otherwise known as potential flooding, or potential flood risk. Computer models usually produce information about future floods. The assessment of future flood risk will primarily rely on a technical review of the Environment Agency's national surface water and groundwater flood maps, the Environment Agency's national Flood Map and local surface water modelling carried out in the Redcar and Cleveland Level 2 SFRA. Further detail on readily available information is provided in Section 3.3.

3.2.3 Identifying Flood Risk Areas

The Regulations require LLFAs to determine whether there is a significant risk in their area based on local flooding and to identify if that risk is significant on a national basis i.e. the Flood Risk Area.

To achieve this, flood risk indicators based on requirements in the Regulations were used to consider consequences of flooding on human health, economic activity, and the environment (including cultural heritage). Key flood risk indicators are summarised in Table 3-1.

Table 3-1: Flood Risk Indicators

Impacts of Flooding on	Flood Risk Indicators
Human Health	<ul style="list-style-type: none"> • Number of people (based on residential properties) • Number of critical services (schools, hospitals, nursing homes, police/fire/ambulance stations)
Economic Activity	<ul style="list-style-type: none"> • Number of non-residential properties (e.g. shops, offices and churches) • Length of road or rail • Area of agricultural land
Environment	<ul style="list-style-type: none"> • Designated sites (SSSIs, SACs, SPAs, etc) and BAP habitat
Cultural Heritage	<ul style="list-style-type: none"> • World Heritage Sites

To ensure a consistent and proportionate approach, using the above indicators, Defra and WAG have identified significance criteria and thresholds for defining Flood Risk Areas. The Environment Agency has then applied these criteria to their nationally available datasets to identify significant areas which exceed the pre-determined thresholds. These pre-determined thresholds are:

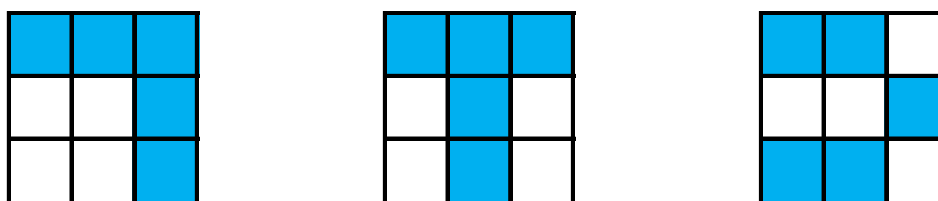
- 200 people, or
- 20 businesses, or
- 1 critical service at risk.

This assessment was carried out nationally based on 1km grid squares, and the grid squares that exceed this criterion were identified. Significant areas in Redcar and Cleveland are shown later in Figures G and H1-H6 in Appendix 1.

The next step in this national approach was to identify clusters where large concentrations of significant areas exist. In England, a cluster is made up of the union of all 3 x 3 km squares that contain five or more touching blue squares.

The blue squares are regarded as touching if they are adjacent up or down, side by side or diagonally as shown in the examples below.

Figure 3-1: Significant Area Clustering Approach



The clustered areas that have been identified using this methodology and exceed 30,000 people at risk of flooding have been mapped and identified as Indicative Flood Risk Areas. For further details, please refer to Defra’s Guidance for selecting and reviewing Flood Risk Areas for local sources of flooding (December 2010).

As these Indicative Flood Risk Areas are only based on nationally available data, this PAR has also undertaken a review using local information. Further detail on this methodology and the outputs can be found in section 7.2.1.

3.3 PFRA data

A crucial part of a PFRA is the task of collating available and readily derivable data and information on flooding to provide an assessment of flood risk. Table 3-2 provides a list of relevant information and datasets available from key stakeholders on both historic and future flood risk.

Table 3-2: Relevant Information and Datasets

Holder	Dataset	Description
EA	Areas Susceptible to Surface Water Flooding	The first generation national mapping, outlining areas of risk from surface water flooding across the country with three susceptibility bandings (less, intermediate and more)
	Flood Map for Surface Water	The updated (second generation) national surface water flood mapping which was released at the end of 2010. This dataset includes two flood events (with a 3.3% annual probability (a.p.) and a 0.5% a.p.) and two depth bandings (greater than 0.1m and greater than 0.3m)
	Flood Map (Rivers and the Sea)	Shows the extent of flooding from rivers with a catchment of more than 3km ² and from the sea
	Areas Susceptible to Groundwater Flooding	Coarse scale national mapping showing areas which are susceptible to groundwater flooding
	National Receptors Dataset	A national dataset of social, economic, environmental and cultural receptors including residential properties, schools, hospitals, transport infrastructure and electricity substations
	Indicative Flood Risk Areas	Nationally identified flood risk areas, based on the definition of ‘significant’ flood risk described by Defra and WAG
	Historic Flood Map	Attributed spatial flood extent data for flooding from all sources
	River Tees and Esk and Coastal Streams Catchment Flood Management Plans (CFMP)	CFMPs consider 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
RCBC	Redcar and Cleveland Level 1 Strategic Flood Risk Assessment (SFRA)	The Level 1 SFRA contains information on historic flooding, collected from RCBC engineer’s records. The Level 1 SFRA also carried out local surface water modelling

	RCBC	RCBC hold records of flooding incidents and have provided more information from local knowledge.
	Redcar and Cleveland Level 2 Strategic Flood Risk Assessment (SFRA)	The Level 2 SFRA provides detailed flood risk information, however this is focused on tidal flooding.
NWL	DG5 Register	DG5 Register logs and records of sewer flooding incidents in Redcar and Cleveland per NWL drainage area. This information was supplied as part of the Redcar and Cleveland SFRA
	Sewer Flooding Locations	The location of sewer flooding locations within 100m square grids.
	Sewer Flooding Pipe References	NWL sewer pipe reference known to be at risk of flooding.
Fire Service and Police	Historical Flooding Records	Records of historic flooding events from the Fire Service and the Police Service historic call out records. Includes location, incident type and response given,
EPU	Emergency Planning Unit	Information on more significant flood events from the Cleveland Emergency Planning Unit.

3.3.1 Data limitations

All data collected during the PFRA process has been recorded in a digital data register. Most data requested was good quality and accurate as expected.

Many historic flooding incidents were made available through data collection. The majority of these datasets could be mapped geographically (GIS) helping to visualise the risk of flooding. Information on the source of flooding was lacking for many of these though. In addition, it was difficult to find out how many properties were flooded and the overall consequence of the events. The RCBC dataset distinguished between flooding to property, external flooding and flooding to roads. Some records just corresponded to a call out for sand bags. In order to try and identify more significant historic flooding events, only the incidents where properties were flooded, have been used in the assessment of current flood risk.

As detailed in Section 4, 784 flooding incidents have been recorded in Redcar and Cleveland, most of these have been collected over the last 10 years.

The historic flood events have only been recorded relatively recently (from 2000 onwards). This means that some historic flooding areas may not been covered. However RCBC were able to provide a flooding hotspots list. This shows the main flooding locations across Redcar and Cleveland based on past flooding events, flood frequency and consequence of flooding.

The identification of flood risk areas will always need to rely on a combination of historic data supplemented by predicted flood risks from modelled approaches.

3.3.2 Data sharing, storage and security systems

RCBC have an information security agreement for which all employees of RCBC should sign up to. This includes RCBC not sharing any data with a third party unless written agreement has been given.

The security of data is also a key consideration when it comes to collecting, collating and storing sensitive data. All RCBC data is encrypted if sent or received no non-secure media (e.g. internet), or if stored on mobile computing devices (e.g. laptop).

JBA consulting, who are completing the PAR for RCBC, have strict data security and sharing systems in place. Only data that has a signed data licence (where applicable), can be used in the project. All data provided is stored in a way that only those working on the project can access it. Once the project has been completed, the data is destroyed, deleted or returned.

RCBC and JBA must adhere to these data security measures to ensure that sensitive data is held in a secure manner.

3.3.3 Data licensing and restrictions

A summary table illustrating the restrictions on the use of this data is included in Table 3-3.

Table 3-3: Summary of Data Restrictions and Licensing Details

Data Owner	Restrictions on Data Use
Environment Agency	This data falls under the license agreement with RCBC and the Environment Agency. The use of some data is restricted to RCBC and their consultants for the preparation of its preliminary flood risk assessment. The use of other data is unrestricted.
Northumbrian Water	This data falls under the license agreement with RCBC and Northumbrian Water. The use of all data provided is restricted to RCBC and their consultants for the preparation of its preliminary flood risk assessment.
Cleveland Fire Service, Police Service and emergency Planning Unit	No data restrictions were identified by these organisations during the collection of historical flood records for the RCBC SFRA. Permission was given to use this data for RCBC flooding studies.

3.3.4 Data quality assurance

Each dataset was reviewed on receipt and its quality and confidence rated for use in the PFRA recorded in a project data register. A qualitative data quality score between 1 and 4 was given along with a comment on the data and its quality.

The scoring system is explained in Table 3-4.

Table 3-4: 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	<ul style="list-style-type: none"> High resolution LIDAR River/sewer flow data Rain gauge data
2	Data with known deficiencies	Best replaced as soon as new data are available	<ul style="list-style-type: none"> Typical sewer or river model that is a few years old
3	Gross assumptions	Not invented but based on experience and judgement	<ul style="list-style-type: none"> Location, extent and depth of much surface water flooding Operation of un-modelled highway drainage 'future risk' inputs e.g. rainfall, population
4	Heroic assumptions	An educated guess	<ul style="list-style-type: none"> 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. Recording also ensures that uncertainties are recognised early and understood at a later stage.

The project data register is provided in Appendix 2, Spreadsheet C.

4. Past Flood Risk

4.1 Overview of historical flooding in Redcar and Cleveland

There is a history of flooding from the sea, main rivers and other local sources within Redcar and Cleveland.

Although RCBC is a coastal authority, there is little history of tidal flooding. This is because much of the land is elevated above the extreme tide levels. There is some tidal interaction with watercourses, for example Skinningrove Beck in Skinningrove.

There are only a small number of main rivers in RCBC. The most significant main river flood risk location, is Chapel Beck in Guisborough. Severe flooding but to a limited number of properties has also occurred in Skinningrove from Skinningrove Beck.

The main source of historic flooding in RCBC is from the other local sources e.g. surface water sewers, water authority combined sewers, smaller (ordinary) watercourses and drains. All of the main urban areas in RCBC have been subject to this type of local flooding at different times.

In total, nearly 800 flooding incidents have been recorded by the different data holders, effecting around 10 main locations. The main local flood risk locations, identified in the SFRA are Eston, Guisborough and Redcar. These have been classed as Critical Drainage Areas (CDAs) within the SFRA.

In general, this local flooding occurs regularly, but it is not particularly hazardous and individual incidents do not affect a large number of properties. However, at a local level, across the whole of RCBC, there are a significant number of properties at risk of regular flooding.

A strategic scale map showing the distribution of historic flood incidents can be seen in Figure A in Appendix 1. Figure B is another strategic map, but shows the number of historic flood incidents per 1km square. Figures C1 to C6 show the distribution of the historic incidents at a more detailed scale.

4.1.1 Surface water flooding

Information on surface water flooding incidents was obtained from a number of sources, as discussed in Table 3-2. Surface water flooding is the main source of flood risk in RCBC. Regular surface water flooding occurs in the main flood risk locations of Eston, Redcar and Guisborough and affects many properties due to the dense urban environments here. The flooding is due to insufficient surface water, combined sewer and culverted watercourse capacity. Runoff, following heavy rainfall events reaches low lying urban areas rapidly due to the small steep catchments here. This puts the surface water sewer infrastructure under considerable pressure and often leads to surcharging and flooding of properties.

4.1.2 Groundwater and mine water flooding

The risk of groundwater flooding in Redcar and Cleveland was assessed during the Level 1 SFRA. The overall level of groundwater flood risk is low through Redcar and Cleveland. The Draft Tees CFMP states that there is little documented evidence of groundwater flooding in the Tees catchment. However there is one groundwater flooding incident that has been recorded. This is to the south of Marske, directly below Errington Wood. In general, the majority of the borough may be subject very wet ground conditions as a result of winter waterlogging.

4.1.3 Sewer flooding

GIS data on historic sewer flooding incidents was provided by NWL. This data can be seen in the historic flood incidents maps (Figures A and C1 to C6). Within the main urban areas, there is a problem with the capacity of combined sewers. During heavy rainfall events, these can surcharge leading to surface water flooding. In some locations across RCBC, this can be

due to drainage ditches being unofficially directed into these combined sewers rather than the correct surface water and highway drains. In other cases, new development and the right to connect has put a strain on the sewer system. The locations where there appears to be a particular problem with combined sewer capacity, is Guisborough, Eston and Marske.

In total, there are 234 records of historic sewer flooding incidents in RCBC.

4.1.4 Canal and ordinary watercourse flooding

There are no canal systems within RCBC.

40 historical flood records have been collected which are attributed to flooding along ordinary watercourses. These incidents are due to insufficient culvert and channel capacity. The main ordinary watercourse flooding locations are:

- Chapel Beck in Guisborough, before it is classed as main river.
- Church Lane culvert at Eston (Teesville)
- The Fleet watercourse at Redcar (Dormanstown)

It can be difficult to distinguish between ordinary watercourse flooding and surface water flooding, as there are many culverted drains and watercourses in the urban areas. It depends on what is classed as a watercourse and what is an urban drain/surface water sewer.

4.1.5 Interaction with Main Rivers and the sea

Within RCBC, the only significant location where local sources of flooding interact with the sea of main rivers is Guisborough.

Guisborough is at risk of flooding from Chapel Back, which is a main river. However, surface water sewers, as well as the culverts can back up and flood the surrounding area when there are high flows on Chapel Beck.

4.2 Analysis of historical flooding in Redcar and Cleveland

Figure 4 - 1 below shows that historically, the main source of flooding has been surface water flooding due to surcharging surface water sewers and drains. NWL's combined sewers also contribute to flooding across RCBC.

Figure 4-1: Local sources of flooding in RCBC

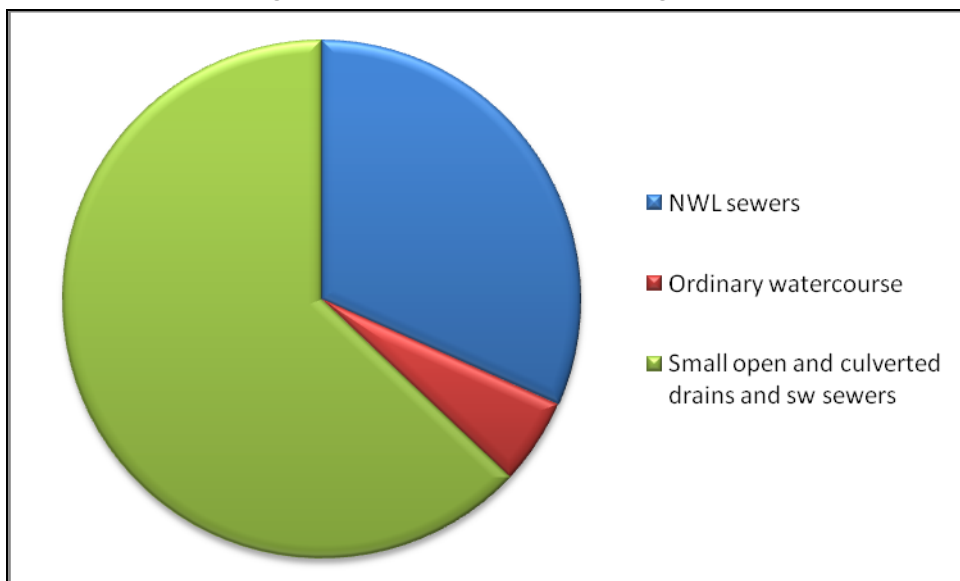
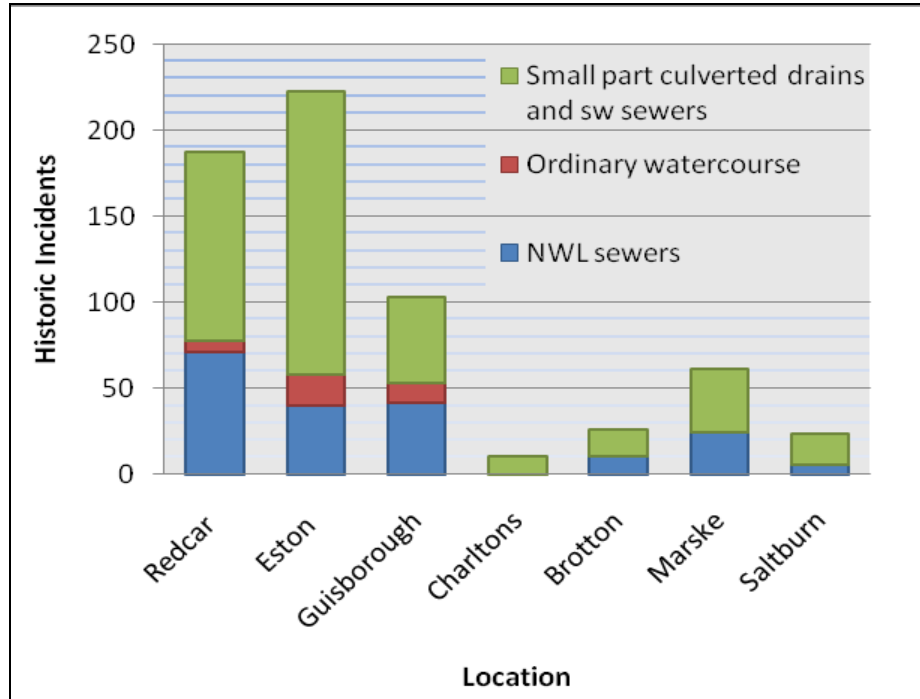


Figure A in Appendix 1 shows that the 1km squares with the most historic flooding incidents (red and purple) are in Guisborough, Eston and Redcar. Figure 4-2 below shows that the most historic incidents per urban area are in Eston (including Grangetown, Normanby,

Teesville and South Bank), shortly followed by Redcar (including Dormanstown). Guisborough then has about half the number of incidents as Redcar and Eston.

The source of flooding in these locations is predominantly surface water flooding from surcharging local authority drains and culverts. NWL combined sewers also contribute to the flooding.

Figure 4-2: Local sources of flooding by location in RCBC



4.2.1 Historic flooding by location

Below is a summary of the historic flooding events in the main locations at risk.

Guisborough - RCBC recorded surface water flooding events here in 2002. The fire brigade recorded flood events to properties here in June 2006 and August 2008 and also during two events in 06/07/09 and 17/07/09.

Redcar - Data from the local authority shows surface water flooding incidents in this area in 2000 and 2002. The Fire Brigade recorded an incident in August 2008. This area was affected particularly badly during the 17/07/09 event and was also flooded in 06/07/09 but to a lesser degree.

Eston - The fire brigade data shows that gardens and houses have been flooded here due to drains overflowing in: August 2003, July 2005, May 2006, August 2006, June 2007 and July 2007. RCBC information shows a number of surface water flooding locations here from events occurring in 2000 and 2002. Two significant flooding events occurred in July 2009. Data from the EPU, RCBC and the police shows many flood incidents in the Eston area from this event.

New Marske and Marske-By-The-Sea - RCBC provided data that shows the New Marske and Marske area has flooded in 2000 and 2002 as well as during the 17/07/09 event. The police and fire brigade data also shows that this area flooded during the 17/07/09 event. The fire brigade data also recorded flooding in July 2005 and in June 2007.

4.3 Significant harmful consequences

The only historic information on the consequence of flooding is the number of residential properties that have flooded. For these residential properties, the total number of people affected was calculated by multiplying the number of residential properties by 2.34. No historical records show flooding to critical services.

Using all the historic flooding data, the number of properties and people at risk can be estimated. In Eston, 222 properties have flooded in the past, putting over 500 people at risk. Along with Redcar and Guisborough, these appear to be the most locally significant flooding locations.

Location	Source	Properties	People*
Eston (Grangetown, Normanby, Teesville and South Bank)	Culverted ordinary watercourse predominantly SW sewers/drains (some NWL sewers)	222	519
Redcar (Dormanstown)	Culverted ordinary watercourse, SW sewers and NWL sewers	187	438
Guisborough	Ordinary watercourse and sw drains interacting with main river	116	271
Charltons	Surface water sewer	10	23
Marske and New Marske	Surface water and NWL sewers	61	143
Brotton	Surface water and NWL sewers	26	61
Saltburn	Mainly surface water some NWL sewers	23	54

*Estimate based on 2.34 x residential properties

The consequence of the local historical incidents assessed on a 1km grid square basis is shown in Figure A. This has been completed in a similar way to the Environment Agency future flood risk methodology (see Section 5.3). None of the 1km squares exceed Environment Agency's "significant" threshold. The total number of people at risk from local sources across RCBC is less than 2000 people, according to the historical data.

Spreadsheet A in Appendix 2 provides more detail on these historic flooding numbers. The number of incidents per grid square can be seen in this spreadsheet along with the future flooding information presented in Chapter 5 for comparison.

Preliminary Assessment Spreadsheet Annex 1 - Past Floods

As the historical incident breakdown (people and non-residential properties) do not identify any 1 km grid squares that exceed the Environment Agency's "significant" threshold, it is assumed that whilst there have been historical flood incidents across RCBC, none are considered to have had significant harmful consequences based on the information that was available.

As a result, none will be recorded in Annex 1 of the Preliminary Assessment Spreadsheet.

5. Future Flood Risk

5.1 Introduction

If a location does not have a recorded history of past floods, it does not mean that there is no risk of flooding. To ensure flood risk is assessed objectively, this PFRA has also considered where flooding might occur in the future. The assessment of future flood risk is primarily based on modelled information.

5.2 Overview of future flood risk in Redcar and Cleveland

5.2.1 Surface water flooding

As identified in Table 3-2 there are a number of national and local datasets available on surface water flood risk in Redcar and Cleveland.

The Environment Agency has produced a national assessment of surface water flood risk in the form of two national mapping datasets. The first generation national mapping, Areas Susceptible to Surface Water Flooding (AStSWF), was released in 2008. The AStSWF map shows areas where surface water would be expected to flow or pond using three susceptibility bandings for a rainfall event with a 0.5% a.p. It was produced using a simplified method, which excluded the underground sewerage, drainage systems, smaller over ground drainage systems and buildings. The Environment Agency updated their national methodology in 2010 and released their second generation national mapping, Flood Map for Surface Water (FMfSW). The revised model included a number of improvements to the AStSWF model including two flood events (3.3% and 0.5% a.p.), the influence of buildings and the influence of the sewer system. The FMfSW also displayed its outputs using two depth bandings (greater than 0.1m and greater than 0.3m).

Using the Environment Agency's national datasets, the number of properties at risk of surface water flooding within Redcar and Cleveland has been estimated. It can be seen that the Environment Agency's second generation national mapping (FMfSW) provides lower estimates of non residential properties at risk but provides higher estimates of residential properties at risk.

Table 5-1: Properties at Risk from Future Surface Water Flooding

National Dataset	Banding	Number of Properties	Number of Residential Properties	Number of non-Residential Properties
Areas Susceptible to Surface Water Flooding	Less	16,200	12,900	3,300
	Intermediate	5,000	3,900	1,100
Flood Map for Surface Water (0.5% a.p.)	>0.1m	15,900	13,200	2,700
	>0.3m	4,200	3,400	800

RCBC has recently completed a Level 2 SFRA which carried out local surface water modelling across Redcar and Cleveland. This local modelling was carried out in 2010 after the Environment Agency's first generation national mapping was released. The modelling approach used local characteristics of rainfall and topography and updated the national methodology to include buildings. Three susceptibility bandings were again used to illustrate areas at risk of surface water flooding.

5.2.2 Locally agreed surface water information

Environment Agency guidance on using surface water flood risk information recommends that RCBC, as a LLFA, should: review, discuss, agree and record, with the Environment Agency, Water Companies, Internal Drainage Boards and other interested parties, what surface water flood data best represents their local conditions. This will then be known as locally agreed

surface water information. Whilst this is not a requirement under the Regulations, it does inform the PFRA process because this information should play an important part in identifying Flood Risk Areas.

As discussed above, there are three sources of surface water information across Redcar and Cleveland; two national Environment Agency maps and one local map produced by RCBC during the preparation of their SFRA. The difference in modelling approach is identified in Table 5-2 below.

Table 5-2: Comparative Surface Water Modelling Approaches

Variable	Surface Water Modelling Outputs in Redcar and Cleveland		
	Areas Susceptible to Surface Water Flood (AStSWF)	SFRA Surface Water Mapping	Flood Map for Surface Water (FMfSW)
Date	2008	2009	2010
Coverage	National	Redcar and Cleveland	National
Modelling Package	JFlow	JFlow	JFlow
Annual Probability Rainfall	0.5% a.p.	0.5% a.p	3.3% a.p. 0.5% a.p
Storm Duration	6.5 hrs	6.5 hrs	1.1 hr
Rainfall Profile	50% summer	50% summer	50% summer
Reduction to rainfall amount to represent infiltration	0 - No infiltration	0 - No infiltration	39% rural 70% urban
Reduction to rainfall amount to represent sewer flow	0 - Drainage systems assumed to be at capacity	0 - Drainage systems assumed to be at capacity	0mm/hr rural 12mm/hr urban
Sewer Spill Volumes	Not considered	Not considered	Not considered
Manning's 'n'	0.1	0.1	0.1 rural 0.03 urban
DTM	Infoterra bare earth LIDAR and Geo-Perspectives	EA LIDAR	EA 2010 Composite
Model Resolution	5m	5m	5m
Buildings	Not represented	Buildings within DTM raised by 5m	DTM raised by 5m
Roads	Not considered	Roads lowered by 150mm	Not considered
Threshold Bands	Less: 0.1 to 0.3m Intermediate: 0.3 to 1m More: >1m	Less: 0.1 to 0.3m Intermediate: 0.3 to 1m More: >1m	Less: >0.1m More: >0.3m

After reviewing the different surface water maps, RCBC agreed that the AStSWF is most representative of surface water flood risk. This information best represents historic surface water flooding extents in RCBC. The AStSWF data should therefore be the 'locally agreed surface water information' for RCBC.

The AStSWF map for RCBC can be seen in Figure D in Appendix 1. Detailed maps of the AStSWF can be seen in RCBC's Level 1 SFRA.

The SFRA mapping picks out individual roads in more detail and will be useful when assessing surface water flow pathways. The SFRA mapping and FMfSW will be of use when looking at locations in more detail (RCBC local strategy and/or future SWMP).

Preliminary Assessment Spreadsheet Annex 2 - Future Floods

The FMfSW is included in Annex 2 of the preliminary assessment spreadsheet as showing an adverse consequences to human health and adverse economic consequences. Property counts have been supplied by the EA and using simple GIS.

5.2.3 Groundwater flooding

The Environment Agency's national dataset, Areas Susceptible to Groundwater Flooding (ASStGWF), has been used to form the basis of the assessment of future flood risk from groundwater. The map has been derived using the top two susceptibility bands of the British Geological Society (BGS) 1:50,000 Groundwater Flood Susceptibility Map and covers consolidated aquifers (chalk, sandstone etc., termed 'clearwater' in the data attributes) and superficial deposits. It does not take account of the chance of flooding from groundwater rebound. It shows the proportion of each 1km grid square where geological and hydrogeological conditions show that groundwater might emerge.

The susceptible areas are represented by one of four area categories showing the proportion of each 1km square that is susceptible to groundwater emergence. This dataset is illustrated in Figure E, Appendix 1.

Preliminary Assessment Spreadsheet Annex 2 - Future Floods

The ASStGWF is included in Annex 2 of the preliminary assessment spreadsheet, however it is unknown if the dataset shows an adverse consequences to human health and adverse economic consequences.

5.2.4 Sewer flooding

No local or national information on future flood risk from sewers has been made available for this PFRA. The national surface water flood maps allow for some initial capacity in the sewer drainage system before they surcharge. The areas at risk from future sewer flooding should therefore be covered by these national maps. The areas at risk of sewer flooding are likely to be more localised and less extensive than the national surface water maps. It may be necessary to model the key locations (e.g. parts of Eston and Redcar) part of RCBC's local strategy (or a SWMP that may come from the local strategy).

5.2.5 Canal and ordinary watercourse flooding

There are no canal systems within Redcar and Cleveland. The Environment Agency's fluvial Flood Map and the Detailed River Network datasets have been used to assess the risk of flooding from ordinary watercourses. There are a number of ordinary watercourses in Redcar and Cleveland which are covered by the Environment Agency's Flood Map and could put properties at risk in the future. These are:

- StaithesBeck / Easington Beck near Staithes
- Mill Beck near Mill Bridge
- Swindale Beck/Hagg Beck near Moorsholme Hill Farm
- Wileycat Beck at Charltons
- Chapel Beck in Guisborough
- Moordale Beck at Dunsdale

Figure F in Appendix 1 shows the number of properties at risk from Ordinary Watercourses within each kilometre square. The locations at risk from these ordinary watercourses are isolated properties and farms and generally do not exceed 10 properties per km square. The

risk from Ordinary Watercourses therefore has a low consequence. An exception is in Guisborough. Chapel Beck is Main River through most of Guisborough apart from in the east of the town. Chapel Beck is classed as Ordinary Watercourse here and puts over 50 properties at risk

Apart from Chapel Beck in Guisborough, the flood zones associated with these ordinary watercourses have a very low quality rating as they are based primarily on early strategic flood zone modelling carried out by the Environment Agency. As the consequence of flooding is low, more detailed modelling is unlikely to be justified.

Preliminary Assessment Spreadsheet Annex 2 - Future Floods

The Flood Map is included in Annex 2 of the preliminary assessment spreadsheet as showing an adverse consequences to human health and adverse economic consequences. However, property counts provide no distinction between main rivers or ordinary watercourses.

5.3 Future flood risk and their consequences

Potential consequences of future surface water flooding have been assessed by the Environment Agency using the FMfSW (0.5% a.p. rainfall event) and the National Receptors Database. By counting the number of people, businesses and critical services at risk, the Environment Agency has identified a number of areas across Redcar and Cleveland, which exceeds the Defra and WAG significance criteria. Significant harmful consequences are defined as:

- 200 people, or
- 20 businesses, or
- 1 critical service at risk.

This assessment was carried out based on 1km² national grid squares, and the grid squares that exceed this criterion were identified. There are 313 1km² grid squares that cover or intersect RCBC's administrative boundary. 22 of these grid squares exceed the thresholds listed above.

Figure G in Appendix 1 shows the location of the blue squares across RCBC. The reference number aligns with Table 5-3 below. More detailed figures showing the blue squares and the breakdown of the numbers can be seen in Appendix 1 Figures H1 to H6.

Table 5-3 provides a breakdown of each significant 1km² grid square. This table can be used to identify which threshold has been exceeded for each grid square. The full table, showing all the squares where there is a future flooding consequence can be seen in Appendix 2 spreadsheet A. Included in this table are the historic flooding incidents and consequences of ordinary watercourse flooding for comparison.

Table 5-3: Summary of Significant Areas in Redcar and Cleveland

Map Location ID	Number of People	Number of Non-Residential Properties	Number of Critical Services
27	243	6	3
28	283	19	0
29	222	20	0
39	285	4	1
52	267	14	0
53	222	14	2
67	0	23	0
107	337	6	0
108	246	1	1
121	229	27	1
123	239	31	1
134	218	5	0
146	0	4	2
150	206	13	2
151	300	50	0
155	0	23	0
158	187	32	3
194	344	11	0
198	37	3	2
209	262	4	0
217	363	15	0
218	784	39	5

The Map Location ID refers to the numbered grid squares in Figures G and H1 to H6.

These significant areas have been clustered to identify Indicative Flood Risk Areas by the Environment Agency (see section 6.1).

5.4 Effects of climate change and long term developments

5.4.1 The evidence

There is clear scientific evidence that global 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 falling 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 2080s.

We have enough confidence in 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, even 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 20% a.p. or rarer) could increase locally by 40%.

5.4.2 Key projections for Northumbria 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 10% (very likely to be between 0 and 23%)
- Precipitation on the wettest day in winter up by around 11% (very unlikely to be more than 24%)
- Relative sea level at Tynemouth very likely to be up between 7 and 38cm 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 13%

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

5.4.3 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 in both rural and heavily urbanised 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 we need to be prepared for the unexpected.

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

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.

5.4.4 Adapting to change

Past emission 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 local decisions against deeper 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.

5.4.5 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).

In RCBC, the historic and future local flood risk locations coincide with areas of large scale future development. This is discussed further in 7.2.3.

6. Flood Risk Areas

6.1 Introduction

Out of the 28 1km grid squares identified as significant in Section 5.3, one location covering Redcar and Cleveland has been identified using the clustering methodology as illustrated in Figure 3-1. This cluster, named by the Environment Agency as 'Redcar', is ranked 173 (out of 219) by number of people at risk in England. This cluster has 1804 people at risk of surface water flooding. This cluster is well below the 30,000 people threshold required to be an Indicative Flood Risk Area.

Of the ten national Indicative Flood Risk Areas, none fall within the North East of England.

6.2 Review of Indicative Flood Risk Areas

It is important to remember that the Indicative Flood Risk Areas are only based on surface water flooding and on a subset of the significance criteria that can be measured at the national level.

It is therefore important that the omission of a Flood Risk Areas in Redcar and Cleveland is reviewed using the local information on past and future flood risk discussed in Sections 4 and 5. In order to do so the following questions have been considered in Table 6-1.

Table 6-1: Indicative Flood Risk Area Review

Question	Response	Action
Is the FMfSW the most appropriate source of information?	RCBC have agreed that the AStSWF will be the locally agreed surface water information (see section 7). There are only fractionally more properties at risk from this outline than the FMfSW. This means the threshold will not be met for this dataset either.	No action
Are the consequences of flooding from other sources e.g. groundwater, ordinary watercourses likely to lead to significant Flood Risk Areas?	The consequences of flooding from these other sources is very limited (i.e. 0-10 properties at risk in one place). These other sources will be assessed within RCBC's local strategy.	No action
Is there information on past floods which had significant harmful consequences?	The main source of historic flooding is surface water flooding from the surface water and sewer drainage systems. However, the consequences of flooding using this information is nowhere near high enough to exceed the Environment Agency thresholds. These local risks will be assessed within RCBC's local strategy.	No action
Is there any other information on the possible harmful consequences of future floods?	No	No action

Preliminary Assessment Spreadsheet Annex 3 - Flood Risk Areas

RCBC agrees with the EA's IFRA's and they do not have a FRA in their administrative area. As a result, Annex 3 of the preliminary assessment spreadsheet will remain blank.

7. Next Steps

7.1 Introduction

Although no Flood Risk Area has been identified in Redcar and Cleveland, triggering the requirement to produce flood hazard and risk maps and a flood risk management plan, the Council must still continue to commit to local flood risk management in its area.

The PFRA cycle will start again in 2016, so it is important to ensure that information is maintained and kept up to date for future use and to support other flood risk assessments (such as SWMPs, SFRAs) and as part of local strategies. In the next cycle, more information will be mandatory for floods that occur after 22 December 2011.

The first review cycle of the PFRA will be led by RCBC and must be submitted to the Environment Agency by the 22nd of June 2017. They will then submit it to the European Commission by the 22nd of December 2017 using the same review procedure described above.

7.2 Local flood risk management strategy

The Act requires RCBC, as a LLFA, to develop, maintain, apply and monitor a strategy for local flood risk management in its area. The LLFA will be responsible for ensuring the strategy is put in place but the local partners can agree how to develop it in the way that suits them best. The Act sets out the minimum that a local strategy must contain, and the LLFA is required to consult on the strategy with risk management authorities and the public. Local partnerships between other risk management authorities (including Northumbrian Water, the Environment Agency and neighbouring LLFAs) will be critical.

Local flood risk includes surface runoff, groundwater, and ordinary watercourses (including lakes and ponds). This PFRA has identified a number of significant flood risk areas in Redcar and Cleveland. Whilst the clustering approach has not identified an area within RCBC that meets the 30,000 people at risk threshold required to identify a Flood Risk Areas, they should provide the focus of the local strategy especially where the analysis shows an overlap between past flood incidents and future flood risk areas.

RCBC will need to consider the full range of measures consistent with a risk management approach in developing their local flood risk strategy. Resilience and other approaches which minimise the impact of flooding are expected to be a key aspect of the measures proposed.

Other local flood risk studies, such as the SFRA will be essential building blocks for the delivery of local flood risk management in Redcar and Cleveland. The strategy should be fully integrated with flood management works planned by the Environment Agency, Northumbrian Water and the Highways Agency.

7.2.1 Analysis of AStSWF and historic data

In order to provide RCBC with an evidence base to take forward their Local Strategy, some new GIS analysis has been undertaken. The AStSWF is the 'locally agreed surface water information' for RCBC. It was decided that an assessment of future flooding should be undertaken but using the AStSWF rather than the FMfSW (which was used for the blue squares).

This information was aggregated in 500m grid squares rather than the 1km grid blue squares. This allows more discreet areas for further assessment to be identified within urban areas.

It was then decided that historical flooding information should be integrated into this new analysis. In order to put more weighting on certain historic incidents, the following was undertaken:

- Key RCBC flood hotspots were multiplied by 10, as these have been the most significant historic events.

- Incidents were multiplied by 5 where properties were flooded
- All other incidents (external and highway flooding) multiplied by 3.

All of the above scores were totalled to give each 500m grid square a historic flooding score.

The total number of properties at risk of future flooding was calculated using the AStSWF map and the National Receptor Dataset (NRD). The properties at risk of future flooding were then added to the historic flooding score and aggregated in the 500m grid squares. This allows us to identify the locations at greatest risk of flooding now and in the future.

Figure I in Appendix 1 shows all of the 500m grid squares in RCBC and a reference number (ID) for each of the squares. The reference number aligns with Spreadsheet B in Appendix 2. This spreadsheet shows all the data that has been used to give each square the combined historic and future flood risk score. In this spreadsheet, the 500m squares have been ranked with the highest score first.

Figure J shows all the squares that have a score above 50.

7.2.2 Key locations for RCBC Local Strategy

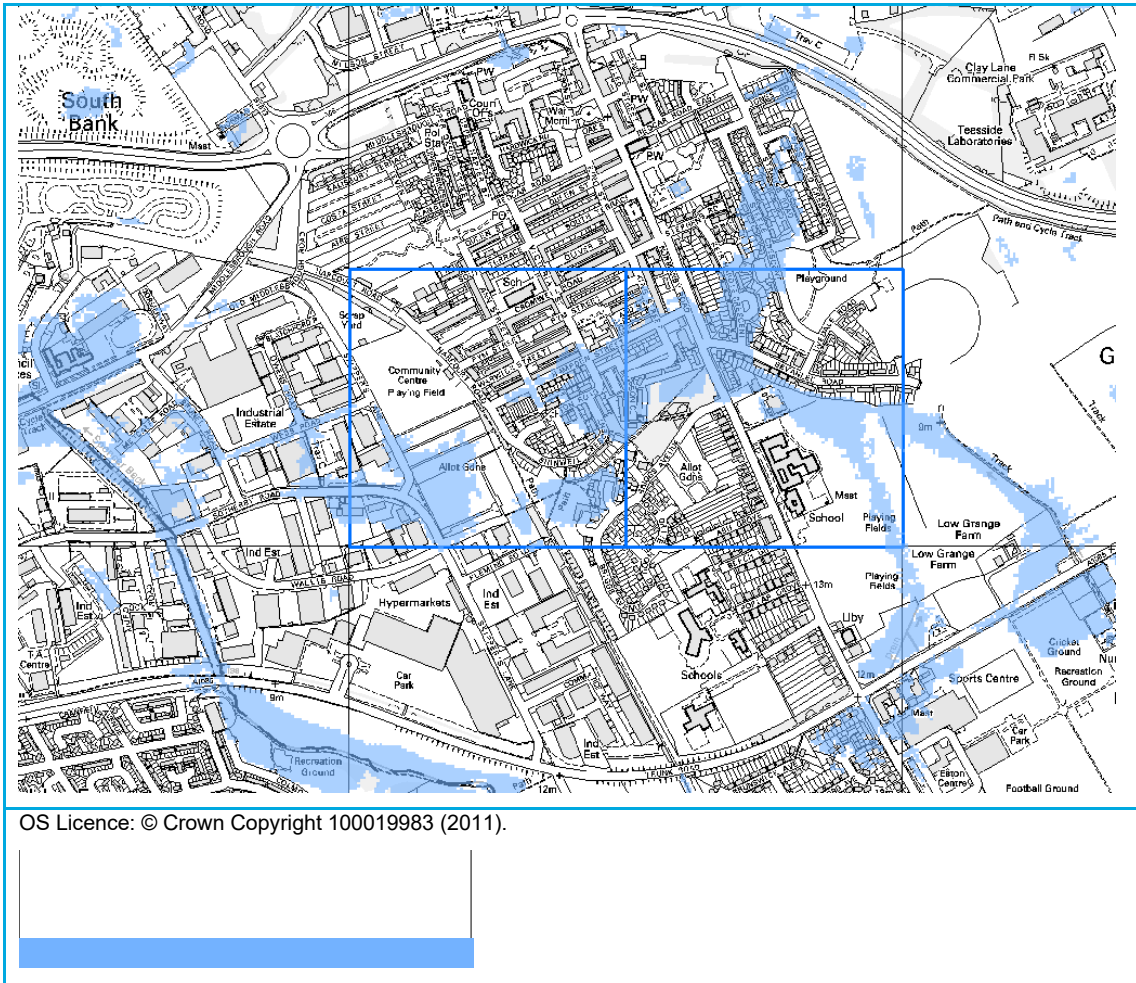
Figure J in Appendix 1 shows that the 500m grid squares with a score above 50, cluster in Eston, Redcar and Guisborough. This aligns with what has been found when completing the SFRA and this also aligns with the nationally produced, blue squares.

Within these three locations, the areas of greatest current and future risk are shown in the following figures. The 500m squares with the highest scores (above 150) and the intermediate AStSWF map is displayed.

Eston

The north part of Eston near the A66 around Normanby Road and Harcourt Road.

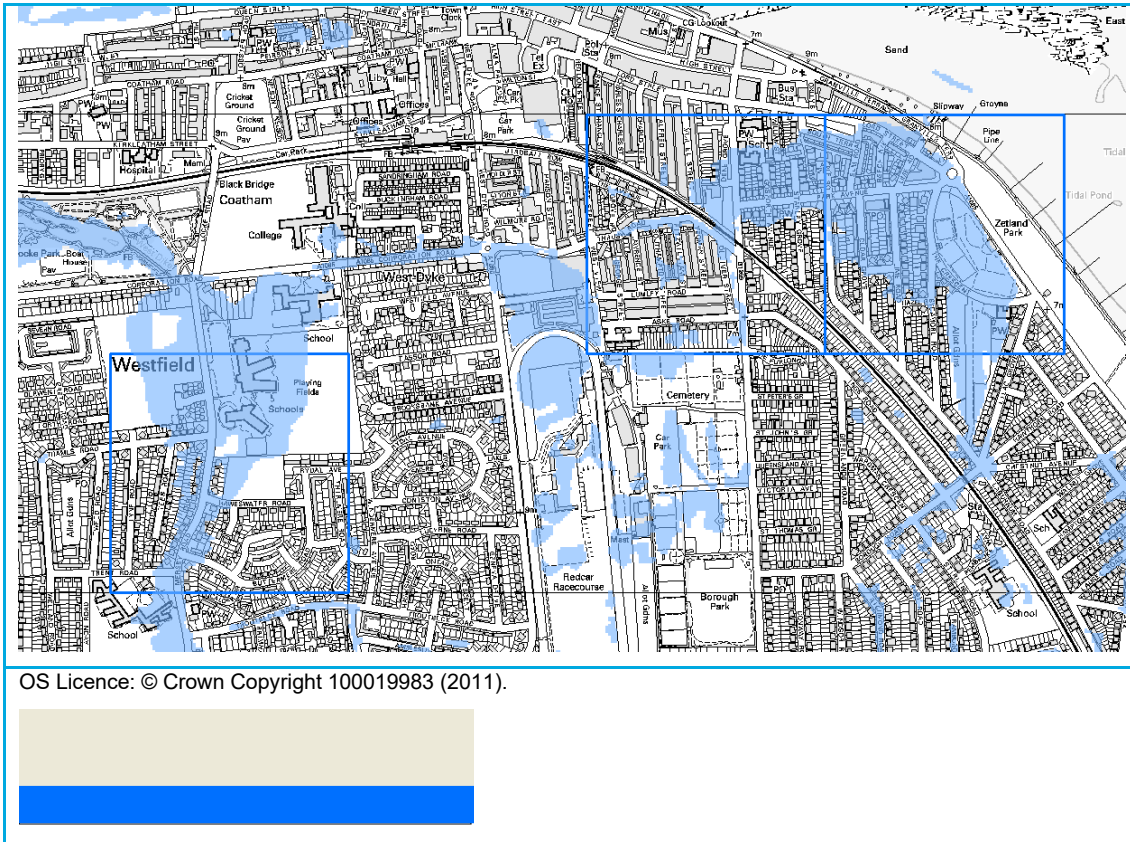
Figure 7-1 – Area of greatest risk in Eston



Redcar

The north part of Redcar, Mersey Road area (Westfield) and the area around Park Avenue / Thrush Road.

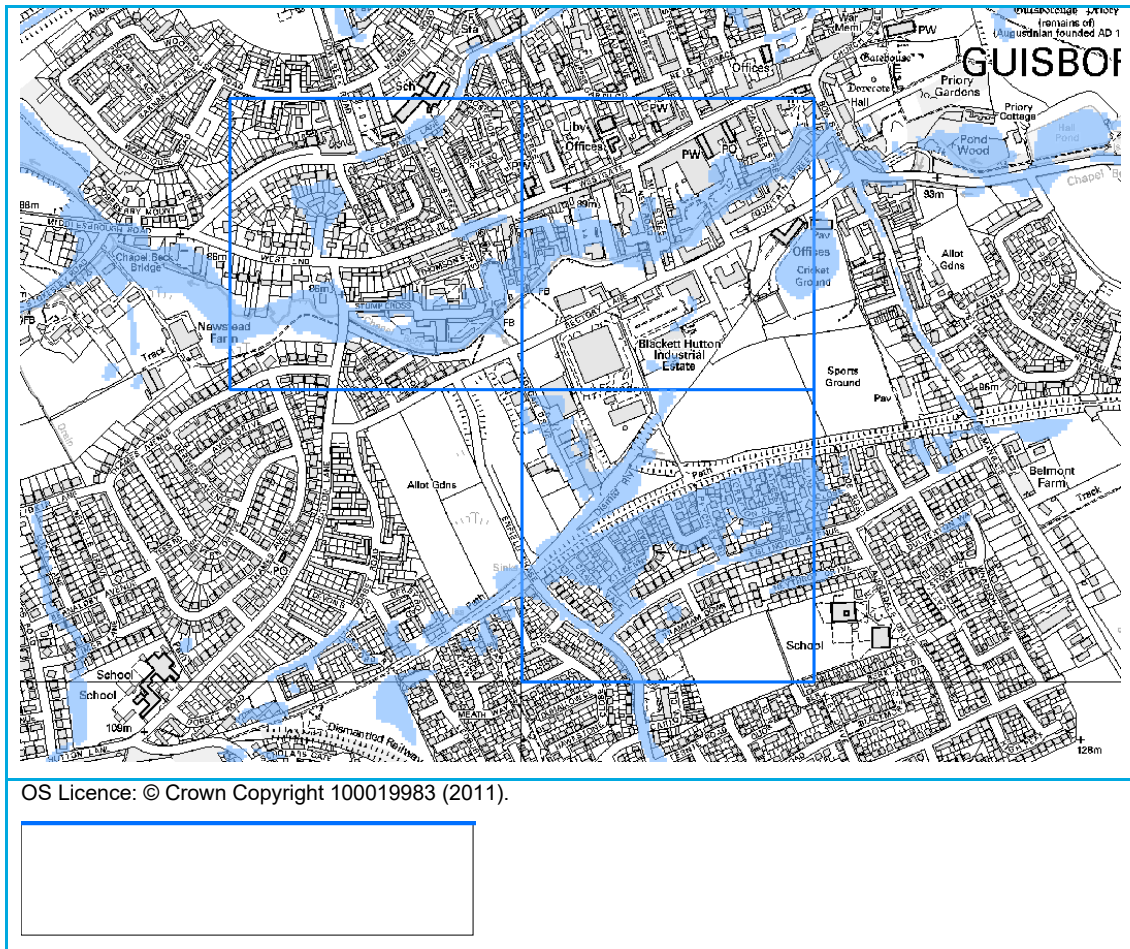
Figure 7-2 – Area of greatest risk in Redcar



Guisborough

The central eastern part of Guisborough, either side of Chapel Beck and Rectory Lane.

Figure 7-3 – Area of greatest risk in Guisborough



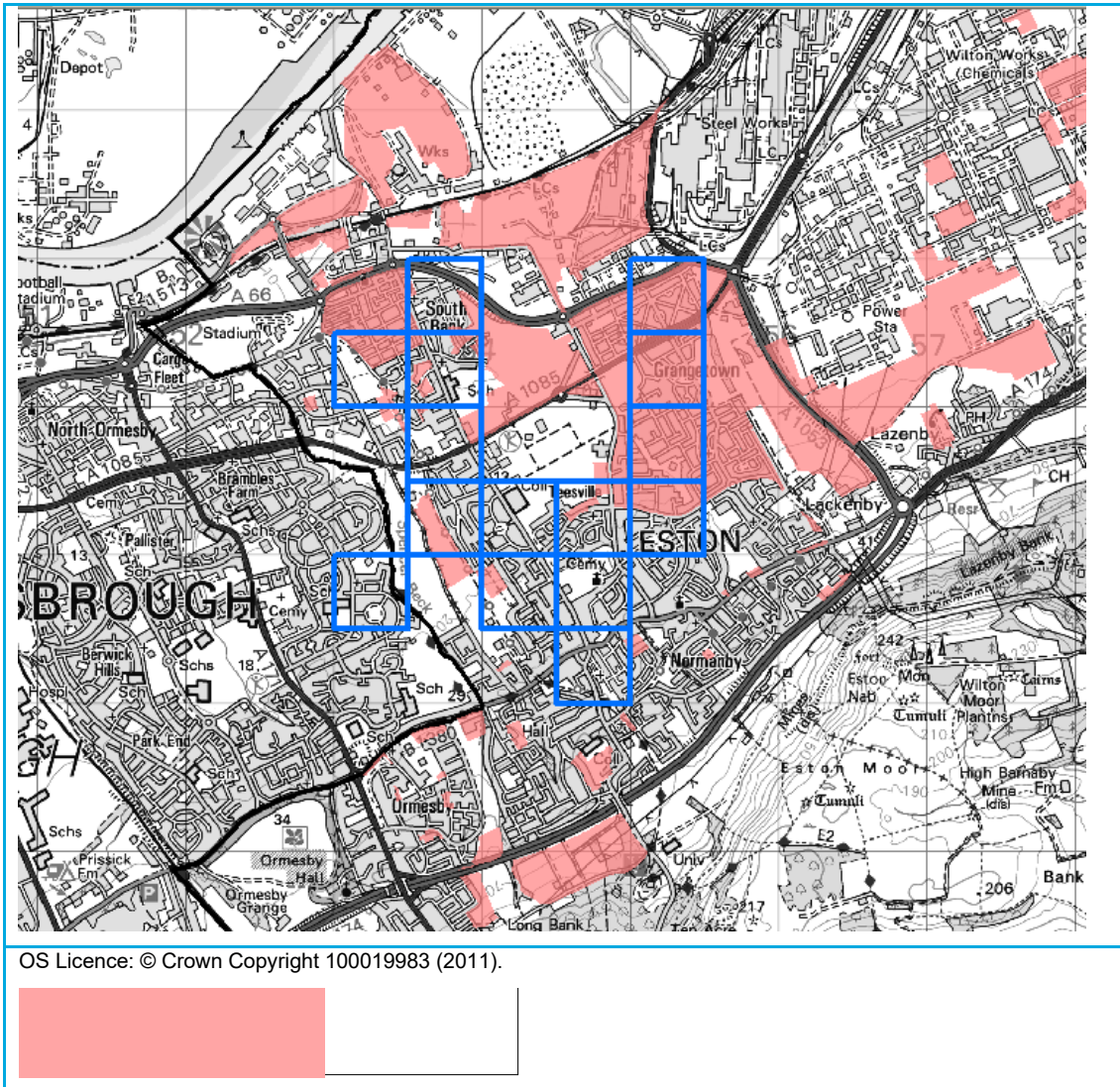
The spreadsheet information and the key locations identified should form the basis of RCBC's local strategy.

7.2.3 Local flood risk and future development

Coincidentally, major development is also proposed for the locations at greatest risk of surface water flooding, particularly Grangetown in Eston. Figure 7.4 shows the 500m grid squares of greatest current and future flood risk along with the proposed future development areas in Eston. This can create problems but also opportunities for improvement. Development of currently undeveloped areas can increase the strain on an already under capacity surface water sewer system. However, if a large area is to be redeveloped, the sewer system can also be restructured (e.g. separation of foul and surface water sewers and increasing capacity).

In locations like Eston and Redcar, where there is major development planned, a Drainage Impact Assessment (DIA) or an area specific Surface Water Management Plan (SWMP) should be undertaken. This should set out a strategic approach to surface water management, integrated into the development master plans. For example, part of the development area could be set aside for the attenuation and treatment of surface water. This approach avoids ad hoc SUDS schemes and passing on the surface water management burden to the last development to come forward, or the location at the lowest part of the surface water sewer system.

Figure 7-4 – Area of greatest risk and future development in Eston



7.3 Quick win schemes

The PFRA is due to be completed and approved by the end of 2011. The next steps for RCBC include setting up the Tees Valley Flood Group and deciding how this group will facilitate the requirements of the Flood and Water Management Act. RCBC will then start to undertake their local flood risk management strategy.

This process that should lead to works being undertaken to reduce flood risk, could take some time. It will be important to work with partners (e.g. Environment Agency and Northumbrian Water) on large-scale, combined flood risk locations (e.g. Guisborough where there are issues with combined sewers, LA drains and a Main River). However, this should not stop RCBC undertaking works at locations where there is a risk of regular flooding from a single source of flooding.

This could be what is known as a ‘quick win’. This is where a relatively simple and cost effective solution could significantly reduce the risk of flooding to the local population. It is important that quick wins are considered within this period in order to keep the public engaged and so that they can see progress is being made. It will also be important to effectively communicate to the public the reasons why works are not being undertaken in other locations (e.g. the need for integration with other partners for locations at risk from multiple sources).

The locations where there are potential quick wins are shown in Table 7-1 below.

Table 7-1: Potential ‘quick win’ locations

Location	Type	Description of problem
Tees Dock Road, Grangetown	Surface water flooding due to capacity problem.	Surface water runoff from industrial land and difficulties with maintenance to surface water drainage systems within industrial land. Surface water flows from industrial land causes capacity problems within the highway drainage system.
Charltons	Surface water flooding.	During heavy and prolonged rainfall events, water flows from the hills down towards the village. The drainage in the village was not designed to cope with the volume of water coming from the hills, which leads to properties being flooded.

Feasibility studies should be completed for these locations. These studies should consider the potential solutions and the economic cost/benefit of them.

7.4 Flood incident investigations and register

In order to continue to fulfil their role as LLFA, RCBC is required to investigate future flood events and ensure continued collection, assessment and storage of flood risk data and information.

The data recorded in the register should be adapted to mirror the requirements of the PFRA and should therefore include the following data fields:

Table 7-2: Historic Incident Register Summary

Field	Description
Start Date	Date and time
Duration	Days
Location	Address, town, postcode and Easting / Northing
Probability	Estimate return period
Main Source	Main rivers, surface runoff, groundwater, ordinary watercourses and any interaction these have with drainage systems and other sources of flooding including sewers.
Additional Source	Main rivers, surface runoff, groundwater, ordinary watercourses and any interaction these have with drainage systems and other sources of flooding including sewers.
Man Mechanism	Natural exceedance, defence exceedance, failure, blockage etc
Flood consequence data	Number of residential/commercial/people/critical services affected
Risk of flooding	Low, medium or high
Response	Action taken i.e. evacuation
Incident registered by	RCBC, NWL, Highway etc.

It is recommended that a centralised database will be kept up to date by RCBC flood risk management lead. This will prove beneficial during the PFRA review process and any subsequent review of the RCBC SFRA and future local strategy.

7.5 Key actions for the next stage

The key actions for the next stages of local flood risk management in RCBC include the following:

- Submit and get approval for the PFRA PAR.

- Establish governance and partnership (Tees Valley Flood Group) for implementing the Flood and Water Management Act.
- Set up and start maintaining a Historic Incident Register (see Table 7-2).
- Undertake prefeasibility studies for key 'quick win' locations.
- Start the Local Strategy process, using the data in Spreadsheet B, Appendix 2 and Figures I and J (Appendix 1) as a starting point.
- Where future major development are proposed in areas that also have a high current and future flood risk (specifically Eston and Redcar), undertake Drainage Impact Assessments or area specific Surface Water Management Plans (SWMPs). The need for these studies should be identified in the RCBC Local Strategy. If development is to come forward in Redcar and Eston before the Local Strategy is established, early action may be required to take these studies forward.

Annexes

Annex 1: Records of past floods and their significances

Please refer to Annex 1 of the Preliminary Assessment Spreadsheet attached with this report.

Annex 2: Records of future floods and their consequences

Please refer to Annex 2 of the Preliminary Assessment Spreadsheet attached with this report. This spreadsheet includes a complete record of future flood risk within Redcar and Cleveland, including details of the potential consequences of flooding to key risk receptors within the borough.

Annex 3: Records of Flood Risk Areas and their rationale

Please refer to Annex 3 of the Preliminary Assessment Spreadsheet attached with this report.

Annex 4: Review checklist

Please refer to Annex 4, attached to this report, which contains the Review Checklist that has been provided by the Environment Agency to act as a checklist for reviewing PFRA submissions.

Appendix 1 - Figures

(Figures provided separately)

Figure A – Historic Flooding Incidents (strategic)

Figure B – Historic flooding incidents per 1km square

Figure C1 to C6 – Historic flood incidents (detailed)

Figure D - Locally Agreed Surface Water Information

Figure E – Areas susceptible to groundwater flooding

Figure F – Risk from Ordinary Watercourses

Figure G – Areas above flood risk threshold (strategic)

Figure H1 to H6 – Areas above flood risk threshold (detailed)

Figure I – Locally significant flood risk areas (strategic)

Figure J1 to J6 – Locally significant flood risk areas (strategic)

Appendix 2 – Spreadsheets

Spreadsheets provided separately

Spreadsheet A – Consequences of future flooding (FMfSW) and historical incidents for all 1km grid squares

Spreadsheet B – Combined assessment of future and historic local flood risk

Spreadsheet C – Project data register



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BD23 3AE

t:+44(0)1756 799919
e:info@jbaconsulting.co.uk

Jeremy Benn Associates Ltd
Registered in England 3246693



Visit our website
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