# Sunderland City Council Preliminary Flood Risk Assessment

Final
June 2011

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# Revision History

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# Contract

This report describes work commissioned Sunderland City Council. Sunderland City Council's representative for the contract was Neil Cole. Peter Grace of JBA Consulting carried out this work.

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# Purpose

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# Acknowledgments

JBA would like to thank all those who provided information and data for this report.  Special thanks go out to Neil Cole and Michael Ratcliffe from Sunderland City Council.

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# Executive Summary

This report has been prepared to assist Sunderland City Council meet its duties, as a Lead Local Flood Authority, to manage local flood risk and deliver the requirements of the Flood Risk Regulations (2009). It is part of the Preliminary Flood Risk Assessment process.

As a Lead Local Flood Authority, Sunderland City Council must submit their Preliminary Flood Risk Assessment to the Environment Agency for review by 22nd June 2011. The methodology for producing this PFRA is based on the Environment Agency's Final Preliminary Flood Risk Assessment Guidance and the Department for Environment, Food & Rural Affairs Guidance on selecting Flood Risk Areas, both published in December 2010 and updated in March 2011.

The Regulations require Lead Local Flood Authorities, through the Preliminary Flood Risk Assessment process, to carry out a high-level screening to determine whether there is a local flood risk within their area based on past (historic) and future (potential) flood risk data. Local flood risk is defined as flooding from surface water, groundwater, ordinary watercourses and canals. Where a local significant flood risk exists, a Flood Risk Area should be defined.

## Indicative Flood Risk Areas

In order to ensure a consistent national approach, the Department for Environment, Food & Rural Affairs and the Welsh Assembly Government identified flood risk criteria and thresholds for defining Flood Risk Areas across England and Wales. The Environment Agency then used these criteria with the Flood Map for Surface Water and the National Receptor Dataset to identify areas (1km grid squares) above the flood risk thresholds. The 1km squares above the flood risk thresholds were then joined together to form clusters. Where clusters were predicted to affect over 30000 people, it was identified as an indicative Flood Risk Area.

Using the Flood Map for Surface Water[1] and the National Receptor Dataset, there are 22500 properties estimated at risk during a 1 in 200-year[2] rainfall event across the City of Sunderland. 19100 of which are residential properties, housing around 45000 people (19100 x 2.34).

Using the Environment Agency's 1km grid square assessment, 43 grid squares above the flood risk thresholds were identified across the City. From these 43 1km grid squares, two clusters were identified; the Washington and Sunderland clusters containing 3400 and 8100 people at risk respectively. As both clusters do not exceed the threshold of 30000 people, the Environment Agency has not identified them as indicative Flood Risk Areas.

## Local Flood Risk Assessment

As national Flood Map for Surface Water provides the only evidence for the indicative Flood Risk Areas, this report has been produced in order to collate and assess local information on past and future flood risk. This local assessment will then be used to review the Environment Agency's indicative Flood Risk Areas, or lack of, and support the identification of any Flood Risk Areas within the City if deemed appropriate. The majority of this local data was sourced from the Environment Agency's national flood risk mapping datasets and the Council's Strategic Flood Risk Assessment (July 2010).

The Preliminary Flood Risk Assessment requires past flood events with 'significant harmful consequences' to be documented. Whilst historical records were obtained from the Strategic Flood Risk Assessment (July 2010), there was insufficient information to identify past flood events that fulfil this criteria. Therefore, no records were included on past flooding in Annex 1 of the Preliminary Assessment Spreadsheet and as such have not influenced to identification of a Flood Risk Area within the City of Sunderland.

[1] It should be noted that the Flood Map for Surface Water was produced at a strategic scale and does not take into account any flood defences or flood alleviation schemes and takes a national assumption on the capacity of the urban drainage system.
[2] A 1 in 200 year flood event indicates a 0.5% probability of the flood level that is expected to be reached on average once in 200 years. This means it has 0.5% chance of occurring in any one year, not that it will occur once every 200 years. This means that over a lifetime of 75-years there is around a 30% chance that a flood of this size will occur.

Future flood risk is assessed using a number of national and local datasets including the

- Environment Agency's national Areas Susceptible to Surface Water Flooding Map
- Environment Agency's national Flood Map for Surface Water
- Environment Agency's national Areas Susceptible to Groundwater Flooding Map
- Environment Agency's national Flood Map for rivers and the sea

Based on the Environment Agency's Flood Map for Surface Water, approximately 7500 properties are estimated to be at risk from potential surface water flooding to a depth of 0.3m and a further 15000 at a depth above 0.1m. These total an estimated 22500 properties (19100 residential) at risk during the 1 in 200-year rainfall event in Sunderland. The PFRA has also identified 95 properties at risk from local ordinary watercourse flooding during the 1 in 100-year fluvial flood event. 58 of which are residential properties, housing around 140 people (58 x 2.34) across the City.

**Using future flood risk data available, the PFRA has identified around 45000 and 140 people potentially at risk from surface water and ordinary watercourse flooding respectively across the City. However, using the Environment Agency's 1km grid square approach, flood risk criteria and thresholds, no Flood Risk Areas have been identified in Sunderland.**

By not having a Flood Risk Area covering Sunderland, the next stage of the Regulations 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.

Whilst the number of properties at risk from local sources is not large or concentrated enough to trigger the next stage of the regulations, there remains 22500 properties (45000 people) at risk from local surface water and 95 properties (140 people) at risk from ordinary watercourse flooding across the City. Sunderland City Council will still be required to produce a local flood management strategy to deal with this risk. Whilst it does not have to carried out to prescribed deadlines in the Regulations, a strategic approach will be required for 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 |
| 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 |
| LoSA | Level of Service Agreement |
| Main River | A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers |
| Manning's 'n' | An empirically derived coefficient, which is dependent on many factors, including surface roughness and sinuosity. |
| MoU | Memorandum of Understanding |
| NRD | National Receptor Dataset – a collection of risk receptors produced by the Environment Agency |
| 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 |
| Receptor | Something that may be harmed by flooding |

| Term or Abbreviation | Definition |
|---|---|
| Regulations | The Flood Risk Regulations |
| Resilience | The ability of the community, services, area or infrastructure to withstand the consequences of an incident |
| RFRA | Regional Flood Risk Appraisal |
| 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 |
| SAB | SuDs Approval Board |
| SACs | Special Area of Conservation |
| SFRA | Strategic Flood Risk Assessment |
| Source | The origin of a hazard (e.g. heavy rainfall, strong winds, surge etc) |
| SPAs | Special Protection areas |
| SSSIs | Sites of Special Scientific Interest |
| SuDS | Sustainable urban Drainage systems |
| 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 |
| 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 Sunderland City Council 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 (such as Sunderland City Council) and in two-tier systems (all County Councils) are designated as Lead Local Flood Authorities (LLFAs) and consequently have a number of new key statutory responsibilities with respect to local flood risk management. Chapter 2 provides a full description of these responsibilities.

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.

In particular, the Regulations 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
- Flood Risk Management Plans

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

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

| Stage | Timescale | Assessment or Plan | Description |
|---|---|---|---|
| 1 | 22nd June 2011 | Prepare a preliminary assessment report | The PFRA should focus on local flood risk from surface water, groundwater, ordinary watercourses and canals. |
| 2 | 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. |
| 3 | 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. |
| 4 | 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) will complete the first two stages in the process. The identification of Flood Risk Areas will establish whether the final two stages of preparing hazard and risk maps and flood risk management plans are required.

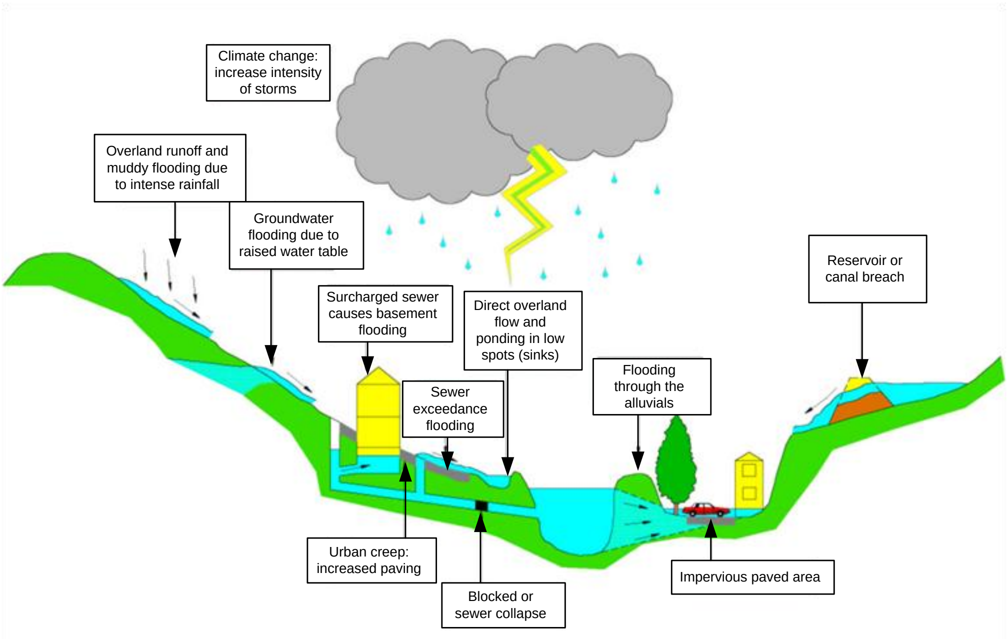
The PFRA (and any subsequent maps and plans) will form part of the local flood risk management strategies that LLFAs are required to prepare under the FWMA. Local strategies will set out how LLFAs will manage local flood risk in their area and will cover areas not identified as being at significant flood risk under the Regulations.

## 1.2 Sources of Flooding

As described in the Regulations, flood risk management associated with the sea, main rivers and reservoirs is the responsibility of the Environment Agency. Whilst the Environment Agency Flood Map is included in the PFRA to illustrate possible interactions and future risk associated with ordinary watercourses, this PFRA does not explicitly deal with those sources not under LLFA responsibility.

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. LLFAs will however have to take into account the interaction of flooding from main rivers, the sea and reservoirs with local sources. Sections 1.2.1 to 1.2.5 provide a description of each relevant source related to Sunderland.

**Figure 1-1: Flooding from all Sources**




### 1.2.1 Surface Water Flooding

Flooding of land from surface water runoff is usually caused by intense rainfall that may last less than an hour or only 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 runoff can also exceed the capacity of the local drainage network and affect areas not obviously susceptible to flooding from the local topography.

### 1.2.2 Groundwater 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 rebound.

### 1.2.3 Sewer Flooding

Foul/combined sewers and surface water drainage systems are spread extensively across urban areas with various interconnected systems discharging to treatment works and into local watercourses. The main dendritic network of trunk sewers within older urban areas will be combined and it is only more recently in the 20th Century that a separate system of sewers has evolved at the periphery of urban areas.

Combined systems necessarily discharge to sewage treatment works; combined Sewer Overflows (CSOs) provide an overflow release from the drainage system into local watercourses or surface water systems when the system cannot cope during times of high flows. Surface water systems collect surface water drainage separately and discharge directly into local watercourses.

Sewer flooding occurs due to large rainfall events causing sewers to surcharge leading to highway and external curtilage flooding and sometimes internal sewer flooding to properties. Basement flooding is a significant issue, which causes much of the DG5 reportable flooding.

### 1.2.4 Canals and Ordinary Watercourse Flooding

There are no canal systems within Sunderland. Flooding of watercourses is associated with the exceedance of channel capacity from either high flows or local factors such as online structures. There are a number of ordinary watercourses in Sunderland, which come under the control of the council. These watercourses are often rural in nature and include drains and tributaries to main rivers. The majority of these have been identified in the Council's SFRA.

### 1.2.5 Interaction with Main Rivers

Many of the sources listed above connect to the main rivers in Sunderland, for instance ordinary watercourses and urban drainage systems outfall into main rivers.

Flooding mechanisms associated with these interactions are often the result of flow backing up because another source (such as a river) 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). This interaction will be difficult to quantify without detailed flood risk studies.

## 1.3 Flooding Likelihood and Consequences

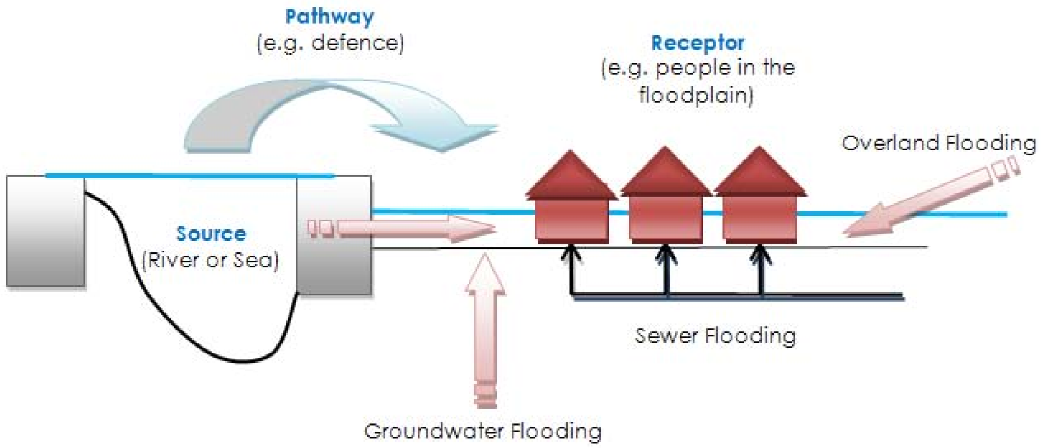
Flood risk is generally accepted to be a combination of the likelihood of flooding and the potential consequences arising. It is assessed using the source – pathway – receptor model as shown in Figure 1-2 below. This is a standard environmental risk model common to many hazards and should be starting point of any flood-risk assessment. However, it should be remembered that flood risk can occur from many different sources and pathways and not simply those shown in the simple form below.

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

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

It is important to define the components of flood risk in order to apply this guidance in a consistent manner. Flood risk is a combination of the likelihood of flooding and the potential consequences arising.

**Figure 1-2: Source-Pathway-Receptor Model**




### 1.3.1 Likelihood

Likelihood of flooding is normally expressed as the percentage probability based on the average frequency measured or extrapolated from records over a large number of years. A 0.5% probability indicates the flood level that is expected to be reached on average once in 200 years, i.e. it has a 0.5% chance of occurring in any one year, not that it will occur once every 200 years.

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

- A 0.5% flood has a 11% (1 in 10) chance of occurring at least once in a 25-year period - the period of a typical residential mortgage
- And a 31% (1 in 3) chance of occurring in a 75-year period - a typical human lifetime

### 1.3.2 Consequences

Consequences of flooding depend on the hazards caused by flooding (depth of water, speed of flow, rate of onset, duration, wave-action effects, water quality) and the vulnerability of receptors (type of development, nature, e.g. age-structure, of the population, presence and reliability of mitigation measures etc).

Flood risk is then normally expressed in terms of the following relationship:

**Flood risk = Probability of flooding x Consequences of flooding**

## 1.4 Study Area

The study area for this PFRA comprises the whole of the City of Sunderland. Sunderland is located in the north east of England and is the largest city between Leeds and Edinburgh with a population of 282000. The City covers an area of 137km² and is one of five metropolitan districts that compromise the conurbation of Tyne and Wear (the others are; Newcastle, Gateshead, North Tyneside and South Tyneside). Figure 1-3 illustrates the geographical extent of the study area.

The City of Sunderland consists of five main sub-areas, North, South, Washington, Coalfield and the Central Sunderland area, which includes the city centre.

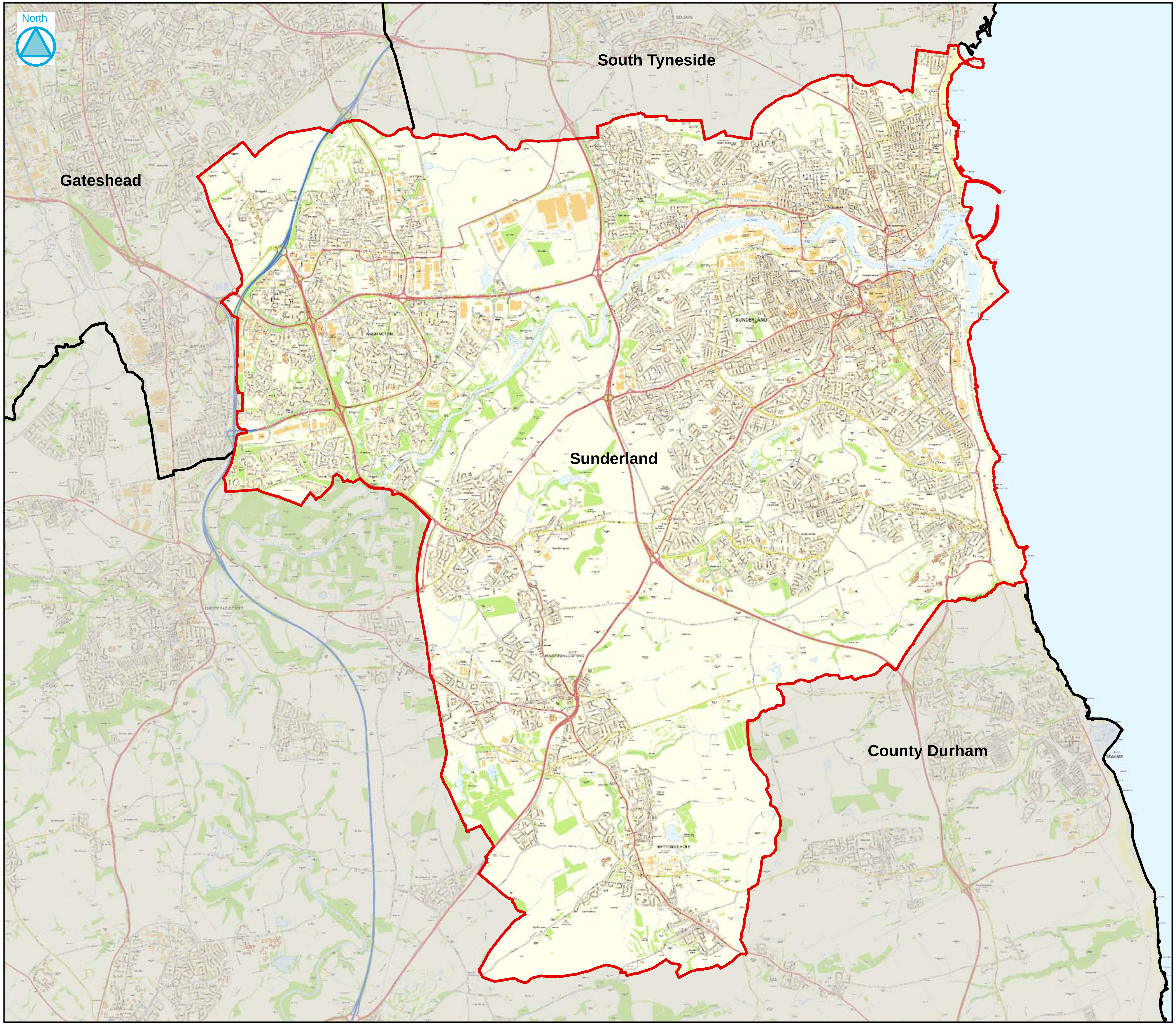
The study area falls within the Northumbria River Basin District and is served by one water company, Northumbrian Water Limited (NWL). The study area is within the Environment Agency's North East region.

## 1.5 Aims and Objectives

The aim of this PFRA is to provide a high level screening assessment of local flood risk across the study area, including information on past (historic) and future (potential) floods and their potential consequences. The PFRA assembles this information to identify Flood Risk Areas, which warrant further examination through the production of maps and management plans.

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 upon in the future and used to support and inform the preparation of the Council's local flood risk management 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.




**Location Plan**


**Legend**

Sunderland City Council Boundary



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for

SUNDERLAND CITY COUNCIL

PRELIMINARY FLOOD RISK ASSESSMENT

Study Area



| | | |
|---|---|---|
| Drawn by: Peter Grace | | Scale: |
| Date: 21/06/2011 | | Not to scale |
| Status: FINAL | | |
| File Name: ..\Graphical Data\ArcView\Projects\ | | |
| Drawing Number: Figure 1-3 | | |

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# 2. Lead Local Flood Authority Responsibilities

## 2.1 Introduction

The Flood Risk Regulations 2009 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 production of a PFRA is a requirement under the Regulations. The FWMA 2010 defines further responsibilities for flood risk management based on the recommendations of the Pitt Review.

This section provides a brief overview of these other responsibilities, which Sunderland City Council is obliged to fulfil, under its 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 FWMA provides for this through the new role of the LLFA, of which Sunderland City Council 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 FWMA recognises the important role district councils, highways authorities and water companies play, and these bodies, together with the Environment Agency, are classed as risk management authorities. The FWMA 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 FWMA and they can delegate to each other. It also empowers a LLFA to require information from others needed for their flood risk management functions.

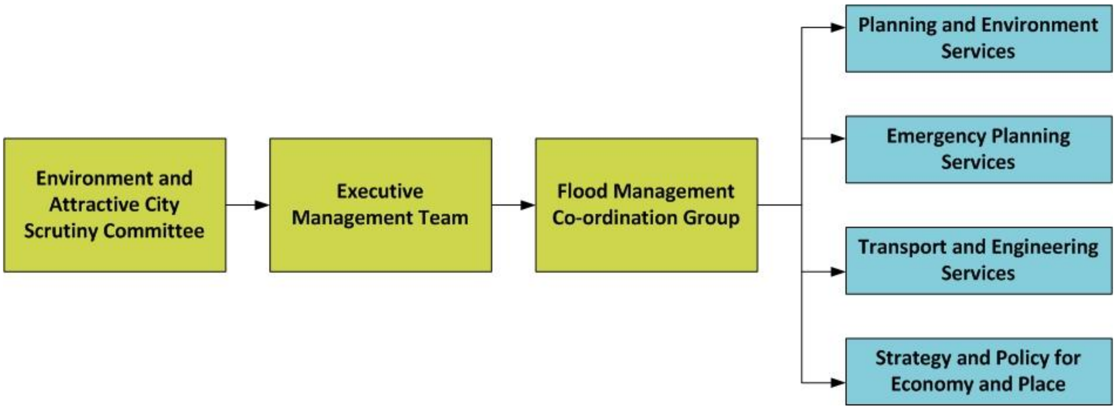
Ideally, these working arrangements should be formalised to ensure clear lines of communication, mutual co-operation and management through the provision of Level of Service Agreements (LoSA) or Memorandums of Understanding (MoU). Partnership working is essential in the management of local flood risk.

Sunderland City Council 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. Regulation 35 of the Regulations and Section 13 of the Act reflects the importance of relevant authorities working and cooperating with one another.

### 2.2.1 Flood Risk Management Structure

For the purposes of the PFRA, Sunderland City Council is developing an internal flood risk management structure (Figure 2-1) to illustrate those within the Council who have a lead role, and those who have a service role for flood risk management. These arrangements are to facilitate the discharge of the Council's new flood risk management responsibilities and to provide a basis for effective engagement within the council and with external stakeholders. These arrangements are draft and may develop further over time.

Figure 2-1: Sunderland Flood Management Group Structure




### 2.2.2 Stakeholder Engagement

As part of the PFRA, Sunderland City Council has sought to engage stakeholders representing the following organisations, authorities and various sector/department leads within Sunderland City Council. The majority of this consultation was carried out during the councils SFRA.

- Environment Agency
- Northumbrian Water
- Tyne & Wear Fire and Rescue Service
- Highways Agency
- Sunderland City Council spatial planning
- Sunderland City Council Emergency Planning
- Sunderland City Council highway maintenance & drainage

## 2.3 Further responsibilities

Aside from forging partnerships, coordinating and leading on local flood management, there are a number of other key LLFA responsibilities that have arisen from the FWMA. These responsibilities are included in Table 2-1 below. A recent letter from Defra to LLFAs date 8th March 2011 identified a number of responsibility commencement dates.

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

| LLFA Responsibility | Description | Legislation Commencement |
|---|---|---|
| Local Strategy for Flood Risk Management | 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 | A LLFA has a duty to investigate and record details of significant flood events within their area. This duty includes identifying risk management authorities and their functions and how they intend to exercise those functions in response to a flood. The responding risk management authority must publish the results of its investigation and notify any other 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 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 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 to alter, remove, or replace it. | Implementation is planned to follow the national strategy coming into force later in the year |
| Asset Register | 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 local 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
- 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 Sunderland City Council 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 and updated in March 2011.

## 3.2 Methodology

To prepare this PAR, Sunderland City Council has gathered information on past and future floods from a range of available or readily derivable sources. The majority of this information was supplied by the Environment Agency and obtained from the Sunderland City Council level 1 SFRA.

Some of this information will be limited to specific locations, local data availability will depend on the Councils own data collection systems and other information will be part of large national datasets obtained from the Environment Agency. Section 3.3 discusses data availability in more detail.

### 3.2.1 Assessing Historic Flood Risk

The Sunderland Strategic Flood Risk Assessment (SFRA, July 2010) provided the majority of historical flood data including Environment Agency and Northumbrian Water datasets, reports and anecdotal information. An SFRA spreadsheet records all historical flood data collected in the SFRA and where possible the source or mechanism of flooding.

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.

The historic data made available for the PFRA consisted of a list of co-ordinates representing sites where flooding incidents have occurred. The limited metadata associated with these historic datasets means it has not been possible to identify any single event with significant consequences within the City of Sunderland. As such, no events are recorded in Annex 1 of the Preliminary Assessment Spreadsheet.

However, as the PFRA process provides an opportunity to summarise all information available on past floods, not just those with significant consequences, all historical records have been included in the summary map(s). Although not required by the Regulations, this information will be useful for Sunderland City Council'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 and the Environment Agency's national Flood Map.

The following list highlights a number of factors considered when assessing future flood risk across the study area

- topography
- location of ordinary watercourses
- location of flood plains that retain water
- characteristics of watercourses (lengths, modifications)
- under-capacity of the sewer network
- effectiveness of any works constructed for the purpose of flood risk management
- location of populated areas
- areas in which economic activity is concentrated
- presence of critical infrastructure
- current and predicted impact of climate change
- predicted impact of any long-term developments that might affect the occurrence or significance of flooding, such as proposals for future development

### 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 the area affected by the risk i.e. the Flood Risk Area. In order to achieve this, the LLFA is required to identify areas with known flood histories, areas at risk of future flooding and where identified, the consequence of that flooding.

The Regulations identify a number of flood risk indicators to consider when assessing the consequences of flooding on human health, economic activity, and the environment (including cultural heritage). Table 3-1 provides a summary of these indicators.

**Table 3-1: Flood Risk Indicators**

| Impacts of Flooding on | Flood Risk Indicators |
|---|---|
| Human Health | • Number of people (based on residential properties)<br>• Number of critical services (schools, hospitals, nursing homes, police/fire/ ambulance stations etc) |
| Economic Activity | • Number of non-residential properties (e.g. shops, offices and churches)<br>• Length of road or rail<br>• Area of agricultural land |
| Environment | • Designated sites (SSSIs, SACs, SPAs, etc) and BAP habitat |
| Cultural Heritage | • World Heritage Sites |

To ensure a consistent and proportionate approach, using the above indicators, Department for Environment, Food & Rural Affairs (Defra) and Welsh Assembly Government (WAG) have identified flood risk thresholds[3] for defining Flood Risk Areas based on human health and

[3] The Environment Agency thresholds are used to identify high risk areas for this PFRA process only and has no links to the Surface Water Management Plan or other local flood risk studies.

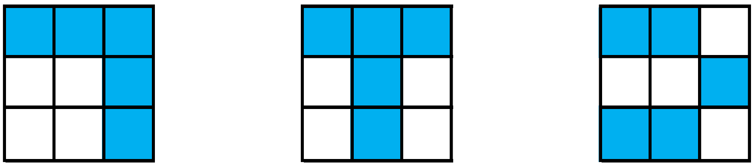
economic activity. Environment and cultural heritage indicators have not been used. These pre-determined thresholds for human health and economic activity are set:

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

The Environment Agency has then applied these criteria to their national surface water maps to identify areas (blue squares), using a 1km square grid approach, which exceeds the pre-determined thresholds. Figure 5-6, discussed later on, illustrates the areas above the flood risk thresholds identified within the study area.

The next step in the national approach was to identify clusters of these areas. In England, the union of all 3 x 3 km squares that contain five or more touching areas (blue squares) makes a cluster. Blue squares are touching if they are adjacent up or down, side by side or diagonally as shown in the examples below.

**Figure 3-1: Areas above Flood Risk Threshold Clustering Approach**



Clustered areas, which also exceed a collective of 30000 people at risk of flooding, are 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 have been identified using a national approach and nationally available data, this assessment focuses on reviewing these areas using locally derived information where available to confirm or adjust the national Indicative Flood Risk Area or to identify any new areas which the Council deemed to be significant. Section 6 provides a further explanation into the Indicative Flood Risk Area review process adopted.

## 3.3 PFRA Data

As mentioned previously, a crucial part of a PFRA process 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 map outlines areas of risk from surface water flooding across the country with three susceptibility bandings (less, intermediate and more). Please refer to Table 5-2 for further detail on modelling approach taken. |
| | Flood Map for Surface Water | The second-generation national surface water flood map released at the end of 2010. This dataset includes two flood events (with a 1 in 30 and a 1 in 200 chance of occurring) and two depth bandings (greater than 0.1m and greater than 0.3m). Please refer to Table 5-2 for further detail on modelling approach taken. |
| | Flood Map (Rivers and the Sea) | Shows the extent of flooding from rivers with a catchment of more than 3km² and from the sea |

| Holder | Dataset | Description |
|---|---|---|
| | 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 |
| | Catchment Flood Management Plans | 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 |
| LLFA | North East Regional Flood Risk Appraisal | The RFRA provides a regional overview of the North East Region, The main aspects of the appraisal included a summary of all the LLFA's flood risk at a regional level, an evaluation into the potential impact of flooding in relation to housing development, an assessment of any potential flood risk economic implications and a review of other sources of flooding |
| | Council Strategic Flood Risk Assessment | The Level 1 SFRA contains useful information on historic flooding, including local sources of flooding from surface water, ordinary watercourses and the drainage system. |
| NW | DG5 Register at Drainage Area Level | The DG5 Register logs and records all sewer flood incidents in Sunderland due to under capacity only. It is NOT a true register of properties/areas at risk of flooding, but a register of properties/areas that have flooded and reported it to Northumbrian Water. DG5 records were supplied at a drainage area level during the SFRA in 2009. |

### 3.3.1 Data Limitations

A brief assessment of the data collection process is included in this chapter to provide transparency with respect to the methodology. Flagging up the issues identified in the data collection phase could serve as a catalyst to improve the collection of flood risk data going forward.

Whilst the PFRA is fit for purpose and based on the best available information, local information on historical flood events highlights a lack of consistent flood data recording systems resulting in incomplete, or sometimes nonexistent, flood record datasets. The information collected will still provide a useful dataset, but records are often anecdotal and/or incomplete and it can be difficult to determine accurately the frequency and consequences of events. Although it is good practice for the Council to record historic flood incidents, this was not a requirement until April 2011, which could be the main reason for incomplete or inconsistent historical records.

The PFRA data register provides a record of all data collected during the PFRA process. Whilst the majority of the datasets could be mapped geographically (GIS) helping to visualise the risk of flooding, other datasets could not be mapped reducing its confidence. Historical flooding information was generally a mix in both quality and quantity. For instance, some local historical records collected from the Environment Agency included photographs of the event, however did not include GIS layers.

### 3.3.2 Data Sharing and Storage Systems

Northumbrian Water and the North East LLFAs are currently preparing a data sharing protocol to aid the exchange of mutually beneficial FRM information. The draft includes:

- roles and responsibilities

- provision of information
- confidentiality
- intellectual property
- data protection

It is anticipated that the protocol will be formalised during the summer of 2011. The shared data used in the preparation of this document will be subject to the terms of the data sharing protocol and the corporate data protection / storage policies employed by Sunderland City Council.

### 3.3.3 Quality Assurance

During the data collection process, each dataset was reviewed and its quality rated for use in the PFRA. A data quality score was given, which is a qualitative assessment based on the Data Quality System provided in the Surface Water Management Plan (SWMP) Technical Guidance document (March 2010). Table 3-3 explains this system.

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 or gaps in information are identified at an early stage.

**Table 3-3: Recording the Quality of Data**

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

### 3.3.4 Data licensing and restrictions

Table 3-4 illustrates the restrictions on the use of this data.

**Table 3-4: Summary of Data Restrictions and Licensing Details**

| Data Owner | Restrictions on Data Use |
|---|---|
| Environment Agency | This data falls under the license agreement with Sunderland City Council and the Environment Agency. The use of some data is restricted to Sunderland City Council and their consultants for the preparation of its preliminary flood risk assessment. The use of other data is unrestricted. |
| Northumbrian Water Limited | This data falls under the license agreement with Sunderland City Council and Northumbrian Water. The use of all data provided is restricted to Sunderland City Council and their consultants for the preparation of the SFRA and PFRA. |

# 4. Past Flood Risk

## 4.1 Introduction

The Sunderland City Council level 1 SFRA provides a good overview of significant historical flood events in the area, sourced from a range of flood risk studies in the area. Whilst this information is good, the specific locations of the incidents are not always identified rather the general area within Sunderland is detailed. Table 4-1 provides a list of all datasets provided.

Only historic incidences with associate GIS have been included in Figure 4- and as such these figures may not correlate to the full list of historic events referenced in this PFRA.

**Table 4-1: Available Historical Flood Datasets**

| Source | Dataset | GIS type |
|---|---|---|
| Sunderland City Council | Highway Drainage Problems | GIS Point |
| Tyne and Wear Fire and Rescue Service | Highway Flood Risk Areas | GIS Point |
| Northumbrian Water | DG5 Records | GIS Polygon |
| Environment Agency | Historic Flood Map | GIS Polygon |

## 4.2 Overview of Historical Incidents in Sunderland

### 4.2.1 Incidents Recorded by Sunderland City Council

Historical flooding records were also collected from the Highway Maintenance Section and the Tyne and Wear Fire and Rescue Service (TWFRS). The types of data provided are highlighted in more detail below:

**Table 4-2: Sunderland City Council Historical Flood Data**

| Source | Reported Damage |
|---|---|
| Sunderland City Council Highway Maintenance | The Highway Maintenance Section provided a copy of the City's Highway's Outstanding Drainage Problems spreadsheet, which is split into the councils six regeneration areas. There have been 257 Reported Incidents throughout Sunderland, however no dates were supplied with this information. This indicates historically the highway drainage based problems throughout the City via a priority 1, 2, or 3 system:<br>1. Flooding from the highway, water ingress into building or serious hazard to road users<br>2. Property flooding to the garden or exterior of building<br>3. Flooding to highway only, not serious hazard to road user. In some case a solution has been identified or work has been completed to solve the problem. |
| Tyne and Wear Fire and Rescue Service | The TWFRS provided a dataset of flooding incidents in which the service responded to between 01/04/2004 and 01/04/2009. This information included incidents of all sources of flooding from internal drains or leaks to large fluvial and surface water flooding in which action was required. This dataset was manually filtered within the SFRA to only include those instances, which were relevant. There have been 38 Reported Incidents throughout Sunderland. |

### 4.2.2 Incidents Recorded by the Environment Agency

The Environment Agency provided their national Historical Flood Map. One area was identified within the City of Sunderland; however, this area is attributed to Main River and does not fall into the scope of this PFRA.

### 4.2.3 Incidents Recorded by Northumbrian Water

During the 2009 Sunderland City Council Level 1 SFRA, Northumbrian Water provided internal and external DG5 records at a strategic drainage area level. DG5 records are a dataset of all properties flooded from the drainage system with internal records being those where sewer flooding has occurred within the property and external to those areas outside.

Table 4-3 provides an overview of DG5 records across the City according to Northumbrian Water drainage areas. Drainage areas have also been attributed with a flood rating. The categories, suggested by NWL, listed below have been used for this rating:

- **Low -** Less than 10 properties on internal register
- **Medium -** Less than 10 properties on internal register and some on external register
- **High -** Greater than 10 properties on internal register and some on external register

The risk rating associated with Northumbrian Water drainage areas have been provided on Figure 4-1.

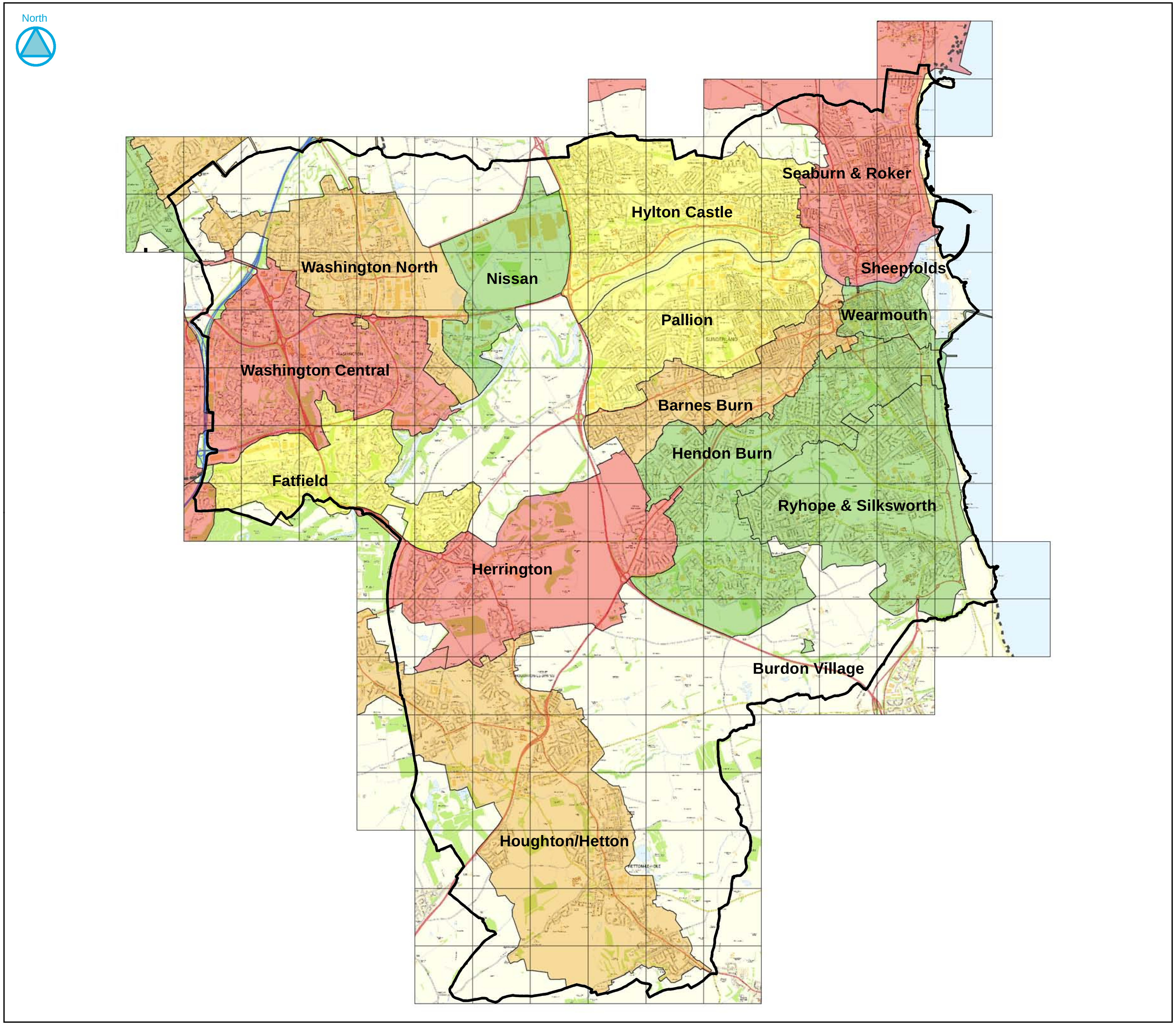
**Table 4-3: Northumbrian Water Limited Historic Incident Databases**

| Drainage Area | Return Period/ Internal Records | | | Return Period/ External Records | | | Flood Rating |
|---|---|---|---|---|---|---|---|
| | 2 in10 | 1 in 10 | 1 in 20 | 2 in 10 | 1 in 10 | 1 in 20 | |
| Houghton/Hetton | 5 | 0 | 0 | 6 | 0 | 2 | **Medium** |
| Hylton Castle | 3 | 0 | 0 | 0 | 0 | 0 | **Low** |
| Herrington | 8 | 12 | 0 | 8 | 1 | 1 | **High** |
| Seaburn & Roker | 5 | 6 | 0 | 3 | 0 | 0 | **High** |
| Hendon Burn | 0 | 0 | 0 | 0 | 0 | 0 | **Low** |
| Barnes Burn | 4 | 1 | 0 | 1 | 0 | 0 | **Medium** |
| Ryhope & Silksworth | 0 | 0 | 0 | 0 | 0 | 0 | **Low** |
| Fatfield | 3 | 0 | 0 | 0 | 0 | 0 | **Low** |
| Pallion | 2 | 1 | 0 | 0 | 0 | 0 | **Low** |
| Washington Central | 8 | 1 | 3 | 11 | 3 | 2 | **High** |
| Washington North | 2 | 6 | 0 | 2 | 0 | 0 | **Medium** |
| Wearmouth | 0 | 0 | 0 | 0 | 0 | 0 | **Low** |
| Nissan | 0 | 0 | 0 | 0 | 0 | 0 | **Low** |
| Leam Lane/ Wardley/ Bill Quay | 0 | 0 | 0 | 0 | 0 | 0 | **Low** |
| Chester le Street | 49 | 3 | 16 | 24 | 5 | 7 | **High** |

Whilst DG5 records provide a good indication of the risk of sewer flooding within Sunderland, it must be acknowledged that DG5 records are historical data only and it is not a true representation of current risk or a prediction of future risk.

## 4.3 Significant Harmful Consequences

Considering all historical data collected, there is insufficient data to confirm the occurrence of an event with significant harmful consequences to people and infrastructures within the City of Sunderland. Figure 4-2 shows all mapped historical incidents collected, whilst Figure 4-3 shows all historical incidents aggregated to a 1km square grid. Therefore, no records were included on past flooding in Annex 1 of the Preliminary Assessment Spreadsheet and as such have not influenced to identification of a Flood Risk Area within the City of Sunderland.




**Location Plan**


**Legend**

- Sunderland City Council Boundary

Northumbrian Water Drainage Areas

Number of DG5 Records

- High
- Medium
- Low
- None



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for

## SUNDERLAND CITY COUNCIL

### PRELIMINARY FLOOD RISK ASSESSMENT

Northumbrian Water Drainage Areas



| | | |
|---|---|---|
| Drawn by: | Peter Grace | Scale: Not to scale |
| Date: | 21/06/2011 | |
| Status: | FINAL | |
| File Name: | ..\Graphical Data\ArcView\Projects\ | |
| Drawing Number: | Figure 4-1 | |

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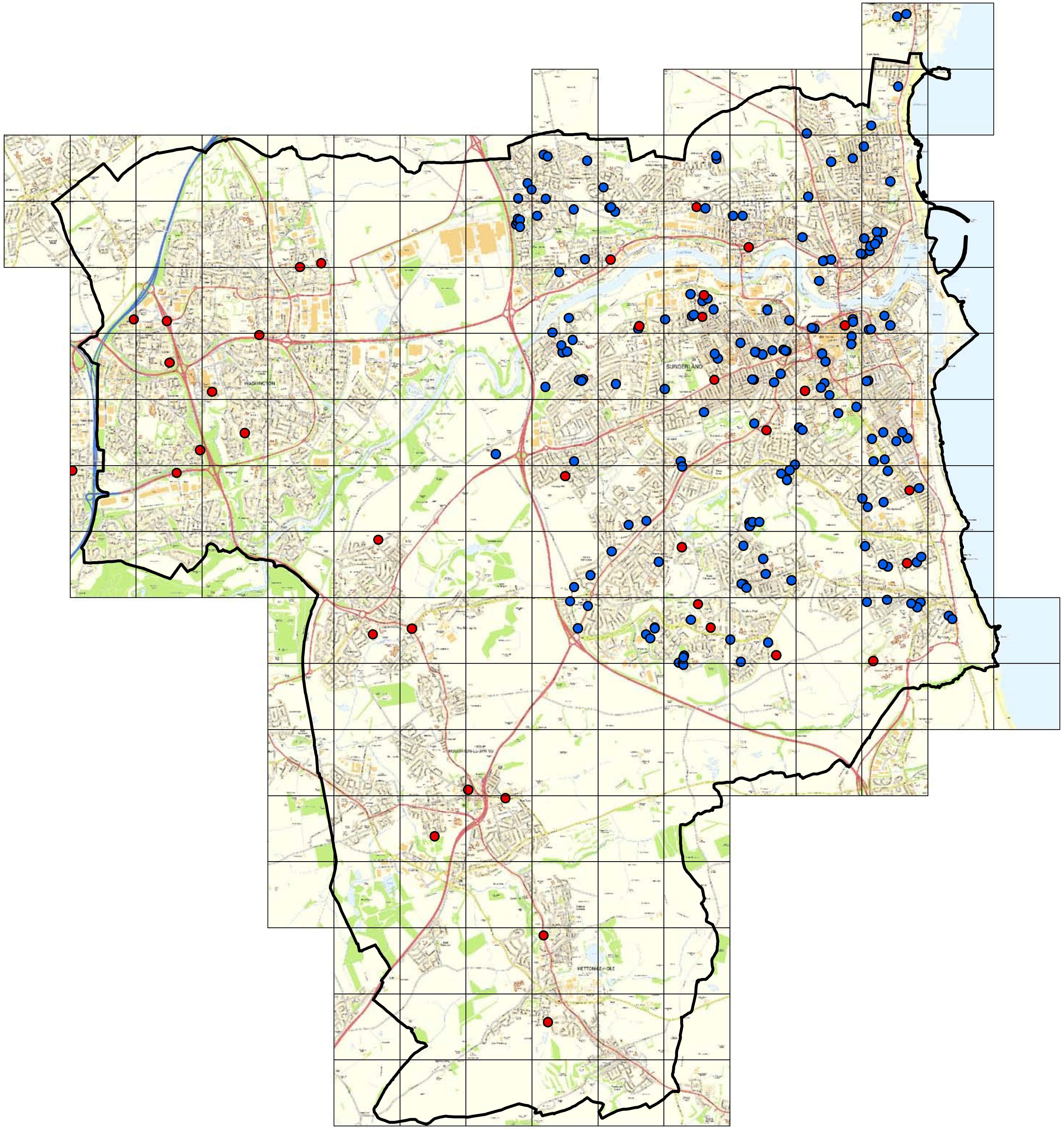
North



## Location Plan


**Legend**

- Sunderland Council Boundary
- Tyne & Wear Fire & Rescue Service Flooding Incidents
- SCC Highway Maintenance Flooding Incidents



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# SUNDERLAND CITY COUNCIL

## PRELIMINARY FLOOD RISK ASSESSMENT

### Local Historical Flood Map



| | | |
|---|---|---|
| Drawn by: | Peter Grace | Scale: Not to scale |
| Date: | 21/06/2011 | |
| Status: | FINAL | |
| File Name: | ..\Graphical Data\ArcView\Projects\ | |
| Drawing Number: | Figure 4-2 | |

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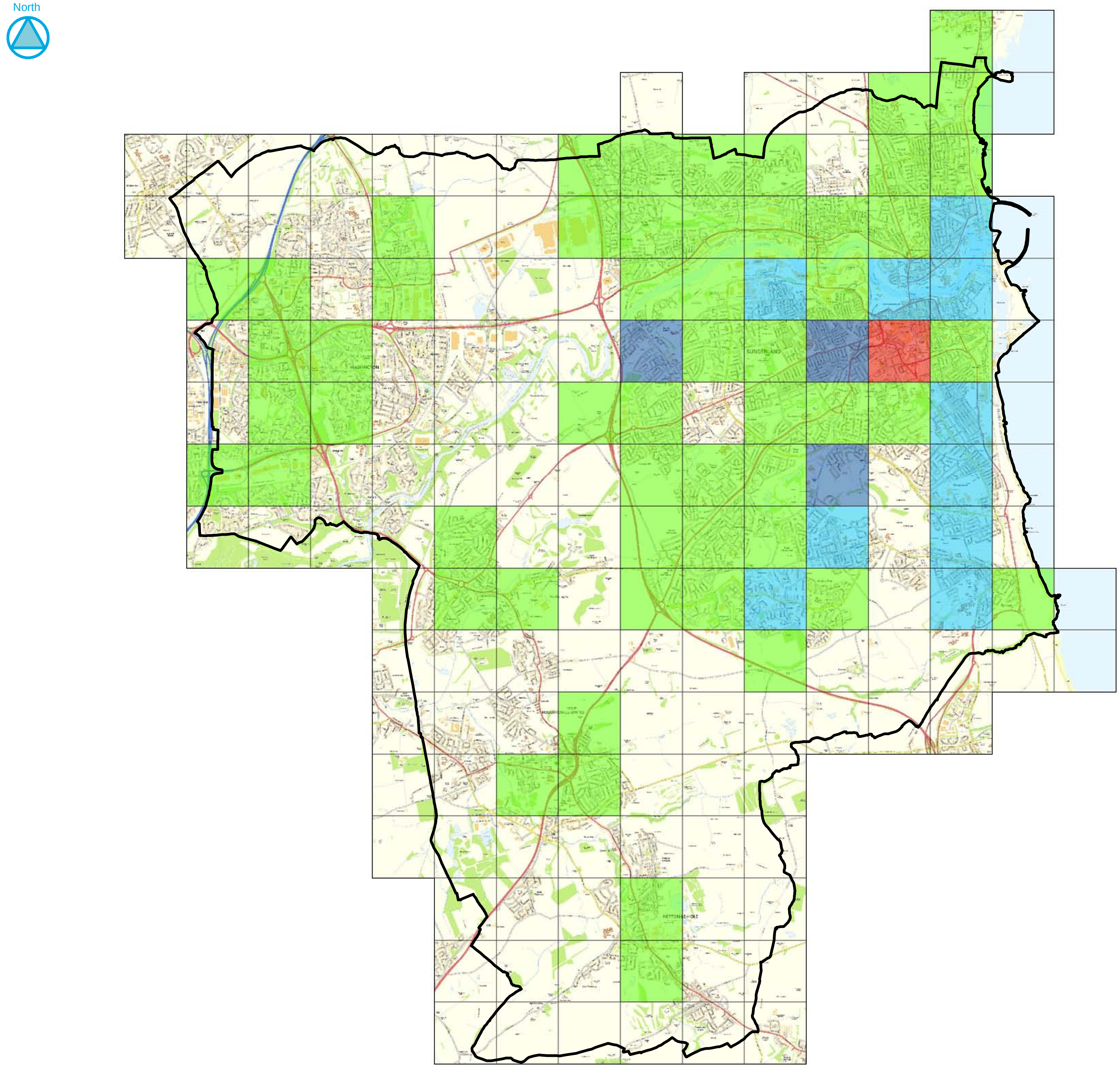


**Location Plan**


**Legend**

Sunderland City Council Boundary

Number of Historical Flood Incidents per 1km square

- 1 - 5
- 6 - 10
- 11 - 15
- 16 - 20
- 21 - 40
- 41 - 80



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Sunderland City Council

for

SUNDERLAND CITY COUNCIL

PRELIMINARY FLOOD RISK ASSESSMENT

Number of Historical Flood Incidents



| | |
|---|---|
| Drawn by: Peter Grace | Scale: |
| Date: 21/06/2011 | Not to scale |
| Status: FINAL | |
| File Name: ..\Graphical Data\ArcView\Projects\ | |
| Drawing Number: Figure 4-3 | |

Original @ A3

# 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. Modelled information provides the basis for the assessment of future flood risk.

## 5.2 Overview of Future Flood Risk in Sunderland

### 5.2.1 Surface Water Flooding

As identified in Table 3-2 there are a number of surface water flooding datasets available for Sunderland.

The Environment Agency has produced a national assessment of surface water flood risk in the form of two national mapping datasets. The Environment Agency released their first-generation national mapping in 2008, Areas Susceptible to Surface Water Flooding (AStSWF). The AStSWF map shows areas susceptible to surface water flow or ponding using three susceptibility bandings for a rainfall event with a 1 in 200 chance of occurring. The Environment Agency adopted a simplified modelling approach, 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 (1 in 30 and 1 in 200 annual chance), 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).

Table 5-1 identifies the number of properties at risk of surface water flooding using the two national datasets.

**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 (1 in 200 yr) | Less[1] | 19,700 | 16,300 | 3,400 |
| | Intermediate | 7,600 | 6,200 | 1,400 |
| Flood Map for Surface Water (1 in 200-yr) | >0.1m[2] | 22,500 | 19,100 | 3,400 |
| | >0.3m | 7,500 | 6,300 | 1,200 |

[1] This includes properties within the intermediate banding
[2] This includes properties within the >0.3m banding

### 5.2.2 Locally Agreed Surface Water Information

Environment Agency guidance on using surface water flood risk information recommends that Sunderland City Council, 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, known as locally agreed surface water information. Whilst this is not a requirement under the Regulations, it does inform the PFRA process as this information should play an important role in identifying Flood Risk Areas.

As discussed above, there are currently two sources of surface water information across Sunderland the AStSWF and the FMfSW. Table 5-2 identifies the different modelling approaches adopted in produced the currently available surface water information.

**Table 5-2: Comparative Surface Water Modelling Approaches**

| Variable | Areas Susceptible to Surface Water Flood | Flood Map for Surface Water |
|---|---|---|
| Date | 2008 | 2010 |
| Coverage | Sunderland | Sunderland |
| Annual Probability Rainfall | 1 in 200 | 1 in 30<br>1 in 200 |
| Storm Duration | 6.5 hrs | 1.1 hr |
| Rainfall Profile | 50% summer | 50% summer |
| Percentage Runoff | 0 | 39% rural<br>70% urban |
| Reduction to rainfall amount to represent sewer flow | 0 | 0mm/hr rural<br>12mm/hr urban |
| Manning's 'n' | 0.1 | 0.1 rural<br>0.03 urban |
| DTM | Infoterra bare earth LIDAR and Geo-Perspectives | EA 2010 Composite (SAR, EA LIDAR and PGA2 LIDAR) |
| Buildings | Not represented | Buildings layer DTM raised by 5m |
| Roads | Not considered | Not considered |
| Threshold Bands | Less - 0.1 to 0.3m<br>Intermediate - 0.3 to 1m<br>More - >1m | - >0.1m<br>- >0.3m |

The FMfSW modelling approach includes both percentage runoff and drainage capacity within the rainfall calculations, which produces a better representation of reality. Whilst the FMfSW approach blocks buildings out of the urban floodplain, the Environment Agency went through a detailed process of producing a buffer around its surface water flood extent to make sure it includes properties, which may be inundated.

The model used for the FMfSW uses the latest methodology developed by the Environment Agency and the best available information. The AStSWF dataset, whilst superseded, will provide good supporting information. It is also noted, as a precautionary approach, that the FMfSW also illustrates the highest number of properties at risk when compared to the AStSWF map in Table 5-1.

Based on the above, the FMfSW is considered to provide the best representation of local conditions in Sunderland and should be the 'locally agreed surface water information'.

### 5.2.3 Groundwater Flooding

The Environment Agency's national dataset, Areas Susceptible to Groundwater Flooding (AStGWF), provides the basis for assessing future flood risk from groundwater.

The map was derived using the top two susceptibility bands of the British Geological Society (BGS) 1:50,000 Groundwater Flood Susceptibility Map and thus 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. Four area categories illustrate susceptible areas, which show the proportion of each 1km square where groundwater might emerge. Figure 5-2 illustrates this dataset. The Environment Agency's AStGWF dataset is included in Annex 2 'Future Floods' of the Preliminary Assessment Spreadsheet.

Using the Environment Agency's areas susceptible to groundwater emergence map, only the south of the catchment in and around Hetton-Le-Hole has high groundwater emergence levels.

### 5.2.4 Sewer Flooding and Critical Drainage Areas

No future sewer flood risk data has been made available for this PFRA. However, the SFRA did identify a number of Critical Drainage Areas (CDAs) within Sunderland, these include:

- Barnes Burn & Hendon Burn
- Houghton & Hetton
- Herrington
- Seaburn & Roker
- Washington Central

CDAs are areas within Flood Zone 1 that have critical drainage problems. The above CDAs have been indicated in Sunderland by combining high-risk Northumbrian Water drainage areas and other areas, which have a high risk of flooding from other sources. Contributing natural catchments have also been identified for those CDAs as the source or surface water flooding may originate outside of the drainage area but still contribute to the overall risk. Figure 5-3 illustrates the location of CDAs.

### 5.2.5 Ordinary Watercourse Flooding

Sunderland contains around 26.5km of inland designated main rivers and another 37km of Ordinary Watercourses. Ordinary Watercourses are those that are not designated as Main River and therefore come under the control of Sunderland City Council, who have Permissive Power to carryout works should this be deemed necessary. These Ordinary Watercourses will usually be a tributary to a main river (River Wear, Don, Lumley Park and Usworth Burn); however, those which are situated along the eastern side of Sunderland, will not be hydraulically connected to a main river and flow directly into the North Sea.

Table 5-3 illustrates all key ordinary watercourses within Sunderland, source of flooding, downstream extent (i.e. if there are a tributary to a large watercourse or flow in to the North Sea) and whether or not they have been modelled within the Environment Agency's Flood Map.

**Table 5-3: Ordinary Watercourses in Sunderland**

| Watercourse Name | Downstream Extent | Source of Flooded | Mapped in Flood Zones |
|---|---|---|---|
| Barns Burn | River Wear | Fluvial | No |
| Biddick Burn | River Wear | Fluvial/Tidal | Yes |
| Burdon Dene, Cherry Knowles Dene, Ryhope Dene | North Sea | Fluvial/Tidal | Yes |
| Cut Throat Dene | North Sea | Fluvial/Tidal | Yes - but only approx 600m from river mouth |
| Hendon Burn | North Sea | Fluvial/Tidal | Yes |
| Herrington Burn | Lumley Park Burn | Fluvial | Yes |
| Hylton Dene Burn | River Wear | Fluvial/Tidal | No |
| Red Burn | Lumley Park Burn | Fluvial | Yes - but only approx 800m from river mouth |
| Rough Dene Burn | Lumley Park Burn | Fluvial | No |
| Whittle Burn | River Don | Fluvial | Yes |

Flooding from ordinary watercourses can be identified using the Environment Agency's Flood Map and the Council's Level 1 SFRA. Fluvial flood risk from ordinary watercourses within

Sunderland is low due to the small catchment areas of those watercourses originating within Sunderland and the large capacity of the River Wear. Figure 5-4 illustrates potential properties at risk from ordinary watercourses within Flood Zone 3. Table 5-4 identifies the number of properties and their breakdown within Flood Zone 3 and 2 of the Environment Agency Flood Map. Flood Zones used in Figure 5-4 and Table 5-4 are clipped to represent ordinary watercourses only.

**Table 5-4: Properties at Risk from Ordinary Watercourse Flooding**

| Flood Zone | Total Properties | Residential | Non-Residential | Critical Infrastructure | Other |
|---|---|---|---|---|---|
| Flood Zone 3 | 95 | 58 | 9 | 2 | 26 |
| Flood Zone 2[1] | 317 | 267 | 13 | 34 | 3 |
| [1] This includes properties within Flood Zone 3 | | | | | |

For the purposes of this assessment the consequences of flooding from ordinary watercourses is not significant and the inclusion of the Flood Zones in the analysis will be insufficient enough to push the predicted flood risk impacts in the clusters over the 30,000 people at risk threshold. The Flood Zones have therefore not been included in the locally agreed surface water information.

## 5.3 Future Flood Risk and their Consequences

The Environment Agency has assessed the potential consequences of future surface water flooding using the national FMfSW (1 in 200-year rainfall). The results of this have been used during the identification of indicative Flood Risk Areas. Although included in Annex 2 'Future Floods' of the Preliminary Assessment Spreadsheet, no other flood risk datasets on future flood risk, other than the FMfSW, was used to identify indicative Flood Risk Areas within this PFRA.

By counting the number of people, businesses and critical services at risk, the Environment Agency has identified a number of areas across Sunderland, which exceeds the Defra and WAG flood risk thresholds. Significant harmful consequences are:

- Greater than 200 people,
- Greater than 20 businesses, or
- Greater than 1 critical services at risk.

The Environment Agency then aggregated these results nationally using a 1km grid squares approach, identifying those grid squares that exceed these thresholds. Figure 5-6 illustrates the 43 1km grid squares across Sunderland which exceeding the future flood risk thresholds. As discussed in Section 6, these areas are clustered to identify indicative Flood Risk Areas by the Environment Agency.

## 5.4 Effects of Climate Change and Long-Term Developments

### 5.4.1 The Evidence

Over the past century across 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 fifty 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 twenty to thirty 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 rainstorms may become more intense, even if we are unsure about exactly where or when. By the 2080s, the latest UK climate projections (UKCP09) are that there could be up to 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%.

### 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 10% (very likely to be between 0 and 23%)
- precipitation on the wettest day in winter up by 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 should 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, local studies should be carried out to understand climate impacts in detail, including effects from other factors like land use. Sustainable development and drainage will help us to adapt to climate change and to manage the risk of damaging floods in the near and distant 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.

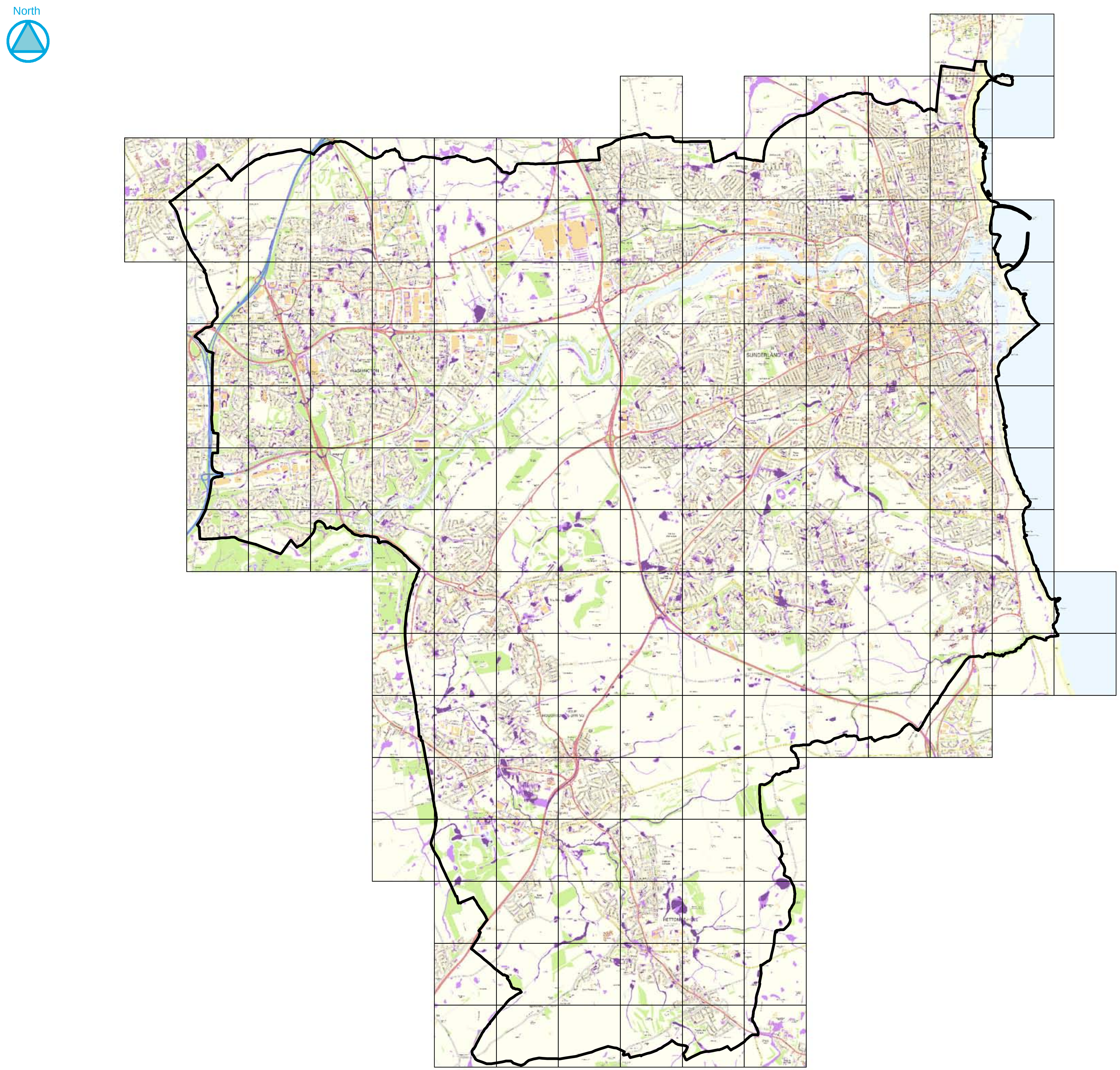
Although the broad climate change picture is clear, we must make local decisions to address uncertainty. We will therefore consider a range of measures and retain flexibility to adapt. This approach, embodied within flood risk appraisal guidance, will help to ensure that we do not increase our vulnerability to flooding.

### 5.4.5 Long-Term Developments

It is possible that long-term developments will 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 that are "significant" (in terms of the Government's criteria).




## Location Plan


## Legend

- Sunderland City Council Boundary
- Surface Water 'Deep'
- Surface Water 'Shallow'



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PRELIMINARY FLOOD RISK ASSESSMENT

Flood Map for Surface Water
(1 in 200 year)



| | | |
|---|---|---|
| Drawn by: Peter Grace | | Scale: Not to scale |
| Date: | 21/06/2011 | |
| Status: | FINAL | |
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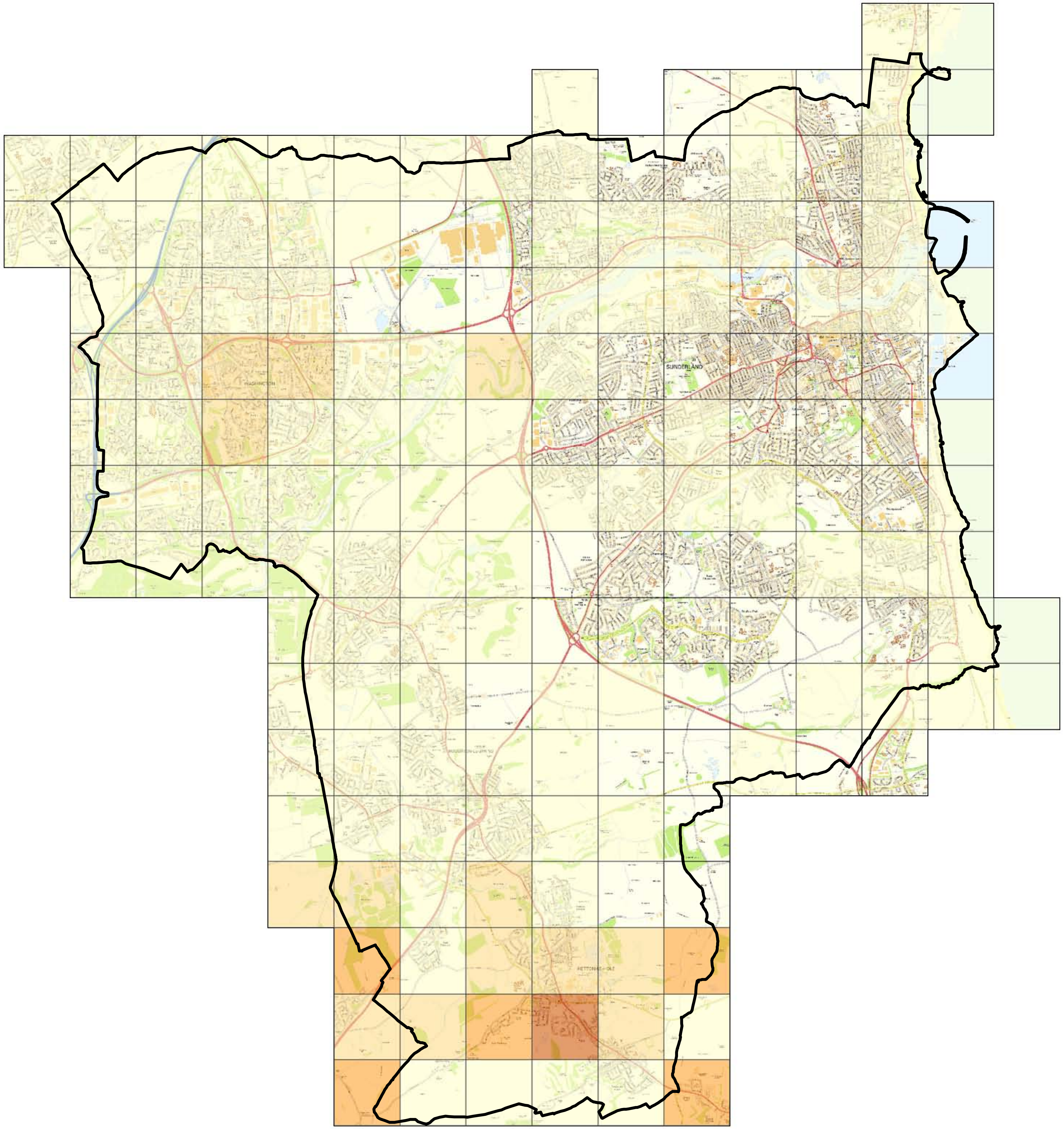
| Drawing Number: | Figure 5-1 | |

Original @ A3

North



## Location Plan


## Legend

Sunderland City Council Boundary

Proportion of Area Susceptible to Groundwater Emergence

- >= 75%
- >= 50% <75%
- >= 25% <50%
- < 25%



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PRELIMINARY FLOOD RISK ASSESSMENT

Areas Susceptible to Groundwater Flooding



| | | |
|---|---|---|
| Drawn by: | Peter Grace | Scale: Not to scale |
| Date: | 21/06/2011 | |
| Status: | FINAL | |
| File Name: | ..\Graphical Data\ArcView\Projects\ | |
| Drawing Number: | Figure 5-2 | |

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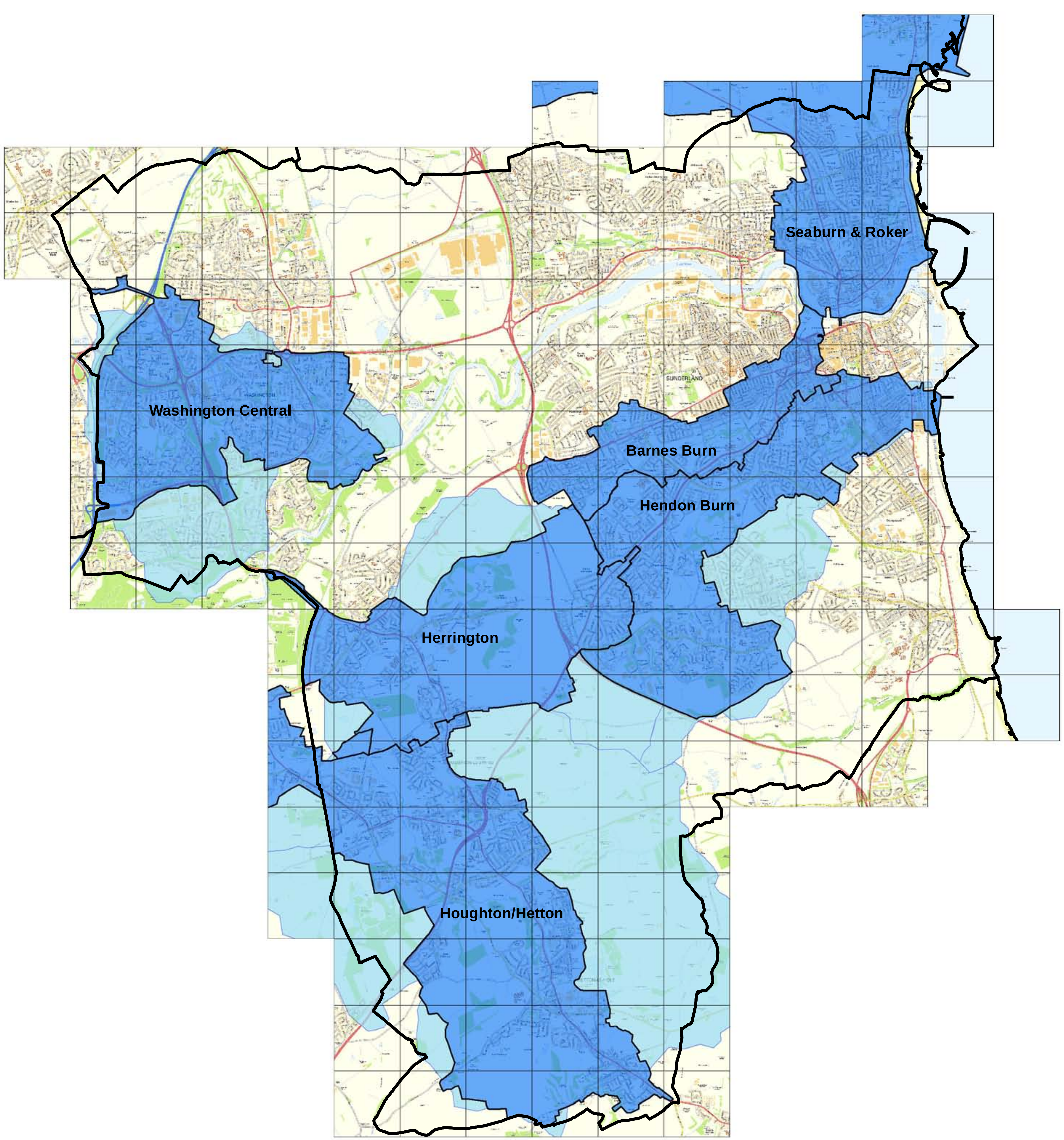


## Location Plan


## Legend

- Sunderland City Council Boundary
- Critical Drainage Areas
- Contributing Natural Catchments




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## PRELIMINARY FLOOD RISK ASSESSMENT

### SFRA Critical Drainage Areas



| | | |
|---|---|---|
| Drawn by: | Peter Grace | Scale: Not to scale |
| Date: | 21/06/2011 | |
| Status: | FINAL | |

File Name: ..\Graphical Data\ArcView\Projects\

Drawing Number: Figure 5-3

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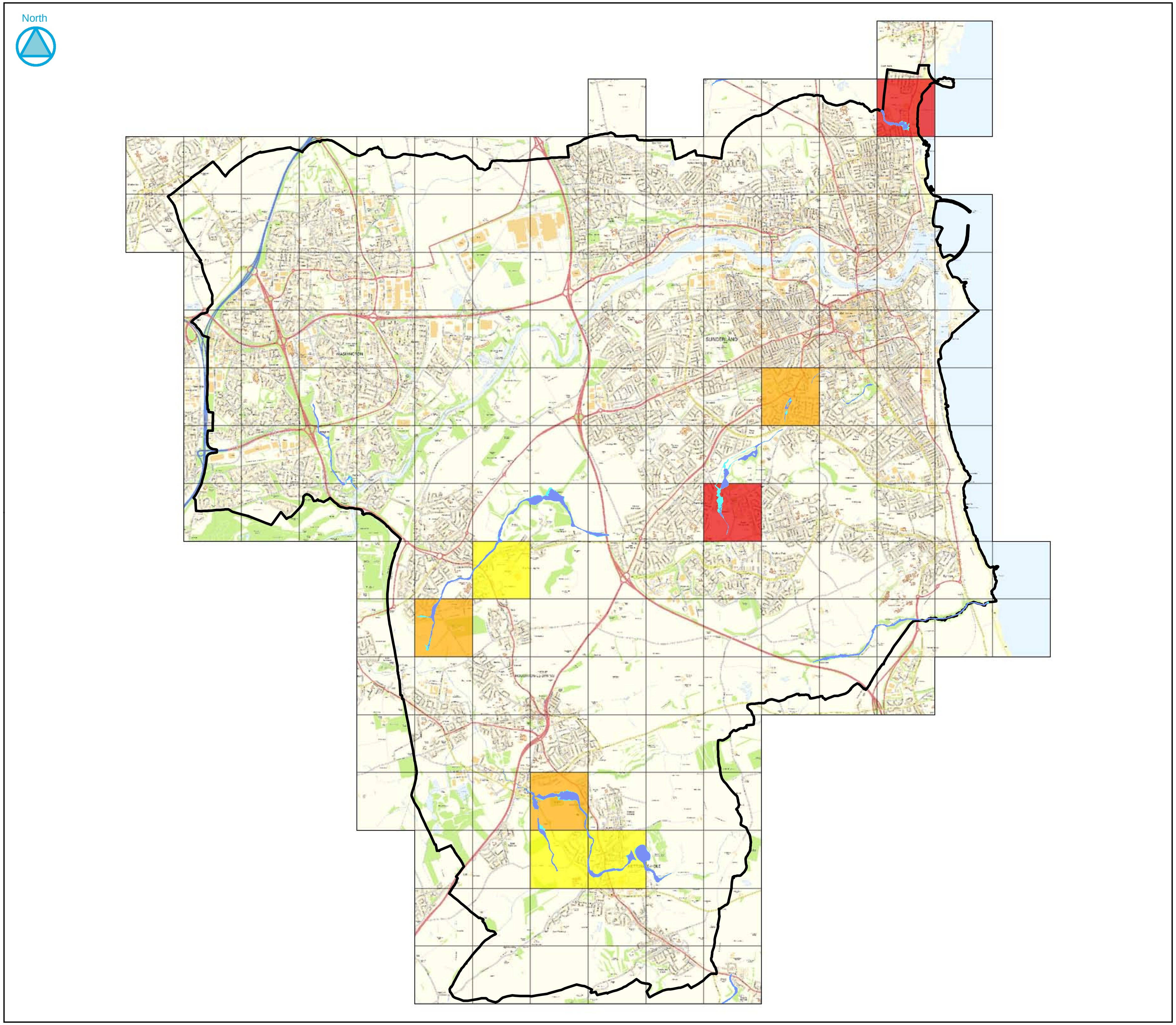


## Location Plan


## Legend

- Sunderland City Council Boundary
- Flood Zone 3
- Flood Zone 2

Number of Residential Properties in Flood Zone 3

- 1 - 5
- 6 - 10
- 11 - 15

The Environment Agency Flood Map has been clipped, showing Flood Zones along ordinary watercourses only.



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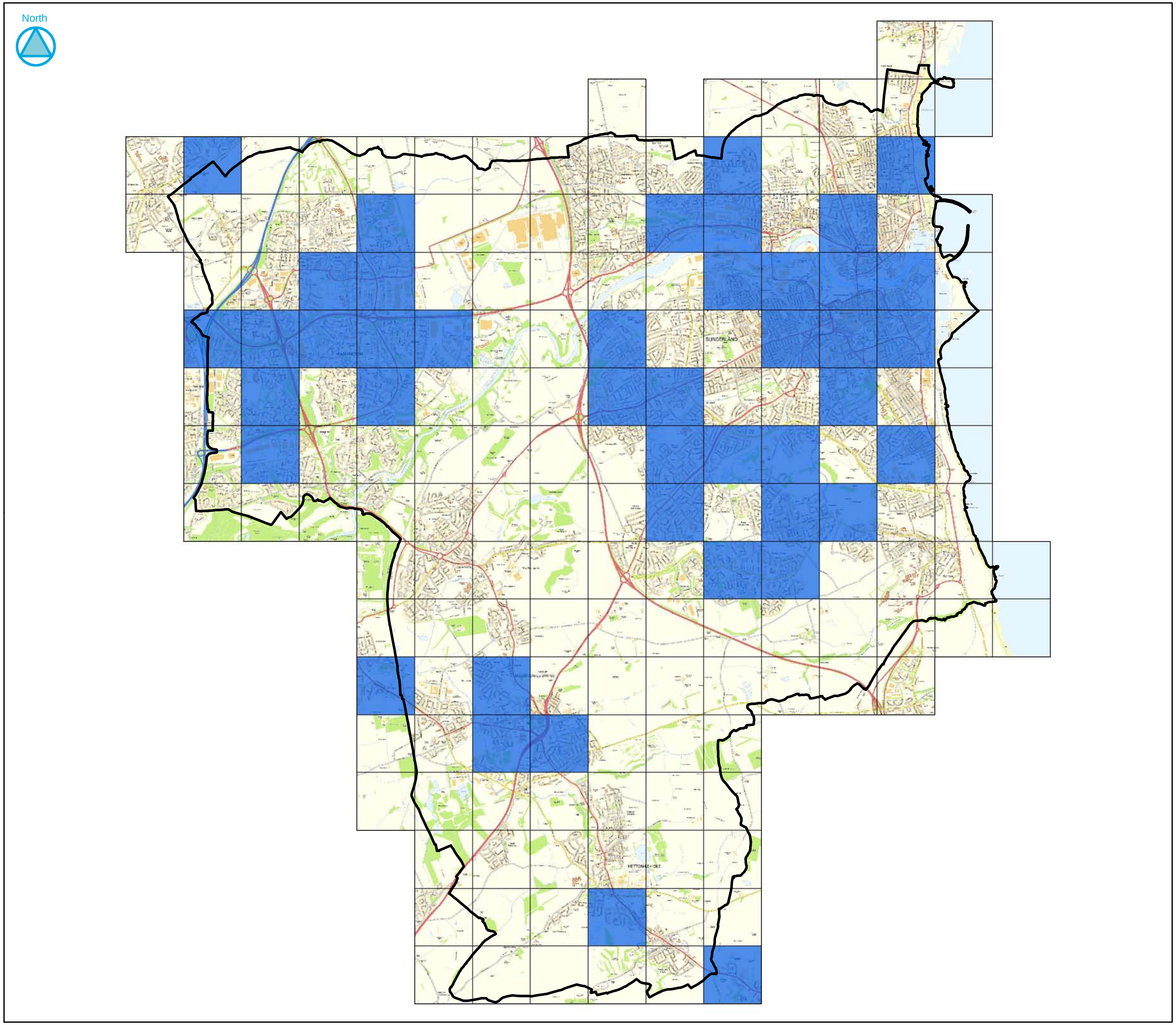
## PRELIMINARY FLOOD RISK ASSESSMENT

### Ordinary Watercourses Flood Map



| | | |
|---|---|---|
| Drawn by: | Peter Grace | Scale: Not to scale |
| Date: | 21/06/2011 | |
| Status: | FINAL | |
| File Name: | ..\Graphical Data\ArcView\Projects\ | |
| Drawing Number: | Figure 5-4 | |




## Location Plan


**Legend**

- Sunderland City Council Boundary
- Areas above Flood Risk Thresholds



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PRELIMINARY FLOOD RISK ASSESSMENT

Areas above Flood Risk Thresholds



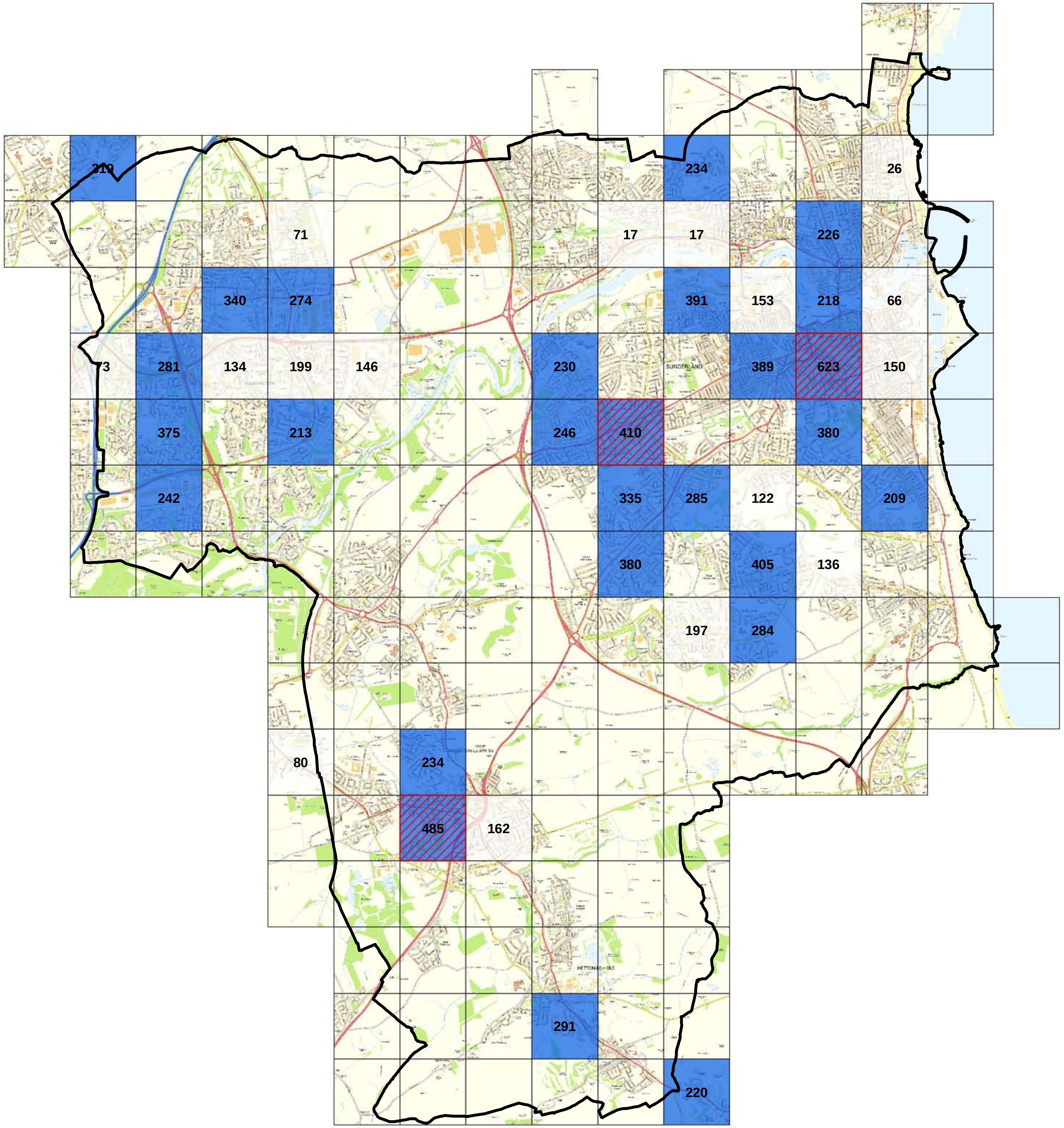
| | | |
|---|---|---|
| Drawn by: | Peter Grace | Scale: Not to scale |
| Date: | 21/06/2011 | |
| Status: | FINAL | |

File Name: ..\Graphical Data\ArcView\Projects\

Drawing Number: Figure 5-5

Original @ A3

North




**Location Plan**


**Legend**

Sunderland City Council Boundary

Top Three Ranked by Total People

623

485

410

Number of People Affected

<= 200

> 200



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PRELIMINARY FLOOD RISK ASSESSMENT

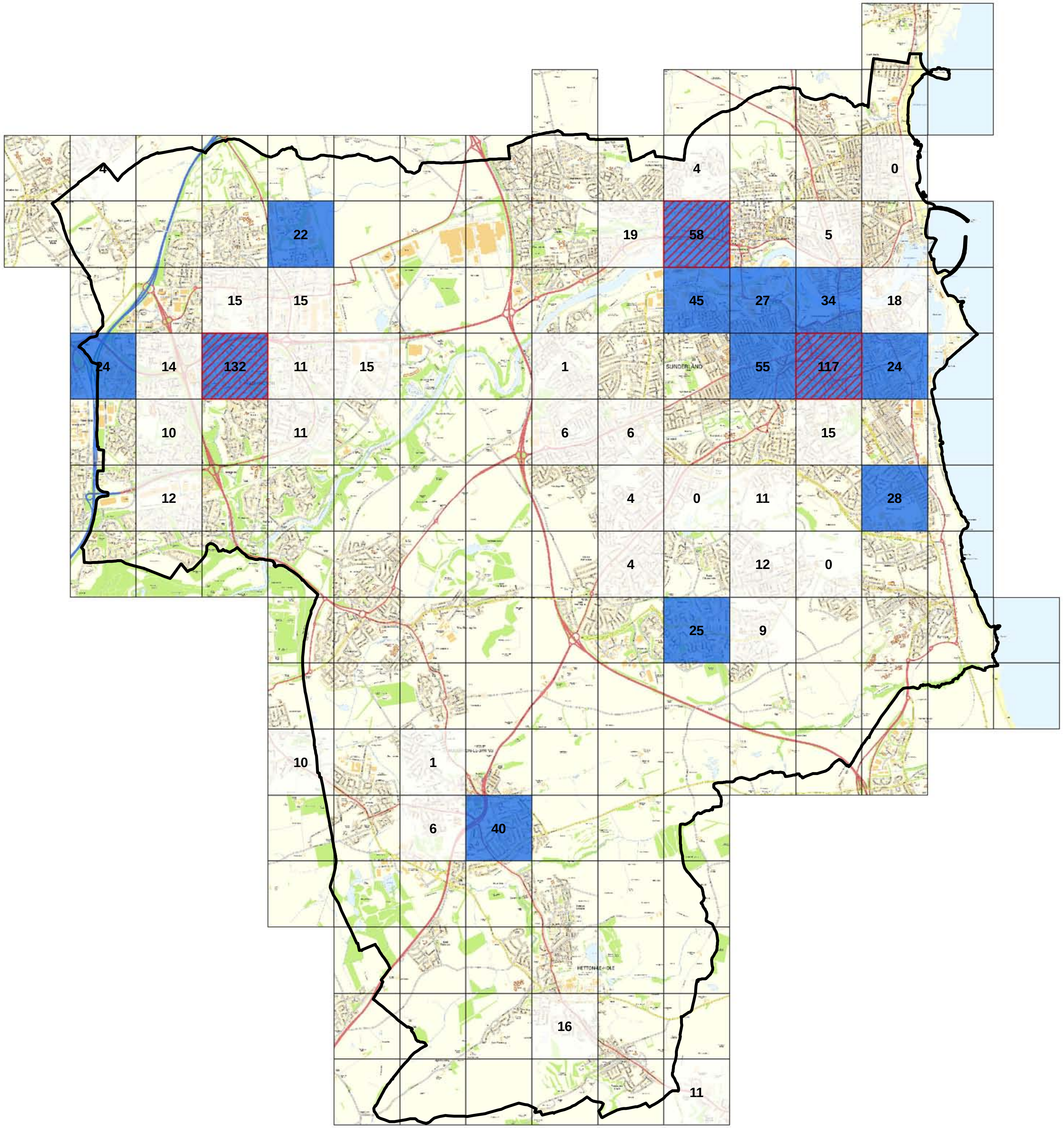
Areas above Flood Risk People Threshold



| | |
|---|---|
| Drawn by: Peter Grace | Scale: Not to scale |
| Date: 21/06/2011 | |
| Status: FINAL | |
| File Name: ..\Graphical Data\ArcView\Projects\ | |
| Drawing Number: Figure 5-6 | |

Original @ A3

North




**Location Plan**


**Legend**

Sunderland City Council Boundary

Top Three Ranked by Total Non Residential

- 132
- 117
- 58

Number of Non Residential

- 0 - 20
- 21 - 200



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PRELIMINARY FLOOD RISK ASSESSMENT

Areas above Flood Risk Non-Residential Threshold



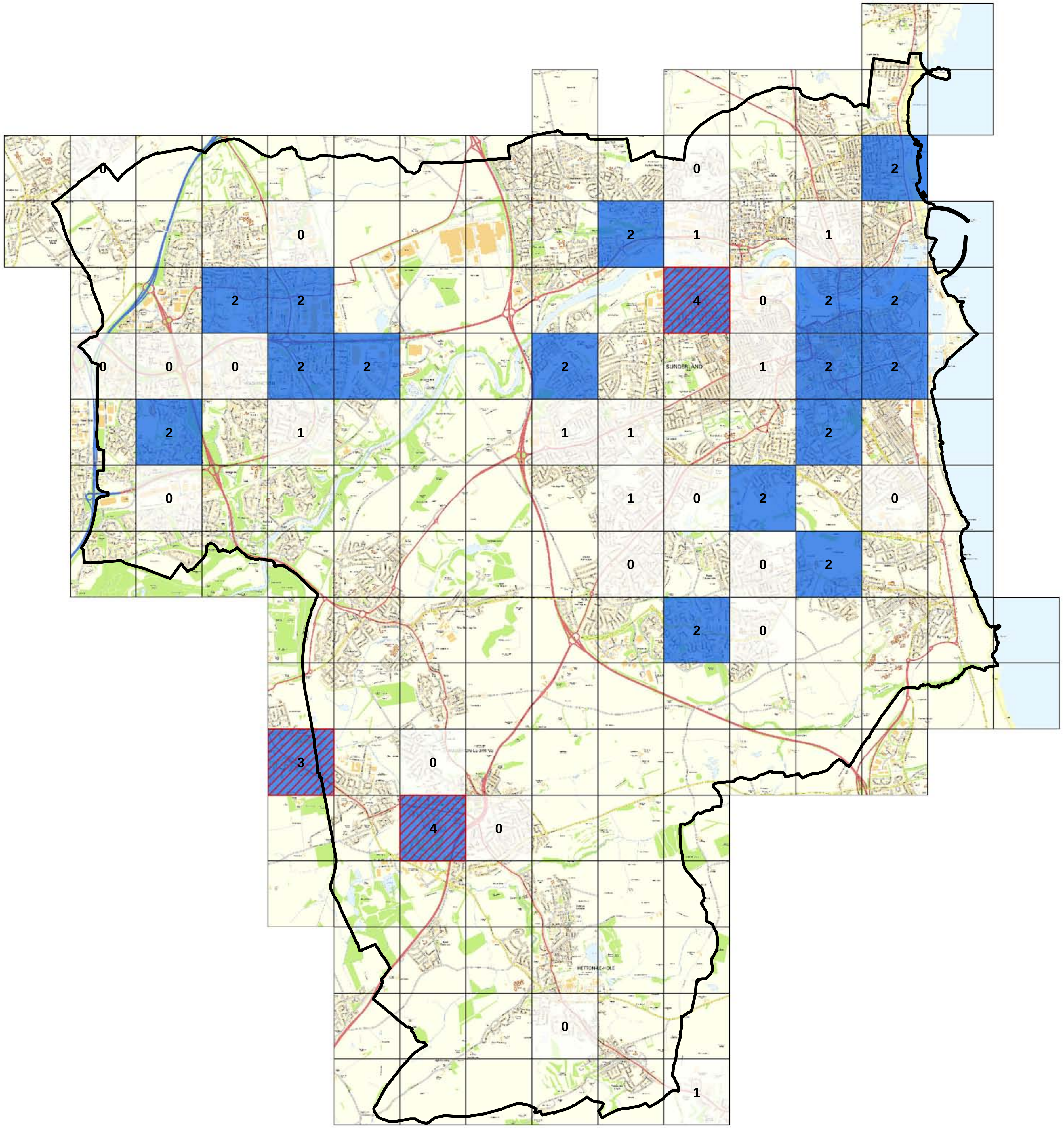
| | | |
|---|---|---|
| Drawn by: | Peter Grace | Scale: Not to scale |
| Date: | 21/06/2011 | |
| Status: | FINAL | |

File Name: ..\Graphical Data\ArcView\Projects\

Drawing Number: Figure 5-7

Original @ A3

North



**Location Plan**


**Legend**

Sunderland City Council Boundary

Top Three Ranked by Total Critical Services

- 4
- 3

Number of Critical Services

- <= 1
- > 1



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## PRELIMINARY FLOOD RISK ASSESSMENT

### Areas above Flood Risk Critical Services Threshold



| | | |
|---|---|---|
| Drawn by: | Peter Grace | Scale: Not to scale |
| Date: | 21/06/2011 | |
| Status: | FINAL | |
| File Name: | ..\Graphical Data\ArcView\Projects\ | |
| Drawing Number: | Figure 5-8 | |

Original @ A3

# 6. Flood Risk Areas

## 6.1 Introduction

Using the FMfSW and the Environment Agency's flood risk thresholds, 43 1km grid squares illustrating local risk were identified in Sunderland (see Section 5.3). By carrying out a grouping approach to the 1km grid squares across England, two clusters were identified; the Washington and Sunderland clusters with 3,400 and 8,100 people at risk respectively As both clusters do not exceed the threshold of 30,000 people, the Environment Agency has not identified them as an indicative Flood Risk Area.

## 6.2 Review of Indicative Flood Risk Areas

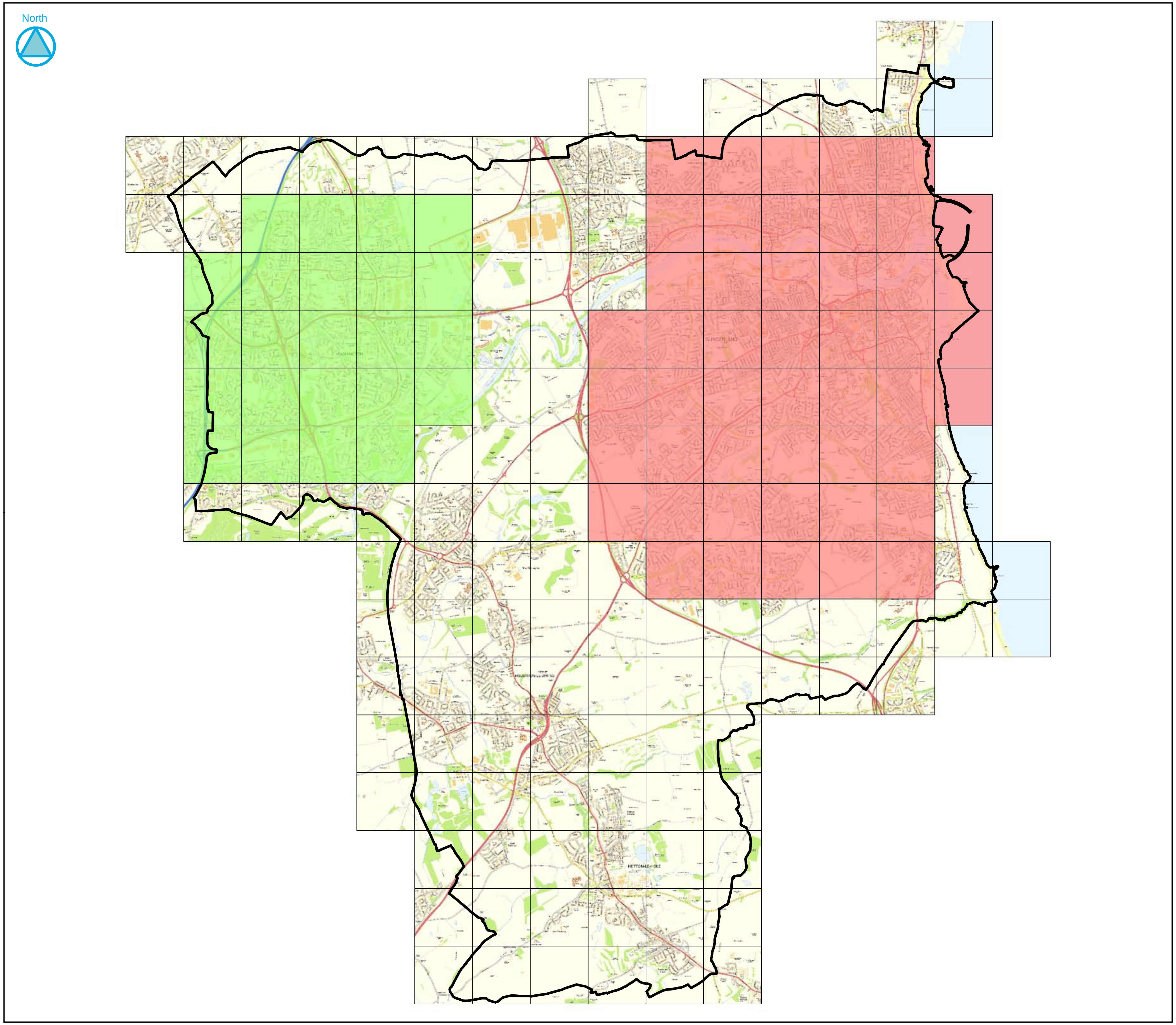
It is important to remember that the indicative Flood Risk Areas have been identified national using surface water flooding data, the National Receptor Dataset and national significance criteria and thresholds. Since no indicative Flood Risk Areas has been identified nationally within the boundary of the Sunderland City Council's administrative area, it is important that this process is reviewed using the local information on past and future flood risk discussed earlier.

In order to do so the questions in Table 6-1 have been considered. Figure 6-2 aids this review. Whilst the data collected does not identify new areas of significant risk, the map highlights those areas in the City of Sunderland at risk from a number of sources; local historical data provides evidence to support the areas at risk.

**Table 6-1: Reviewing the indicative Flood Risk Area Approach**

| Question | Response |
|---|---|
| Is the FMfSW the most appropriate source of information? | Yes, the FMfSW should be the ‘locally agreed surface water information’ across the City of Sunderland. |
| Are the consequences of flooding from other sources e.g. groundwater, ordinary watercourses likely to lead to significant Flood Risk Areas? | The PFRA has identified a number of sources, which will have a consequence on people, property and the environment if flooding occurs including ordinary watercourses, sewers and their interaction with main rivers.<br>However, information on the actual consequence of flooding from these sources is limited, mainly to those ordinary watercourses, which are included in the Environment Agency Flood Map. The consequence of flooding from ordinary watercourses will not be significant enough to push the clusters over the 30000 people at risk threshold. There will however be local risks. |
| Is there information on past floods, which had significant harmful consequences? | Based on the historic data collected, whilst there have been historical flood incidents across the City, there is insufficient information available to identify event s of significant harmful consequences. |
| Is there any other information on the possible harmful consequences of future floods? | There are a number of modelled outputs available to the PFRA, which have identified sources of local flood risk.<br>The Environment Agency Flood Map does identify a risk associated with ordinary watercourses and main rivers. The FMfSW used to define the indicative Flood Risk Area can help identify risks along ordinary watercourse to some degree where they are not shown in the Flood Map. The Flood Map will also help identify possible interactions when compared to the FMfSW. |

This PFRA supports the Environment Agency's national assessment within Sunderland that there are no identifiable Flood Risk Areas in the City. Therefore, there to stages 3 and 4 of the Flood Risk Regulations 2009 are not triggered.




**Location Plan**


**Legend**

Sunderland City Council Boundary

Clusters Covering Sunderland

Sunderland

Washington



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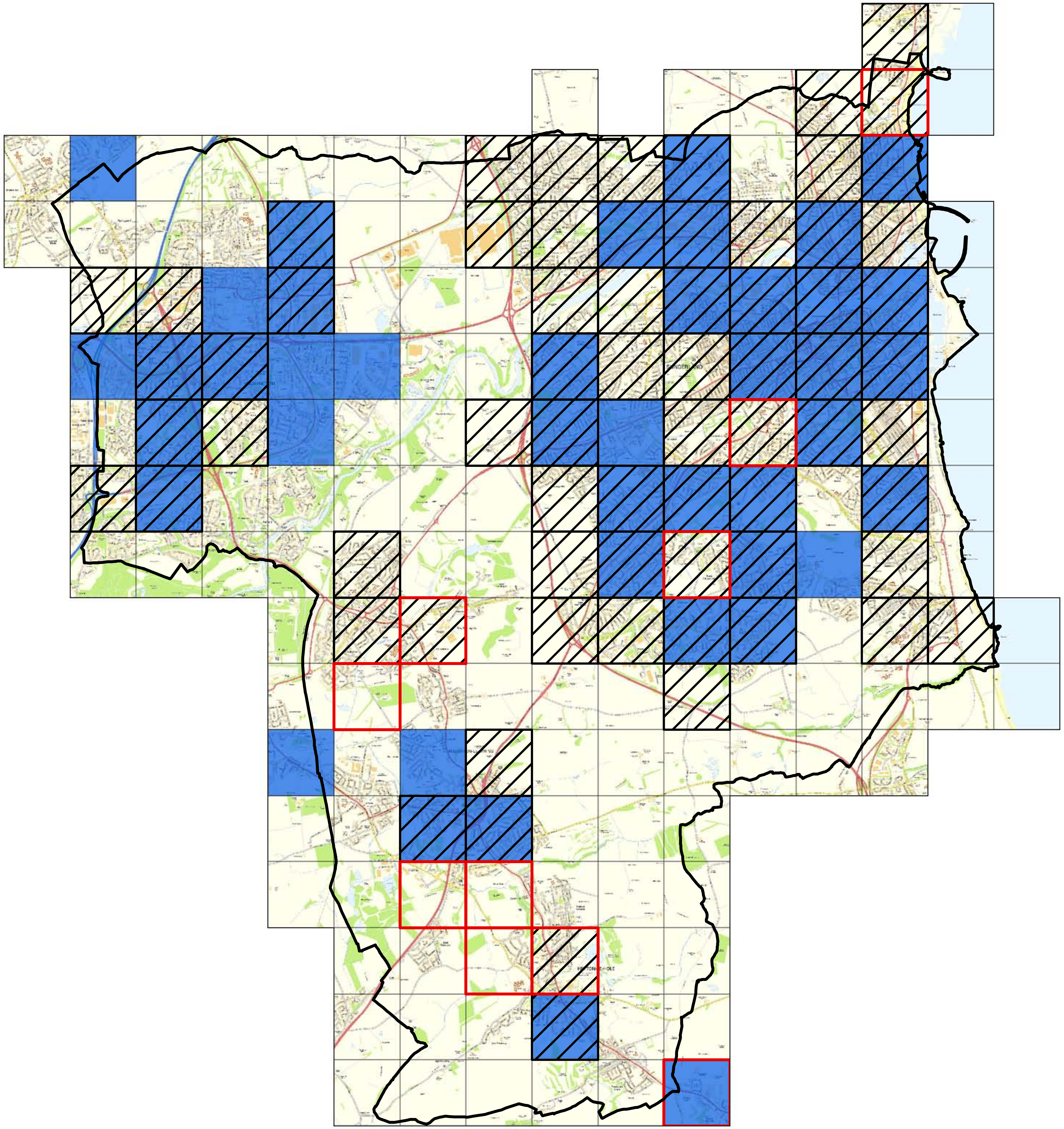
PRELIMINARY FLOOD RISK ASSESSMENT

Clusters of Areas above Flood Risk Thresholds



| | | |
|---|---|---|
| Drawn by: | Peter Grace | Scale: Not to scale |
| Date: | 21/06/2011 | |
| Status: | FINAL | |
| File Name: | ..\Graphical Data\ArcView\Projects\ | |
| Drawing Number: | Figure 6-1 | |

North



### Location Plan


### Legend

- Sunderland City Council Boundary
- Areas with Ordinary Watercourse Flood Risk
- Areas with Historical Flood Incidents
- Areas above Flood Risk Thresholds



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## SUNDERLAND CITY COUNCIL

## PRELIMINARY FLOOD RISK ASSESSMENT

## Areas of Future and Historical Flood Risk



| | | |
|---|---|---|
| Drawn by: | Peter Grace | Scale: Not to scale |
| Date: | 21/06/2011 | |
| Status: | FINAL | |

File Name: ..\Graphical Data\ArcView\Projects\

Drawing Number: Figure 6-2

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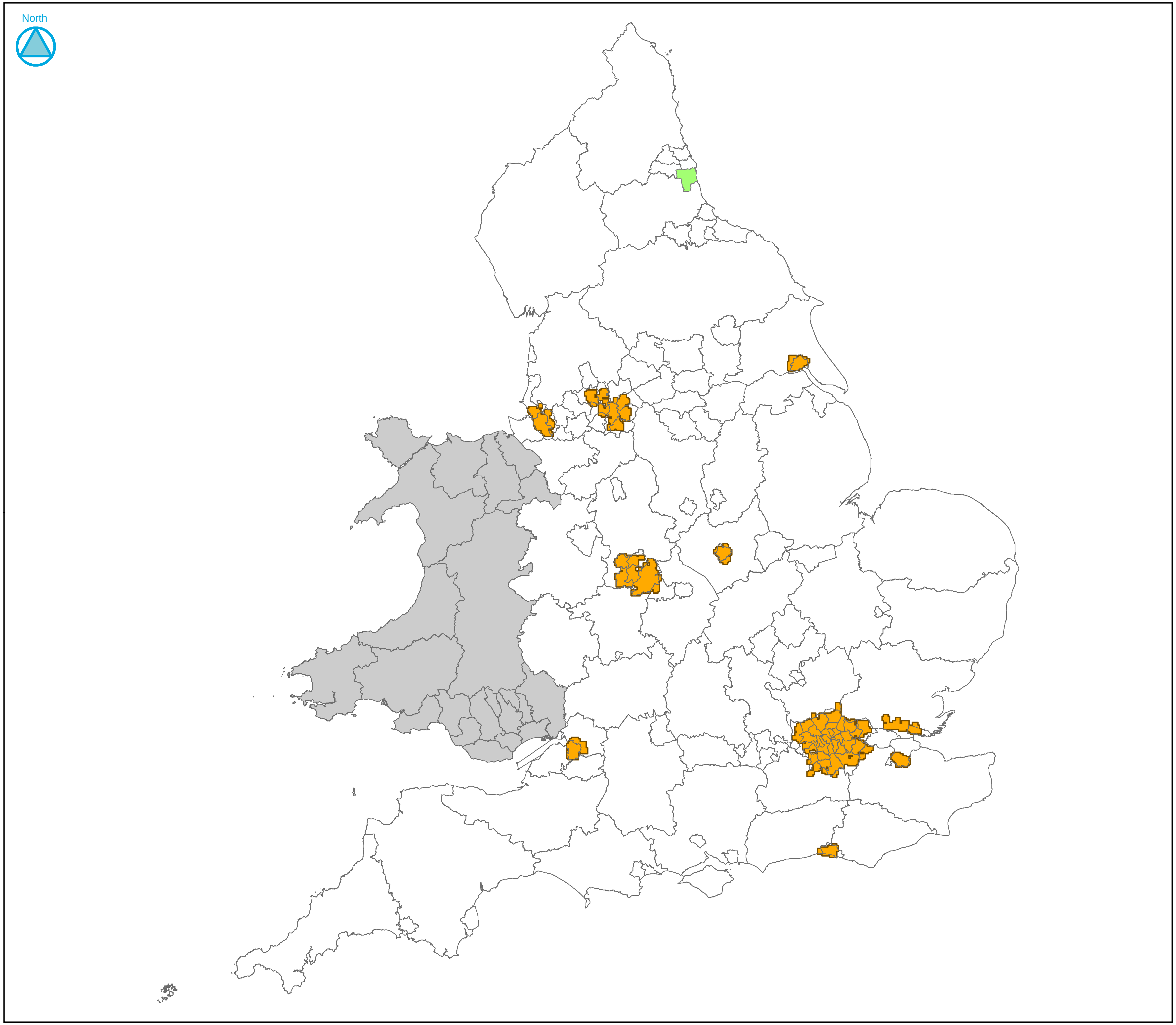


**Legend**

- Sunderland City Council
- Lead Local Flood Authorities
- Indicative Flood Risk Areas



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PRELIMINARY FLOOD RISK ASSESSMENT

Environment Agency Indicative Flood Risk Areas



| | | |
|---|---|---|
| Drawn by: | Peter Grace | Scale: Not to scale |
| Date: | 21/06/2011 | |
| Status: | FINAL | |

File Name: ..\Graphical Data\ArcView\Projects\

Drawing Number: Figure 6-3

Original @ A3

# 7. Next Steps

## 7.1 Introduction

No Flood Risk Areas are identified for the City of Sunderland and therefore the next stage of the Regulations are not triggered and as such the Council do not have to produce flood hazard, risk maps and a flood management plan for their 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 assessments of flood risk (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.

Sunderland City Council will lead the PFRA review, and must submit the PFRA 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 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 Flood and Water Management Act 2010. Local strategies will set out how LLFAs will manage the local flood risks in their areas and will cover areas not identified as being at significant flood risk under the Flood Risk Regulations 2009. For Sunderland City Council, the strategy will focus on managing the 22500 properties at surface water risk identified in this PFRA.

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 areas at risk of local flooding in the City of Sunderland. These should provide the focus of the local strategy especially where the analysis shows an overlap between past flood incidents and future flood risk areas.

Sunderland City Council 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 Level 1 SFRAs and any future SWMP in Sunderland will be essential building blocks for the delivery of integrated local flood risk management in the City of Sunderland and should be fully integrated into the strategy along with flood management works planned by the Environment Agency and Northumbrian Water.

## 7.3 Flood Incident Investigations and Register

In order to fulfil their role as a LLFA, Sunderland City Council is required to investigate future flood events and ensure continued collection, assessment and storage of flood risk data and information. The Council's internal flood incident register should be maintained and updated as new incidents occur. Table 7-1 lists a number of fields to be recorded for each incident, which will be required during the next cycle of the PFRA.

It is recommended that a centralised database be kept up to date by Sunderland City Council, as a LLFA. This will prove beneficial during the PFRA review process, the flood risk management plan, local strategy and any subsequent review of the Sunderland City Council SFRA.

**Table 7-1: 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. |
| Main 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 | LLFA, Northumbrian Water, Highway etc. |

# A. Preliminary Assessment Report Spreadsheet

## A.1 Annex 1: Records of past floods and their significances

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

## A.2 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 each LLFA, including details of the potential consequences of flooding to key risk receptors within the borough.

## A.3 Annex 3: Records of Flood Risk Areas and their rationale

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

# B. PFRA Review Checklist

## B.1 Review checklist

Please refer to the spreadsheet 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.

# C. References


1. Association of North East Councils (2010) North East Regional Flood Risk Appraisal
2. Defra (2010) Surface Water Management Plan Technical Guidance
3. Defra / WAG (2010) Selecting and reviewing Flood Risk Areas for local sources of flooding – Guidance to Lead Local Flood Authorities.
4. Environment Agency (2008) Wear Catchment Flood Management Plan
5. Environment Agency (2010) Preliminary Flood Risk Assessment: Final Guidance (Report – GEHO1210BTGH-E-E)
6. Environment Agency (2011) Preliminary Flood Risk Assessment: Annexes to the Final Guidance Version 2 (Report – GEHO1210BTHF-E-E)
7. Environment Agency Building Trust with Communities
8. Sunderland City Council (2009) Sunderland Level 1 Strategic Flood Risk Assessment
9. The Pitt Review (2008) Learning lessons from the 2007 floods

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