North Tyneside Council Level 1 Strategic Flood Risk Assessment

Volume II: SFRA Technical Report

Final Report

July 2010

North Tyneside Council

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Final Draft SFRA Volume II Report 19th November 2009	Draft SFRA updated to include comments made in meeting with NWL and NTC on the 15th October 2009 Final draft version of Volume III has been incorporated within Volume I	Claire Dobinson, NTC Cameron Sked, EA Niki Mather, NWL
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Contract

This report describes work commissioned by North Tyneside Council under ORDER CD/SFRA/090129 of 29/01/2009. North Tyneside Council's representative for the contract was Claire Dobinson. Chris Isherwood of JBA Consulting carried out the work.

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Purpose

This document has been prepared as a final report for North Tyneside Council. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by the North Tyneside Council for the purposes for which it was originally commissioned and prepared.

JBA Consulting has no liability regarding the use of this report except to North Tyneside Council.

Acknowledgments

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Executive Summary

Development and Flood Risk

North Tyneside Council is required to undertake a Level 1 Strategic Flood Risk Assessment (SFRA) as an essential part of the pre-production/evidence gathering stage of the Local Development Framework (LDF) and in preparing their Local Development Documents (LDDs). The SFRA provides baseline information for use in the preparation of the Sustainability Appraisal (SA) of LDDs for the scoping and evaluation stages.

The requirement for and guidance on the preparation of SFRAs is outlined in Planning Policy Statement 25 Development and Flood Risk (PPS25) and its Practice Guide. This requires Local Planning Authorities (LPAs) to take a more dominant role in local flood risk management. They also need to demonstrate that due regard has been given to the issue of flood risk at all levels of the planning process to avoid inappropriate development.

Local authority planners must demonstrate that a risk based, sequential approach has been applied in preparing development plans and that flood risk has been considered during the planning application process. This must be achieved through the application of the Sequential and Exception Test as outlined in PPS25.

By providing a central store for data, guidance and recommendations on flood risk issues at a local level, the SFRA is an important planning tool that enables the LPA to carry out the Sequential and Exception Test and to select and develop sustainable site allocations with regard to flood risk.

SFRAs can also provide a much broader and inclusive vehicle for integrated, strategic and local Flood Risk Management (FRM) assessment and delivery, by providing the linkage between Catchment Flood Management Plans (CFMPs), Regional Flood Risk Appraisals (RFRAs) and Surface Water Management Plans (SWMPs). The suite of flood risk policy issues and information on the scale and nature of the risks in these various documents needs to be brought into “real” settings with the SFRA tasked with improving the understanding of flood risk across the districts.

North Tyneside Council Level 1 SFRA

This report has been produced as a Level 1 SFRA for North Tyneside Council, in accordance with PPS25 and its Practice Guide. The Level 1 SFRA is presented across two separate volumes, and is referred to as the North Tyneside Level 1 SFRA Volume I and II.

Volume I: SFRA Guidance Report

Volume I of the North Tyneside Level 1 SFRA introduces the SFRA process. It is a reference document for current flood risk management drivers, national regional and local planning policy and introduced Environment Agency policy such as the Tyne CFMPs and SMPs.

The report also provides a brief understanding of the mechanisms of flooding and flood risk for those new to the subject. More importantly it provides a comprehensive discussion on PPS25, the Sequential and Exception Test and links the Flood Risk Management framework within national, regional and local flood risk assessments.

This report provides significant guidance and recommendations for Spatial Planners, Development Management and Developers in how to apply the sequential approach by carrying out both the Sequential and Exception Tests and links the flood risk information provided in the North Tyneside Level 1 SFRA Technical Report (Volume II) into useful step by step guidance

Volume II: Level 1 SFRA Technical Report

Volume II provides the technical information and methods used in the assessment of flood risk across North Tyneside. It initially begins with the introduction to the study area and the 'Consultation & Data Management' section, identifying key stakeholders and their involvement in the SFRA process followed by a review of important data sources within the SFRA.

The main sections within the report focus on the assessment of all sources of flooding include; fluvial, tidal, surface water, sewers, groundwater and reservoirs and other artificial sources. The Volume also introduces current flood risk management measures including the Environment Agency Flood Warning System flood defences.

As discussed flood risk has many dimensions and as a result has been presented through a suite of maps. These extend the level of detail in the Environment Agency Flood Map. The SFRA maps include:

SET A:	PPS25 Flood Zones	2009s0059-D01 to D06
SET B:	Strategic 1 in 100 year Fluvial Depths	2009s0059-D07
SET C:	Strategic 1 in 100 year Fluvial Hazards	2009s0059-D08
SET D:	Tidal Climate Change Sensitivity	2009s0059-D09
SET E:	Flood Risk Management Measures	2009s0059-D10
SET F:	Areas Susceptible to Surface Water Flooding	2009s0059-D11 to D16
SET G	NWL Drainage Areas	2009s0059-D17
SET H	Critical Drainage Areas	2009s0059-D18

Volume II along with the suite of SFRA maps should provide the main evidence base of the North Tyneside Level 1 SFRA. It has been arranged in one volume to allow technical information to be easily updated when reviewed. It is only this Volume that can be updated with new flood risk information when available.

Section 6 provides the assessment of North Tyneside's proposed development sites against the Flood Zones and areas susceptible to surface water flooding zones. North Tyneside Council should use the spreadsheet developed to carryout the first pass of the Sequential Test.

This volume ends with key recommendations for further work required such as Level 2 SFRAs and SWMPs which will provide North Tyneside Council with a strategic and coherent framework for managing flood risk in their area.

Use of SFRA Data

Whilst all data collected and produced during the North Tyneside Level 1 SFRA process has been supplied to North Tyneside Council (report, maps, GIS, modelled output) there should be controls on its use. It is anticipated that the SFRA report (both Volumes) and associated maps will be published on the Council website as PDFs as the central source of SFRA data and available to download.

North Tyneside Council will be able to use any modelled output for internal use. The use of this information must consider the context within which it was produced. The use of this data will fall under the license agreement between the LPA and the Environment Agency as it has been produced using Environment Agency data. It should be remembered that any modelling undertaken for the SFRA is of a strategic nature and more detailed FRAs should seek to refine the understanding of flood risk from all sources to any particular site.

SFRA data should not be passed on to third parties outside of the LPA. Any third party wishing to use existing Environment Agency flood risk datasets should contact External Relations in the Environment Agency North East Region. A charge is likely to apply for the use of this data..

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Abbreviations

ABD	Areas Benefiting from Defences
AEP	Annual Exceedance Probability
CDA	Critical Drainage Area
CFMP	Catchment Flood Management Plans
CLG	Communities and Local Government
CRR	Community Risk Register
CS	Core Strategy
DPDs	Development Plan Documents
EA	Environment Agency
EU	European Union
FAS	Flood Alleviation Schemes
FEH	Flood Estimation Handbook
FCERM	Flood and Coastal Erosion Risk Management
FRA	Flood Risk Assessment
FRM	Flood Risk Management
FRMP	Flood Risk Management Plan
IMP	Indicative Floodplain Map
LDDs	Local Development Documents
LDF	Local Development Framework
LRF	Local Resilience Form
LPAs	Local Planning Authorities
NEA	North East Assembly
NFCDD	National Fluvial and Coastal Defence Database
NLRF	Northumbria Local Resilience Form
NWL	Northumbrian Water
PFRA	Preliminary Flood Risk Assessment
PG	Practice Guide
PPS	Planning Policy Statement
RBD	River Basin District
RBMP	River Basin Management Plan
RFRA	Regional Flood Risk Assessment
RPB	Regional Planning Bodies
RPG	Regional Planning Guidance
RRF	Regional Resilience Forums
RSS	Regional Spatial Strategy
SA	Sustainability Appraisal
SEA	Strategic Environmental Assessment
SFRA	Strategic Flood Risk Assessment
SMP	Shoreline Management Plans
SoP	Standard of Protection
SPD	Supplementary Planning Document
SUDS	Sustainable (Urban) Drainage Systems
SWMP	Surface Water Management Plan
UKCIP	United Kingdom Climate Impacts Programme
UKCP	United Kingdom Climate Projections
WCS	Water Cycle Study

1. Introduction

1.1 Background

JBA Consulting was commissioned in January 2009 by North Tyneside Council to undertake a review of the existing Tyne and Wear Strategic Flood Risk Assessment (SFRA) published in 2007. This report details a Level 1 SFRA for North Tyneside alone and has been prepared in accordance with current best practice, Planning Policy Statement 25 Development and Flood Risk (PPS25)[1].

1.2 North Tyneside Council Level 1 SFRA Volume II

The purpose of this investigation is to provide a spatial assessment of flood risk within North Tyneside, and to develop on the detail included in the North East Regional Flood Risk Appraisal. Together these sources will assist the Local Development Framework (LDF) and the policies and proposals produced for the development and use of land within North Tyneside.

This technical volume of the Level 1 SFRA introduces the key sources and mechanisms of flood risk in NTC and measures that are taken to manage the risk. This Volume then provides sufficient data and information to inform the application of the Sequential Test by NTC. This information includes the suite of strategic flood risk maps:

- PPS25 Flood Zones
- Strategic 1 in 100 year Fluvial Depth & Hazards
- Tidal Climate Change
- Flood Risk Management Measures
- Areas Susceptible to Surface Water Flooding
- NWL Drainage Areas
- Proposed CDAs

To aid NTC undertaking the Sequential Test, a spreadsheet has been developed which provides the results of a spatial assessment for each proposed development site against Flood Zones and surface water susceptibility zones. The analysis includes area (ha) and percentage (%) cover of each zone and the proposed development land use.

This Volume then provides recommendations for further work.

1.3 Study Area

The study area comprises the whole of the NTC. North Tyneside is located in north east of England and is one of five metropolitan districts that compromise the conurbation of Tyne and Wear.

The North Tyneside coastline extends from St. Mary's Island in the north, down through Whitley Bay to Tynemouth. The area is recognised as a site of international nature conservation interest and through other protective designations including a SSSI, which runs from Tynemouth to Seaton Sluice. The northern fringe of the borough is open countryside and is identified as a greenbelt area.

North Tyneside has a number of large towns including Whitley Bay, Killingworth, North Shields and Wallsend. Along the northern edge of the borough area there are also a number of former mining villages. A large new settlement at Northumberland Park is currently being built between Shiremoor and Backworth.

[1] Communities and Local Government (2010) Planning Policy Statement 25: Development and Flood Risk

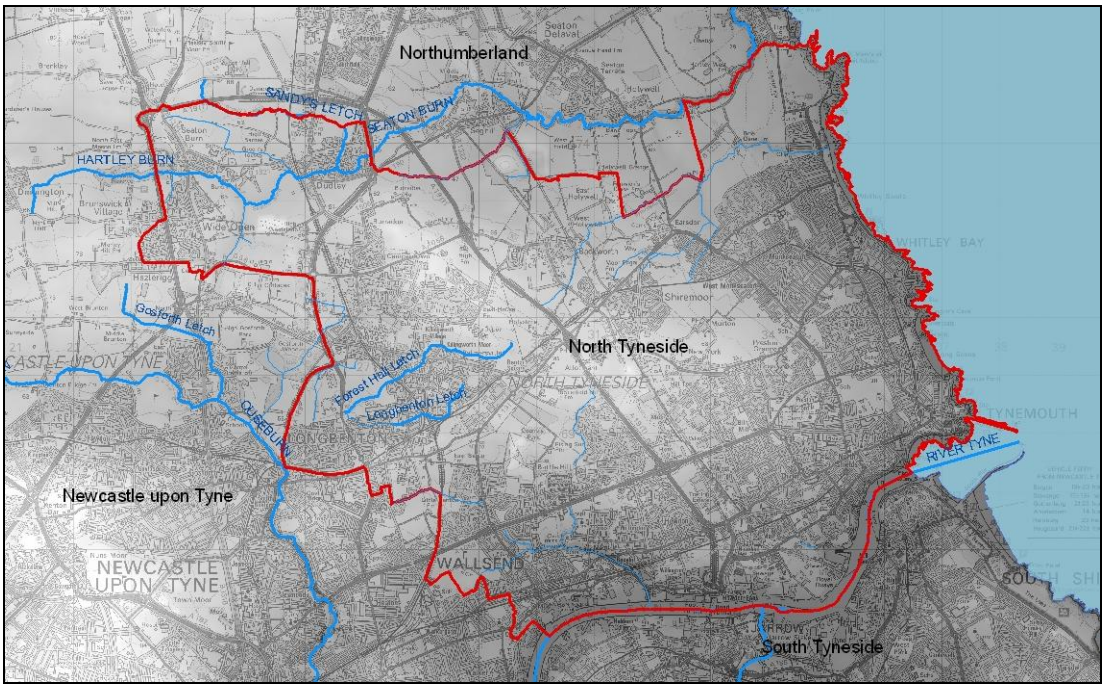
In addition to North Tyneside's residential areas, the borough is known for its industrial centres along the River Tyne including Wallsend and North Shields. The area was predominant in the development of maritime-based industry, producing large quayside factories and shipyards.

The tidally-influenced River Tyne forms the southern boundary to North Tyneside, and a number of its tributaries flow through the District including Wallsend Burn, Willington Gut and Redburn Dene. Killingworth, Longbenton and Benton are situated on the west side of the borough. The area falls within the Ouseburn catchment, one of the Tyne's major tributaries. Two former Critical Ordinary Watercourses (COWs), Forest Hall Letch and Longbenton Letch, drain the area as they flow west to the Ouseburn.

Seaton Burn originates southeast of Dinnington, flowing east through Big Waters nature reserve before entering North Tyneside underneath the A1. The watercourse flows through Dudley and is joined by Sandy's Letch from the north, forming part of the North Tyneside northern boundary before flowing further north into Northumberland, entering the North Sea at Seaton Sluice.

Brierdene Burn forms southwest of Backworth, flowing under the A19 north through rural land. It is joined by a number of small drains originating from Shiremoor and South Wellfield before flowing through Whitley Bay Golf Course and out into the North Sea.

Figure 1-1: North Tyneside SFRA Study Area



2. Consultation and Data Management

2.1 Consultation Process

To carry out an appropriate and comprehensive assessment of flood risk across North Tyneside, it is essential to collate and build upon the best available data and studies already carried out. This information has been used to form the foundation of the SFRA.

The Environment Agency Flood Map is the main source of fluvial and tidal flooding across England and Wales and is the basis of PPS25 Flood Zones. However, the SFRA must also consider flooding from all sources and this is only achievable through consulting with those stakeholders with specific interest or knowledge in other sources of flooding. This data collection process is a key part of the SFRA and has enabled this SFRA to be based on a significant amount of information that already exists on North Tyneside.

PPS25 outlines a number of key consultees to the planning process, which are discussed below and their involvement within the North Tyneside SFRA.

2.2 Key Stakeholders

2.2.1 North Tyneside Council

NTC were the main stakeholder for the preparation of this SFRA. They focused the scope of the SFRA and provided the detail needed for its production.

An initial SFRA meeting was held to discuss the requirements of PPS25 in producing a Level 1 SFRA and to determine the main tasks needed to be completed. The meeting also outlined the Council's own timetable relating to preparing an evidence base for their LDF process.

Correspondence has occurred since the initial meeting requesting information on historical flooding and work currently being prepared by their Emergency Planning Team in preparing a Flood Plan for the Council.

NTC supplied numerous datasets including:

- Growth Point and SHLAA data;
- Historical flood data;
- Ordinary Watercourse data; and
- OS MasterMap.

NTC Emergency Planning Team also provided excellent knowledge of current local and regional Flood Plans.

2.2.2 Environment Agency

The Environment Agency is a statutory consultee for RSSs, LDDs, Sustainability Appraisals and Strategic Environmental Assessments. They are also a statutory consultee for planning applications.

With regards to the North Tyneside SFRA, the Environment Agency has discretionary powers under the Water Resources Act (1991) to manage flood risk and, as a result, hold the majority of flood risk data in the UK. Separate departments were consulted from the External Relations Team including Development Control, Flood Mapping and Reservoir Safety Teams on the SFRA approach and available data. A full list of data provided by the Environment Agency is available in the Data Register discussed in Section 2.3 but the main themes can be summarised below:

- Tyne Catchment Flood Management Plans;
- Strategic flood risk mapping models;
- LIDAR data (Geomatics Group);

- Historical flood data; and
- Flood warning data.

The Environment Agency was also consulted on the draft version of the North Tyneside SFRA and their comments and guidance have been included within the final report. Revisions of the SFRA reports and general changes made can be found on page i within each Volume.

2.2.3 Highways Agency

All major roads and motorways have the potential to impact on flood risk. This is especially the case in an urban environment when roads can form potential flow routes or major structures such as bridges or culverts can significantly reduce the capacity of watercourses and therefore increase flood risk. Road networks that are at risk of flooding also have the potential for wider impacts reducing access and egress routes to and from sites which could increase the vulnerability of areas to flooding.

The Highways Agency was consulted on all know flood incidences on their road networks. The Highways Agency forwarded this request on to A-One who manage and maintain the trunk roads and motorway network in the north east of England on behalf of the Highways Agency.

2.2.4 Northumbrian Water

Local water authorities are identified as a key consultee within PPS25 as they are generally responsible for surface water drainage from developments. This SFRA should therefore take account any information they may hold on capacity issues or know historical flood incidences.

Sewers are a significant source of flooding especially within urban areas. Flood risk data that Northumbria Water (NWL) holds on the public sewer network are seen as critical in getting an understanding of flooding from all sources in North Tyneside.

The main source of information requested from NWL was a copy of their DG5 records, which was supplied as internal and external DG5 records at a strategic drainage area level.

NWL were also consulted on the draft copies of the SFRA report and Maps. Whilst accepting the methodology adopted, no formal comments have been made specifically on the report and maps, other than those made in SFRA meetings (see Appendix C). The final version of the SFRA report and maps have been finalised without specific agreement from NWL. Comments will not be included in the report if made after the final version released.

It is recommended that NTC continue to liaise with NWL. NWL are currently progressing on the preparation of the flood risk data sharing protocol for SFRAs, SWMPs and WCS across the North East. It will be critical to future NTC studies that this is put in place.

2.2.5 Tyne & Wear Fire & Rescue Service

Emergency services are a good source of historical flood data. For instance when the fire brigade are called out to flood related incidences, they keep a detailed registers of all call outs which includes the source of flooding and the action taken.

The Tyne and Wear Fire and Rescue Service (TWFRS) were extremely helpful in providing this information producing a database of over 300 flood related call outs dating back to January 2004.

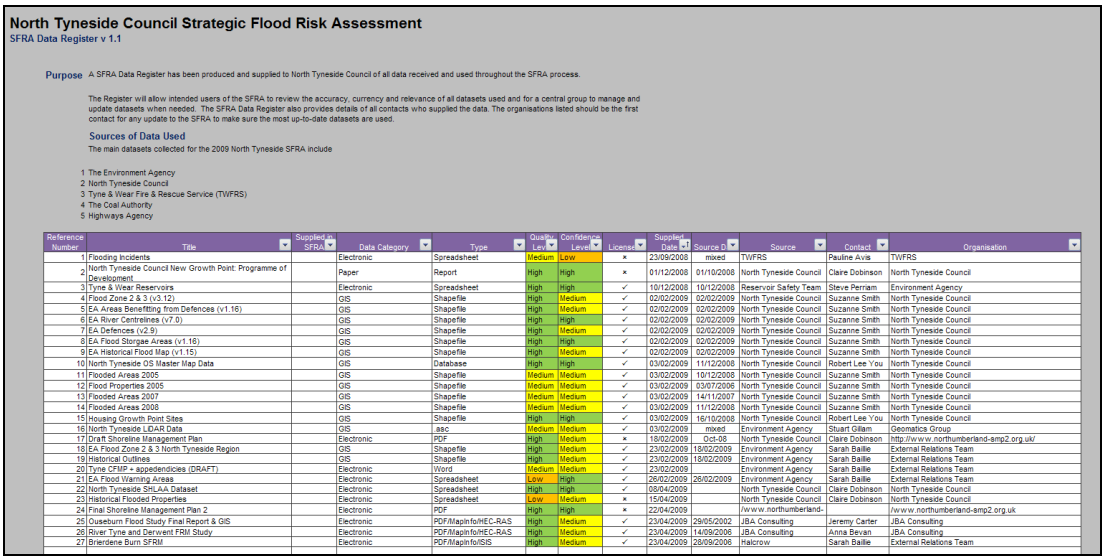
2.3 SFRA Data Management & Review

This SFRA should be viewed as a ‘living’ document which is anticipated to be used in the day-to-day process of planning and development.

Therefore it is important that datasets collected for the North Tyneside SFRA are transparent and accessible. A Data Register has been produced and supplied to NTC listing all data received throughout the SFRA process.

A screen shot of the register is shown below in Figure 2-1. A hard copy of the register has been provided in Appendix A of this report.

Figure 2-1: North Tyneside SFRA Data Register (Screenshot)



North Tyneside Council Strategic Flood Risk Assessment

SFRA Data Register v 1.1

Purpose A SFRA Data Register has been produced and supplied to North Tyneside Council of all data received and used throughout the SFRA process.

The Register will allow intended users of the SFRA to review the accuracy, currency and relevance of all datasets used and for a central group to manage and update datasets when needed. The SFRA Data Register also provides details of all contacts who supplied the data. The organisations listed should be the first contact for any update to the SFRA to make sure the most up-to-date datasets are used.

Sources of Data Used

The main datasets collected for the 2009 North Tyneside SFRA include

1 The Environment Agency
2 North Tyneside Council
3 Tyne & Wear Fire & Rescue Service (TWFRS)
4 The Coal Authority
5 Highways Agency

Reference Number	Title	Supplied to SFRA	Data Category	Type	Quality Level	Confidence Level	Licensed	Supplied Date	Source Date	Source	Contact	Organisation
1	Flooding Incidents		Electronic	Spreadsheet	Medium	Low	×	23/09/2008	mixed	TWFRS	Pauline Avis	TWFRS
2	North Tyneside Council New Growth Point: Programme of Development		Paper	Report	High	High	×	01/12/2008	01/10/2008	North Tyneside Council	Claire Dobinson	North Tyneside Council
3	Tyne & Wear Reservoirs		Electronic	Spreadsheet	High	High	✓	10/12/2008	10/12/2008	Reservoir Safety Team	Steve Perriam	Environment Agency
4	Flood Zone 2 & 3 (v3.12)		GIS	Shapefile	High	Medium	✓	02/02/2009	02/02/2009	North Tyneside Council	Suzanne Smith	North Tyneside Council
5	EA Areas Benefiting from Defences (v1.16)		GIS	Shapefile	High	Medium	✓	02/02/2009	02/02/2009	North Tyneside Council	Suzanne Smith	North Tyneside Council
6	EA River Centrelines (v7.0)		GIS	Shapefile	High	High	✓	02/02/2009	02/02/2009	North Tyneside Council	Suzanne Smith	North Tyneside Council
7	EA Defences (v2.9)		GIS	Shapefile	High	Medium	✓	02/02/2009	02/02/2009	North Tyneside Council	Suzanne Smith	North Tyneside Council
8	EA Flood Storgae Areas (v1.16)		GIS	Shapefile	High	High	✓	02/02/2009	02/02/2009	North Tyneside Council	Suzanne Smith	North Tyneside Council
9	EA Historical Flood Map (v1.15)		GIS	Shapefile	High	Medium	✓	02/02/2009	02/02/2009	North Tyneside Council	Suzanne Smith	North Tyneside Council
10	North Tyneside OS Master Map Data		GIS	Database	High	High	✓	03/02/2009	11/12/2008	North Tyneside Council	Robert Lee You	North Tyneside Council
11	Flooded Areas 2005		GIS	Shapefile	Medium	Medium	✓	03/02/2009	10/12/2008	North Tyneside Council	Suzanne Smith	North Tyneside Council
12	Flood Properties 2005		GIS	Shapefile	Medium	Medium	✓	03/02/2009	03/07/2006	North Tyneside Council	Suzanne Smith	North Tyneside Council
13	Flooded Areas 2007		GIS	Shapefile	Medium	Medium	✓	03/02/2009	14/11/2007	North Tyneside Council	Suzanne Smith	North Tyneside Council
14	Flooded Areas 2008		GIS	Shapefile	Medium	Medium	✓	03/02/2009	11/12/2008	North Tyneside Council	Suzanne Smith	North Tyneside Council
15	Housing Growth Point Sites		GIS	Shapefile	High	High	✓	03/02/2009	16/10/2008	North Tyneside Council	Robert Lee You	North Tyneside Council
16	North Tyneside LiDAR Data		GIS	.asc	Medium	Medium	✓	03/02/2009	mixed	Environment Agency	Stuart Gillam	Geomatics Group
17	Draft Shoreline Management Plan		Electronic	PDF	High	Medium	×	18/02/2009	Oct-08	North Tyneside Council	Claire Dobinson	http://www.northumberland-amp2.org.uk/
18	EA Flood Zone 2 & 3 North Tyneside Region		GIS	Shapefile	High	Medium	✓	23/02/2009	18/02/2009	Environment Agency	Sarah Baillie	External Relations Team
19	Historical Outlines		GIS	Shapefile	High	Medium	✓	23/02/2009	18/02/2009	Environment Agency	Sarah Baillie	External Relations Team
20	Tyne CFMP + appendenlcies (DRAFT)		Electronic	Word	Medium	Medium	✓	23/02/2009		Environment Agency	Sarah Baillie	External Relations Team
21	EA Flood Warning Areas		Electronic	Spreadsheet	Low	High	✓	26/02/2009	26/02/2009	Environment Agency	Sarah Baillie	External Relations Team
22	North Tyneside SRLAA Dataset		Electronic	Spreadsheet	High	High	✓	09/04/2009		North Tyneside Council	Claire Dobinson	North Tyneside Council
23	Historical Flooded Properties		Electronic	Spreadsheet	Low	Medium	×	15/04/2009		North Tyneside Council	Claire Dobinson	North Tyneside Council
24	Final Shoreline Management Plan 2		Electronic	PDF	High	High	×	22/04/2009		//www.northumberland-		//www.northumberland-amp2.org.uk
25	Ouseburn Flood Study Final Report & GIS		Electronic	PDF/MapInfo/HEC-RAS	High	Medium	✓	23/04/2009	29/05/2002	JBA Consulting	Jeremy Carter	JBA Consulting
26	River Tyne and Derwent FRM Study		Electronic	PDF/MapInfo/HEC-RAS	High	Medium	✓	23/04/2009	14/09/2006	JBA Consulting	Anna Bevan	JBA Consulting
27	Brierdene Burn SFRM		Electronic	PDF/MapInfo/ISIS	High	Medium	✓	23/04/2009	28/09/2006	Halcrow	Sarah Baillie	External Relations Team

All data was reviewed on receipt and its quality and confidence rated for use in the SFRA. This process was purely based on professional judgement on a high, medium and low scale.

Most data requested was quality and accurate as expected. Whilst the majority of the datasets could be mapped geographically (GIS) helping to visualise the risk of flooding others were not reducing its quality. Historical flooding information was generally marked as both medium quality and confidence, as whilst it could be placed on a map there was no detail behind it stating the source of flooding. The confidence in its precision was also questionable; however, this would always be expected in historical flood records.

The Data Register will allow intended users of the SFRA to review the accuracy, currency and relevance of all datasets used and for a central group to manage and update datasets when needed. The Data Register also provides details of all contacts who supplied the data. The organisations listed should be the first contact for any update to the SFRA to make sure the most up-to-date datasets are used.

This register will also allow for a control on the publication and release of SFRA data to third parties outside of the main stakeholders. Initially the SFRA report and associated maps should be published on the NTC website as the central source of SFRA data and available to download. However, if a third party requests additional data (i.e. GIS data, hydraulic models), they should be advised to contact the original supplier of the dataset directly as there maybe licensing issues involved. If data is supplied by NTC, this should be logged in the outgoing data section of the register.

2.4 SFRA Data Gaps

The next Section of this Volume, “Data Sources”, provides a review of all major flood risk information collected for the North Tyneside SFRA including:

- Environment Agency Flood Map
- NFCDD
- Hydraulic Modelling Studies
- Topographic data
- Historical Flooding Incidents.

During the data collection phase, it became apparent that there are some data gaps in flood risk information relevant to the North Tyneside SFRA. Whilst the majority key information was available for main sources of flooding in the study area, the most significant missing data highlighted in Volume II included.

- Detailed Sewer flooding information
- Comprehensive climate change outlines or data to create

2.5 SFRA Monitoring

Whilst this SFRA has been produced using the most up-to-date national guidance and flood risk data, it is recommended that the SFRA should be updated on a regular basis. The Environment Agency has suggested this be every 3 to 4 years, unless there is a significant flood affecting the area, arising to new information or areas at flood risk. A review of the SFRA should also be undertaken if there are any major national policy changes.

There are a number of key outputs from possible future studies and dataset which are known to be regularly updated. These should be incorporated in any update to the SFRA. Table 2-1 contains a list of SFRA review triggers.

Whilst all data collected and produced during the SFRA process has been supplied to NTC (report, maps, GIS, modelled output) there should be controls on its use. It is anticipated that the SFRA report (all volumes) and associated maps will be published on NTC website as PDFs as the central source of SFRA data and available to download.

NTC will be able to use any modelled output (depths, hazards and outlines) or GIS created during the SFRA for internal use. The use of this information must consider the context within which it was produced (i.e. strategic). NTC has not been supplied with any actually models supplied by the Environment Agency or created during the SFRA process, only the modelled outputs.

It should be remembered that any modelling undertaken for the SFRA is of a strategic nature and more detailed FRAs should seek to refine the understanding of flood risk from all sources to any particular site.

Any information produced on the back of data collected from the Environment Agency (hydraulic river models, flood zones) will fall under the license agreement between NTC and the Environment Agency. Any third party wishing to use these flood risk datasets should contact External Relations in the Environment Agency.

Table 2-1: SFRA Review Triggers

Trigger	Sources	Possible Timescale
Tyne CFMP	Environment Agency	Updated every 5 years
Northumberland & North Tyneside Shoreline Management Plan 2	Northumbria Coastal Authorities Group	2019 (ten years time)
Flood Zones	Environment Agency	Updated quarterly (significant change is not expected)
NFCDD	Environment Agency	Ongoing
Significant Flood Events	All	Unknown
Sewer Flood Data	Northumbrian Water	Unknown
Planning Policy	CLG	Unknown
Completion of SWMP/Drainage Strategy	North Tyneside Council	Unknown

3. Data Sources

3.1 Flood Zone Map

The Environment Agency Flood Zone Map provides an overview of areas considered susceptible to flood risk in the study area as a result of fluvial and tidal flooding. These maps have been prepared in a consistent manner across England and Wales and provide an estimation of the extent of flooding for both the 1 in 100 year (1%) and 1 in 1000 year (0.1%) events.

The Flood Zone maps were prepared using a methodology based on the national digital terrain model (NextMap), derived river flows (Flood Estimation Handbook (FEH)) and two dimensional flood routing.

The theoretically derived Flood Zone extents have been adjusted in some locations where the results are inconsistent with historical flooding extents, more detailed flood mapping studies are available or where there are known errors in the digital terrain model. In North Tyneside, the majority of fluvial and tidal Flood Zones have already been updated with the results of detailed flood mapping studies (see Section 3.3).

The Environment Agency Flood Zone Maps are precautionary in that they do not take account of flood defences because these can be breached, overtopped and may not be in existence for the lifetime of the development and, therefore, represent a worst-case extent of flooding. They do not consider other forms of flooding and do not take account of climate change.

PPS25 divides the country into three basic flood zones, Flood Zones 1, 2 and 3, corresponding to areas of low, medium and high flood risk, respectively.

3.1.1 Delineation of Low Risk Zone 1

PPS25 considers areas within Flood Zone 1 to be at low risk to flooding. The annual probability of flooding within this zone is less than 0.1% or can be easily defined as areas within the Council area located outside either Flood Zone 2 or 3.

3.1.2 Delineation of Medium Risk Zone 2

PPS25 considers areas within Flood Zone 2 to be at medium risk of flooding. The annual probability of fluvial flooding within this zone is between 0.1% and 1% (or between 0.5% and 0.1% for tidal flooding). In general, Flood Zone 2 is considered suitable for most development except highly vulnerable land uses where the Exception Test is required, such as police stations, fire stations and ambulance stations.

3.1.3 Delineation of High Risk Zone 3

PPS25 considers areas within Flood Zone 3 to be at high risk of flooding. PPS25 splits Flood Zone 3 into two sub-zones 3a and 3b, which correspond to high probability flooding and the functional floodplain.

- Flood Zone 3a: High Probability
    - In accordance with Table D.1 of PPS25 “This zone comprises land assessed as having between a 1% and 0.1% annual probability of flooding or between a 0.5% and 0.1% annual probability of sea flooding in any year.”
- Flood Zone 3b: The Functional Floodplain
    - In accordance with Table D.1 of PPS25 “This zone comprises land where water has to flow or be stored in times of flood”

3.1.4 Delineation of the Functional Floodplain

SFRAs are tasked with the responsibility of defining Flood Zone 3b. PPS25 suggests the 5% (1 in 20 years) flood event for the baseline of a functional floodplain however; a more extreme

probability can be used where appropriate, depending on catchment characteristics and on agreement between the LPA and the Environment Agency.

SFRAs can also identify where it might be appropriate to extend the 5% (or more extreme) flood outline to areas within Flood Zone 2 and 3 to restore or expand the functional floodplain. The ability to identify and safeguard large enough areas against redevelopment and development in both urban and rural areas, means that existing open space can potentially be used for flood storage, effectively reducing flood risk downstream. This process assists Flood Zone 3 policy aims, identified in table D.1 in PPS25, which include:

- "Reduce the overall level of flood risk in the area through the layout and form or the development and the appropriate application of sustainable drainage systems,"
- "Create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocation and safeguarding open space for flood storage."

The SFRA should be fully integrated with CFMPs and other Strategies that show, at catchment scale, the need to protect the floodplain and avoid inappropriate development in high flood risk areas.

3.2 Flood Defences

As discussed above the Environment Agency Flood Zones do not take account of the presence of flood defences. PPS25[2] states that defended areas (i.e. those areas that are protected to some degree against flooding by the presence of a formalised flood defence) are still at risk of flooding, and therefore sites within these areas must be assessed with respect to the adequacy of the defences.

The Environment Agency's National Flooding and Coastal Defence Database (NFCDD) has been supplied and provides information of existing defences in the area, as well as categorising them by type and providing information on who owns and maintains them. Areas Benefiting from Defences (ABDs) have also been provided. ABDs are those areas which benefit from formal flood defences in the event of flooding from rivers with a 1% chance in any given year or from the sea with a 0.5% chance in any given year. If the defences were not there, these areas would be subjected to increased flood risk.

3.3 Hydraulic Modelling Studies

Many of the main rivers throughout North Tyneside have been represented using detailed hydraulic models and the Flood Zones in these locations give a good representation of reality. However, there is no single comprehensive hydraulic model for each of the river systems within North Tyneside. Available hydraulic models from the Environment Agency include the:

1. River Tyne & Derwent FRM Study (2005)
2. River Tyne Estuary Model (2007)
3. Ouseburn Flood Study (2002)
4. Seaton Burn S105 Phase 1 Study (2001)
5. Brierdene Burn SFRM Study (2005)

Flood Zone on un-modelled reaches are still represent by the broad scale modelling techniques used in the original floodplain mapping studies and are therefore open to error.

3.3.1 Rivers Tyne & Derwent FRM Study

The River Tyne and Derwent study was undertaken by JBA Consulting in 2005 for the Environment Agency as part of the Section 105 Framework Agreement for Flood Risk Mapping. The sections of the River Tyne modelled include the mouth of the River Tyne downstream to Scotswood Bridge.

[2] Communities and Local Government (2006) Planning Policy Statement 25: Development and Flood Risk

A hydrological study was undertaken, and extreme fluvial flows were estimated using the FEH statistical method, with hydrograph shapes derived from event data. High frequency flows of less than QMED were estimated by cumulative frequency analysis of daily flow series extracted from over 20 years of data. Extreme tide levels were determined using the SRJPM method for estimating spatially consistent extreme tide levels around the UK coast that has become widely accepted for studies of this type. This method incorporates both astronomical high tides and the effects of North Sea surges. Tide levels of less than a 1-year return period were estimated by cumulative frequency analysis of over 10 years of peak tide data at North Shields.

The hydraulic modelling approach taken is 1D hydrodynamic, as backwater models cannot represent tidal reverse flow. The model was created in HEC-RAS 3.1.1 using a variety of topographic data sources including conventional cross-section survey, bathymetric survey in DEM form obtained from the Port of Tyne Authority, and spot level survey from aerial photogrammetry.

Design runs were required by the brief for the 100 year fluvial (1% AEP) and 200 year tidal (0.5% AEP) design events – those events which will be used to produce the IFM. Additional model runs were carried out for a range of return periods (10, 25, 50, 100 years), for the purposes of Level 2 mapping and determining the onset of flooding in areas of flood risk.

The impact of climate change was investigated using Defra guidance under the UKCIP02 scenarios. The climate change scenarios modelled as part of the study are provided in Table 3-1.

Table 3-1: River Tyne FRM Study Climate Change Scenarios

Climate Change Scenario	Fluvial Flows	Tidal Levels
100 year fluvial event plus climate change to 2054	100 year hydrograph increased by 20%	0.014 year tidal series increased by 0.2m
200 year tidal event plus climate change to 2054	Constant inflows at 0.014 year flow	200 year tidal series increased by 0.2m

3.3.2 Rivers Tyne Estuary Model

The original NE Region Tidal Flood Zone was produced by Atkins using either simple projection (for thin coastal zones) or a simple 2D hydrodynamic model for regions in which the tidal zone was expected to reach further inland. The previous 2D hydrodynamic modelling was carried out using HYDROF (an in-house Atkins product) at a model definition of 50m.

An estuary model of the River Tyne was produced for the North East Broad Scale Modelling Project[3] which JBA carried out for the Environment Agency to aid the production of CFMPs in the region. This was an improvement over the previous modelling by, firstly, using the now industry standard, TUFLOW fully hydrodynamic 2D modelling software and, secondly, increasing the model definition to 10m. The modelling was based on edited SAR (NEXTMAP) data.

The 1 in 200, 1 in 1000 and 1 in 200 plus climate change (up to 2050) scenarios (defended & undefended) were investigated and modelling extents and maximum depths were supplied as part of the project. The undefended 1 in 200 and 1 in 200 year plus climate change depth girds have been used within this SFRA to investigate the impacts of climate change on current risk. These outputs are discussed in SFRA Flood Risk Mapping section of this report.

3.3.3 Ouseburn Flood Study

JBA Consulting was commissioned by the Environment Agency in 2000 to update the 1995 Section 105 study of the Ouseburn Catchment. The main findings of the study were published in 2002.

Although the study investigated the entire main river reach of the Ouseburn and Harey Dene it also included non-main tributaries including Sunniside Drain the Kingston Park tributary, the

[3] JBA (2008) *Broad Scale Risk Modelling for CFMP's in NE Region*

un-named tributary through the City of Newcastle Golf Club, The Letch (Gosforth), Crag Hall Dene and the West Moor tributary, The Letch (Forest Hall), The Letch (Longbenton) which are located with NTC.

A range of 1D hydraulic models were created using HEC-RAS 3.0.1 for the study including three steady state models for the West Moor tributary and Forest Hall and Longbenton Letches.

A range of return periods were investigated including 2, 5, 10, 25, 50, 75, 100, 150 and 200 years events and the possible effects of climate change. Climate change was investigated for the next 50 years by adding an additional 20% on to the 100 year event.

The study concluded that:

- Longbenton Letch had a Standard of Protection (SoP) of 1 in 2 years and 1 in 75 years whilst flooding 4 properties
- Forest Hall Letch had a SoP of between 1 in 2 to 1 in 25 years with around 92 properties at risk along its length

3.3.4 Seaton Burn S105 Phase 1 Study

Seaton Burn and its tributary Sandy's Letch were investigated by JBA Consulting in 2001 as part of the Environment Agency Section 105 study.

The study was based largely on information from the Environment Agency archives and databases, supplemented by detailed site visits to walk the watercourse and catchment. A survey of residents was also undertaken to establish any flooding problems but with a very poor response.

Extensive use was made of a Geographical Information System (GIS) to collate and verify data. Data sets contained in this system include photographs and notes from the JBA site walk-over survey, OS digital mapping at various scales, Digital Elevation Data (OS Profile), the Environment Agency's Indicative Floodplain Maps (IFM 2000), sewer records (from NWL), historic OS Maps (from Cramlington Library) and data from the FEH CD-ROM.

FEH Statistical method was used to estimate peak flows for the Seaton Burn catchment. Flood estimates for a range of return periods were calculated including 2, 5, 10, 25, 50, 75 and 100 years were calculated. The impact of climate change was not investigated.

The capacity of the channel was then calculated to adjust the 1 in 100 year outline.

3.3.5 Brierdene Burn SFRM Study

To improve flood risk information in the Brierdene Burn catchment, Halcrow was commissioned by the Environment Agency in 2004 to carry out a detailed study as part of the Strategic Flood Risk Mapping programme. Work on the project started in February 2005 and the findings published in September 2006.

The study involved "detailed hydrologic and hydraulic modelling of the catchment and the production of flood risk outlines in GIS format for input to the Agency's National Flood and Coastal Defence Database (NFCDD) for a number of design events and also for updating the Agency's Flood Zone maps.[4]"

Hydrology was calculated for a range of return periods including 2, 5, 10, 25, 50, 75 and 100 year events. The 1 in 1000 year peak flows were also calculated. The effect of climate change was assessed against the 1 in 100 year fluvial event by increasing peak flows by 20%.

A 1D hydraulic model was constructed in ISIS (version 2.4) which was based upon a survey undertaken by Halcrow in February 2005. Flood outlines were generated for the following events:

- 2, 5, 10, 25, 50, 100 and 1000 year events

[4] Environment Agency (2006) *Brierdene Burn Flood Mapping Study Final Modelling Report*

- 1000 year tidal events
- 100 year fluvial events without the Backworth FSA

The main findings of the investigation show that:

- "The maximum water levels stay in-bank for the entire range of fluvial events from 2 to 1000 years for a substantial portion of the river length. 50%, to 0.1% Annual Exceedance Probability (AEP).
- The most significant flood prone areas are the left bank floodplain of the water body called "Lake" (NZ 30972 72606), the left bank floodplain upstream of the road A192 (NZ 32166 73109) and the right bank of the Weltfield drains upstream of the confluence with the Brierdene Burn (NZ 32820 73352).
- Tidal flooding is only restricted to the coastal area with marginal influence in the fluvial system.[5]"

3.4 Topographic Data

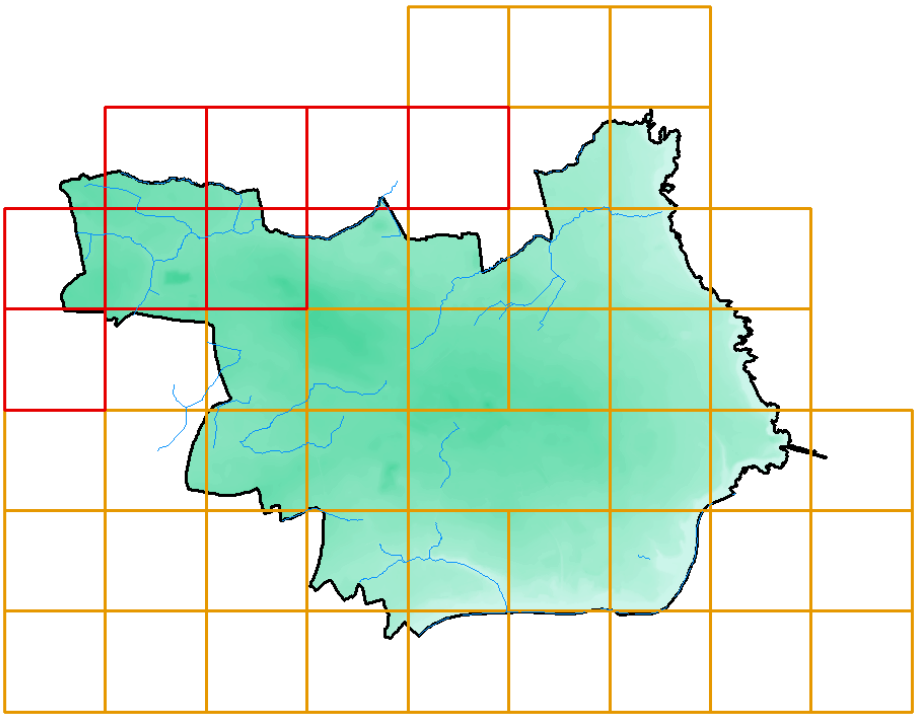
The essential dataset required for flood modelling and mapping is a Digital Elevation Model (DEM). There are three main sources of DEM data for Havering, as shown in Table 3-2.

Table 3-2: DEM availability

Data type	Owner	Resolution	Filtering	Date Flown
Nextmap SAR	Environment Agency	5m	Filtered	-
LIDAR	Environment Agency	2m	Filtered & unfiltered	1998, 2000 & 2005
LIDAR	Environment Agency	1m	Filtered & unfiltered	2007

LIDAR will be used in preference to Nextmap SAR data as it has a higher vertical accuracy. The coverage of the LIDAR datasets available is shown in Figure 3-1. It will be necessary to use both the Environment Agency and JBA LIDAR to obtain full coverage of the catchment.

Figure 3-1: LIDAR Coverage in North Tyneside



[5] Environment Agency (2006) Brierdene Burn Flood Mapping Study Final Modelling Report

Environment Agency LIDAR datasets coverage North Tyneside is shown by red (1m) & orange (2m) tiles. JBA NextMap dataset is shown in green.

3.5 Historical Flooding

There are a number of information sources of historical flood information. The majority of historical data collected was received from key stakeholders during the SFRA consultation process or by reviewing past flood studies in the area.

The Rivers Tyne and Derwent FMS provided a comprehensive list of historical flood events on the River Tyne taken from extensive research carried out by Archer (1992)[6]. There is a large history of flooding on the River Tyne which spans back to medieval times; however, reports are focused on sites and ship yards around Newcastle. The regular flooding of these tidal riverside areas ended with the commencement of extensive dredging in the mid-1850s, which moved the tidal limit further upstream to Wylam.

The increased volume of the channel can convey very large fluvial flows, and control on the water level in the whole estuary is now dominated by the tide. The dredging of the tidal reach of the Tyne, and impoundment of reservoirs upstream, means the disasters of the past are less likely.

However, the knowledge of past flooding should not be disregarded or forgotten. Dredging upstream of the Newcastle bridges was discontinued in the late 1960s, and natural siltation is occurring, albeit very slowly. Archer (1992) suggests that in the future, "…perhaps after a century, one might expect a return to the flood vulnerability of the early nineteenth century".

There is little evidence of flooding on smaller watercourses with North Tyneside with the majority of historical events pointed towards surface water flooding rather than fluvial or tidal.

All historical flood data collected has been collated in one Flooding Incident Register and has been supplied to NTC as part of the SFRA. The register identifies:

- Event data
- Location
- District
- Easting & Northing
- Recorded date
- Source of flooding
- Impact of flooding
- Number of properties affected
- Data Source

Key historical flood datasets collected are identified below.

3.5.1 Environment Agency

The Environment Agency is a key source of all flood risk information in England and Wales. As part of the Flood Map, the Environment Agency provides a national historical flood map layer. This shows the extent of major flood incidences. Those identified in North Tyneside include:

- Wheatfield Grove – Properties flooded on low lying ground along line of culvert and surface water drains 30th June 2007
- Hailsham Avenue – 30th June 2007
- A189 Roundabout – 6th September 2008
- Earsdon – Flooded fields due to poor drainage to Wellfield Beck 10th July 2008

[6] Archer, D. (1992) Land of Singing Waters: Rivers and Great Floods of Northumbrian. The Spodden Press

3.5.2 North Tyneside Council (NTC)

Local Authorities are a great source of historical flood information. NTC provided GIS datasets of properties flooded in 2005 (598 properties), 2007 (74 properties) and 2008 (171 properties). Some of the same properties flooded in multiple events, however it does not show the source or severity of the flooding rather than it was just flooded. The data represents surveys of flooding done by Traffic, Dev - Engineering, Design and Partnering. NTC also provided a GIS layer of general flooded areas within the same events.

The data was included within the PPS25 Flood Zone, Areas Susceptible to Surface Water Flooding and proposed CDA Maps provided within this SFRA as a valuable source of real life validation. It shows an excellent relationship with the surface water flow routes outside of the Environment Agency Flood Map confirming the high risk of surface water flooding in North Tyneside.

3.5.3 Northumbrian Water (NWL)

NWL provided both internal and external DG5 records at a strategic drainage area level. This data can be used to identify areas which have a recorded of historically flooded properties from the drainage network (See Section 4.5).

3.5.4 Tyne and Wear Fire and Rescue Service (TWFRS)

The TWFRS provide has provided a geo-referenced data in spreadsheet format of over 300 flood related callouts since January 2004. These have also been mapped along with all other historical data collected.

4. Flood Risk in North Tyneside

4.1 Introduction

There is a need to understand the risk of flooding from all sources in North Tyneside, consider where the most at risk locations are, and plan future development and regeneration accordingly.

This section assesses flood risk in North Tyneside from all sources, now and in the future. It makes use of all the data and information described in Section 3. It includes providing the tidal and fluvial Flood Zones and assesses flood risk from other sources, with the aim of providing enough information for NTC to perform the Sequential Test.

The major watercourse in North Tyneside is the River Tyne which originates outside of its administrative boundary. However smaller watercourses such as Seaton Burn or the tributaries to the Ouseburn originate within North Tyneside and flow into neighbouring Councils. Whilst it is unlikely that land use change on the River Tyne will have significant impacts on its tidal stretch at North Tyneside, major land use change surrounding smaller watercourses could have localised impact on river flows and significantly effect flood risk downstream.

This highlights the need for the NTC and the Environment Agency to work together on flooding problems, particularly where actions could exacerbate flooding in downstream communities. Managing the network of tributaries is also complicated, but is important, as they could also increase flooding problems in downstream areas.

4.2 Tidal Flood Risk

Tidal flooding is flooding caused by extreme tide levels exceeding ground levels. In the case of North Tyneside this means extreme tide levels in the River Tyne estuary caused by high tides or storm surges in the North Sea.

Flooding that occurs in estuaries can be complex and difficult to predict because it is influenced not just by the volume of fresh water travelling down the estuary from the river system, but also by the height of tides and tidal surges coming up the estuary.

Extreme tidal levels were calculated in the Rivers Tyne and Derwent FRM study in 2005 for the years 1990 and 2004. Estimates are provided below.

Table 4-1: Extreme tidal level estimates for North Shields[7]

Return Periods (yrs)	1	10	25	50	100	200	250	500	1000
Level (1990) mAOD	3.20	3.53	3.68	3.77	3.92	3.98	4.06	4.13	4.23
Level (2004) mAOD	3.23	3.56	3.71	3.80	3.94	4.01	4.09	4.16	4.27

Tidal and coastal flood risk zones have been provided on map 2009s0059-D01 to D06 and are discussed further in Section 5.2.

4.2.1 River Tyne

Most of the dockside areas of Wallsend Shipyard are at risk from flooding at the 1 in 25 year to 1 in 50 year tidal events, although there maybe limited overtopping at the 1 in 10 year return period. Many of the dry docks are at risk by the 1 in 25 year return period. By their nature they are at low level and, as far as can be concluded from the LIDAR and spot heights, their gates are also below the flood levels. Obviously the actual extent of the flooding within the dry docks will depend on the height of the gates as these controls the volume of water

[7] Environment Agency (2005) *Rivers Tyne and Derwent Flood Risk Mapping Study*

that will get in, and also on surface waves, which may be as high as 0.63 m above still water level.

Further downstream, flooding is expected at the western end of Amec Yard, at Willington Quay which begins to flood at the 1 in 10 year event and extents increase with return periods. However no properties are currently at risk. The Willington Boat Club, nearby commercial properties and their access road are very low-lying and expected to flood at the 1 in 10 year flood level or lower. The outlines then increase in extent with increasing return period, with depths at the 1 in 200 year return period of up to 0.8 m.

The Gas Works at Shields Harbour is at risk from overtopping of the quays during the 1 in 25 year tidal flood event and above.

Figure 4-1: Willington Quay[8]

According to the Rivers Tyne and Derwent FRM Study, *"Riverside roads and many properties along the left bank at North Shields are at low elevations. Much of the Fish Quay area is below the 10-year tide level, although parts of it, such as Union Quay, are protected by slightly higher bank levels. At the 25-year level, the car park along the Western Quay, Bell Street, the shops along Union Quay, the roads and buildings surrounding Cliffords Fort, the Fish Market and the Lifeboat Station are all at risk. Depths and likelihood of property flooding increase up to the 200-year return period, when depths could be up to 1m around the Fish Market."*

4.2.2 Coastal Flood Risk

The North Tyneside coastline covers a length of 15km from Seaton Sluice to Fish Quay north of the River Tyne estuary. The coastline is a mix between cliff frontage to the north, a number of bays and sea walls from Whitley Bay to Tynemouth North Pier and heavily defended concrete masonry walls around Fish Quay.

Due to the nature of the coastline, tidal flood risk is relatively small. Both Flood Zone 2 and 3a follow the Mean High Water (MHW) line, placing no properties at risk.

Flood Risk is heavily dependent on the presence of sea defences as discussed later in this chapter.

[8] Environment Agency (2005) Rivers Tyne and Derwent Flood Risk Mapping Study

Figure 4-2: North Tyneside Coastline[9]

4.3 Fluvial Flood Risk

North Tyneside contains around 14km 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 the local authority, who have Permissive Power to carryout works should this be deemed necessary.

The key watercourses in North Tyneside include:

- Brierdene Burn
- Forest Hall Letch (tributary to Ouseburn)
- Longbenton Letch (tributary to Ouseburn)
- Redburn Dene
- River Tyne (tidal)
- Seaton Burn
- Sandy's Letch (tributary to Seaton Burn)
- Wallsend Burn (Willington Gut)

In addition to fluvial flood risk problems, there are combined tidal/fluvial issues with the lower reaches of Willington Gut and the downstream extent of Brierdene Burn. The River Tyne throughout North Tyneside is tidal as discussed previously.

Both Forest Hall and Longbenton Letch are former Critical Ordinary Watercourses (COWS). The former designation reflected a known issue with respect to flooding, and is generally associated with (for example) limited channel capacity, channel constrictions and/or a poor maintenance regime. In 2006/7 the Environment Agency enmained all the remaining COWs

[9] Source: http://www.northtyneside.gov.uk/pls/portal/NTC_PSCM.PSCM_Web.download?p_ID=506457

and took over responsibility for their maintenance and management. All the previous COWs are now defined as 'Main Rivers'. Fluvial flood risk zones have been provided in map 2009s0059-D01 to D06 and are discussed further in Section 5.2.

4.3.1 Brierdene Burn

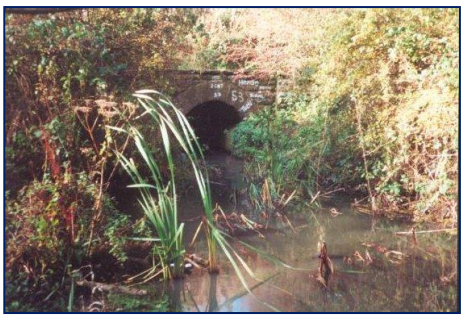
Brierdene Burn is located in the north east of North Tyneside north of Whitley Bay. It has a catchment area of 19.93km². Both Flood Zone 2 and 3 were updated in 2005 as part of the Brierdene Burn Strategic Flood Risk Mapping Study undertaken by Halcrow. It concluded that the maximum water level obtained from their modelling exercise stayed in-bank for an entire range of fluvial events from 1 in 2 to 1 in 1000 years for a substantial potion of the river length.

It was identified that the main areas prone to flooding included the left bank floodplain of the water body called "Lake" (West Holywell), the left bank floodplain upstream of the A192 and the right bank of the Wellfield drains.

The extents of Flood Zones around Wellfield are unusually as they seem to stop suddenly without any topographical reason. Investigating this further, it is presumed that this is the chosen model extent at the confluence of two drains which results in an unnatural Flood Zone extent. According to the 2005 study by Halcrow these drains had been surveyed so it is unsure why this location was chosen instead of extending the model further upstream towards the urban boundary. There is no obvious reason why this could not be done if the model is revisited, however the possible resulting extension in the Flood Zone will place no further or proposed development at risk so is not a high priority to correct.

4.3.2 Seaton Burn & Sandy's Letch

The Seaton Burn catchment is located approximately 10km north of Newcastle upon Tyne and lies adjacent to the Tyneside conurbation. The catchment is elongate with Seaton Burn running roughly west to east, from Dinnington to Seaton Sluice draining an area of 49km².



Concentrating on the study area, the catchment includes the settlements of Seaton Burn and Dudley before entering Northumberland. Downstream of Holywell, Seaton Burn returns to North Tyneside forming its northern boundary then entering the North Sea at Seaton Sluice. Seaton Burn has two Major tributaries upstream of Fordley; Hartley Burn and Sandy's Letch, which forms part of North Tyneside's District Boundary with Northumberland.

Environment Agency Flood Zone 3 was derived as part of the S105 study by JBA in 2001, whilst Flood Zone 2 is still defined by generalised JFLOW modelling. The updated Flood Zone 3 outline is an improvement of the Environment Agency's Indicative Floodplain Map (IFM) however no model was created. The study removed all 424 properties at risk from the original IFM outline.

There are a number of critical structures including bridges and culverts which could potentially increase flood risk if blocked. A small amount of blockage will not result in flooding, but there are a number of houses on either side of the watercourse which are below culvert overflow level.

Sandy's Letch receives some surface water from the South Cramlington industrial development area and it is assumed some attenuation has been incorporated in these plans. However, the culvert beneath Dudley Middle School Playing Fields is a restriction to flow.

4.3.3 Wallsend Burn

Wallsend Burn (and Wallsend Dene) is a small tributary to the River Tyne flowing through Wallsend and discharging into the Tyne at Point Pleasant. Both Flood Zone 2 and 3 are still defined by generalised JFLOW modelling and therefore have not been specifically modelled in detail.

Upstream of the Metro Line both flood zones are constrained as the watercourse flows through playing fields and allotment gardens. Downstream of the Metro Line Flood Zone 2 is extensive and covers a number of work buildings. Without a detailed model both zones should be considered indicative and the affect of tidal locking is unknown.

4.3.4 Forest Hall Letch

Forest Hall and Longbenton Letch are Former Critical Ordinary Watercourses (COWS) and are main tributaries to the Ouseburn in Newcastle. The two watercourses have been integrated into the urban environment and are culverted for long stretches.

Flood Zone 2 and 3 was updated in 2002.

Forest Hall Letch flows adjacent to residential developments, but poses little significant risk of flooding, apart from parts of playing fields. Along Willowdene properties on the right bank are vulnerable at the 1 in 25 year flood event.

Downstream of Willow Dene Road Bridge residential property gardens and allotment gardens are at risk. From the Woodlea culvert exit to the railway all the properties on either side of the watercourse are at risk as well as Glebe Road. At Benton Lane the Letch enters a long culvert leading to the Ouseburn at the Metro Bridge.

4.3.5 Longbenton Letch

Most of the Longbenton Letch through Longbenton flows through gardens which are vulnerable to flooding at high flows but houses are likely to remain above the 1 in 100 year flood level. Across Station Road in St Bartholomew's Cemetery the access bridge in the centre of the Cemetery is a pinch point which can cause backwater and overbank flow into the Cemetery.

Downstream of the bridge, The Letch enters a long culvert that eventually leads to the Ouseburn. According to the flood risk mapping study of the Ouseburn capacity of the culvert is sufficient to contain the 1 in 100 year flow but there is a high risk of blockage at the culvert screen which could cause overbank flow into lower lying properties in Goathland Avenue to the west.

However, NWL have stated that the 42 inch culvert is under capacity (see Appendix C) and is known the cause flooding further upstream around Mead Way and Granville Drive.

The key issues with both tributaries is that they are urban in form and the effect of litter, leaves, twigs and other detritus collecting in the channel could poses a significant blockage risk to culverts.

The surrounding area of Benton has also been identified at high risk of surface water flooding, flooding from the underlying drainage system and watercourses. There is significant interaction between all three sources increase the risk of flooding in this area.

4.4 Flooding from Land

Surface water flooding has been assessed within this Level 1 SFRA using the Environment Agency national surface water map. Historical flood records have also provided an indication of flood risk areas outside of the immediate Flood Zones of watercourses, which could be attributed to surface water.

These data sources have been provided in map 2009s0059-D11 to D16 and are discussed further in Section 5.6.

The national surface water map typically show less susceptible areas on tributaries and feeder streams to Main Rivers, where steeper sloping valleys exist and on the edge of the natural floodplain of Main Rivers, again where land levels tend to rise more steeply. The more susceptible areas are predominantly in valley bottoms, in the Main River floodplain or on low lying Greenfield land. From the maps it can be seen that there are many areas of land outside Flood Zone 3, that are susceptible to surface water flooding and this needs to be considered as an integral part of the assessment.

There is an excellent correlation between areas identified as susceptible to surface water flooding using the Environment Agency dataset and historically flooded properties collected. This is especially noticeable around West Monkseaton, Killingworth and Forest Hall.

Key areas susceptible to surface water flooding include:

- Meadow Field;
- Nelson Road, South Wellfield;
- Otterburn Avenue, South Wellfield;
- North Ride, Whitley Bay;
- Fairfield Green, West Monkseaton; and
- Churchill Avenue, West Monkseaton.
- Camperdown, Killingworth;
- Killingworth;
- Killingworth Moor, Killingworth;
- Forest Hall, Killingworth;
- Longbenton;
- Balliol Business Park, Longbenton; and
- Gosforth Business Park, Longbenton.

4.5 Flooding from Sewers

Northumbrian Water (NWL) provided internal and external DG5 records at a strategic drainage area level. Table 4-2 provides an overview of DG5 records in North Tyneside aggregated to NWL drainage areas. Drainage areas have also been attributed with a flood risk rating.

The categories, suggested by NWL, listed below have been used for this rating:

- Low Risk < 10 properties on internal register
- Medium Risk < 10 properties on internal register and some on external register
- High Risk > 10 properties on internal register and some on external register

NWL drainage areas have been mapped according to their risk rating in Map 2009s0059-D017. This maps and their use/interpretation are further discussed in Section 5.8. It must be noted that DG5 records are only a snap shot in history of those current properties on the register at the time supplied. Properties may have been removed since.

Table 4-2: NWL DG5 Register Overview

Drainage Area	Internal				External				Risk Rating
	2 in 10	1 in 10	1 in 20	Total	2 in 10	1 in 10	1 in 20	Total	
Benton	32	34	6	72	11	4	21	36	High
Brierdene	32	1	4	37	8	8	1	17	High
Chirton	0	9	11	20	0	1	7	8	High
Cullercoats	10	3	7	20	11	3	1	15	High
North Shields	1	1	1	3	0	0	1	1	Med
Royal Quays	0	0	0	0	0	0	0	0	No Risk
Seaton Valley	9	6	0	15	5	3	1	9	High
Tynemouth	28	0	0	28	16	2	0	18	High
Wallsend	4	2	1	7	0	0	0	0	Low
Whitley Bay	18	12	11	41	8	5	11	24	High
Whitley Lodge	0	0	0	0	0	0	0	0	No Risk
Willington Quay	4	0	0	4	2	1	1	4	Med

NWL also provided NTC with a summary of flooding projects within the North Tyneside area. These projects primarily focus on surface water flooding issues but there are some watercourse issues being dealt with including working being carried out on Longbenton Letch as the watercourse feeds into a Combined Sewer Overflow (CSO). These projects include:

- **Preston Village, North Shields Flooding** - Construction is expected to commence on the 18th May 2009, for the excavation of a tank and mobilisation of compound/cabins to the North Shields RFC first team pitch.
- **Grey Street, North Shields Flooding** - This project is currently at a detailed design stage. It is proposed that the current system along Jackson Street is replaced by a smaller diameter carrier sewer (750mm at a 3m depth). All storage sewers are now in Grey Street as this is a much wider street and therefore creates less structural risk to the surrounding properties.
- **Prudhoe Street, North Shields Flooding** - This project is currently at a detailed design stage. Additional trail pit investigations undertaken to the north side of Prudhoe Street on two locations on the existing 150mm sewer. Provisional start date of construction was the 1st September 2009 with a 6 week construction period.
- **Longbenton Flooding** - Northumbrian Water has untaken a number of studies including flow, water quality, CCTV survey and ecological survey in the area. They have built an unverified sewer model and reviewed ISIS and HEC-RAS models provide by the Environment Agency.
- **Whitley Bay Flooding** - Sewer improvements have been carried out on Gerrard Street and Gerrard Road. Improvements are planned on Brierdene Road and Gorsedale Road.
- **West Allotment Flooding**

According to the NWL website, NWL are also to begin sewer improvements in Monkseaton where flooding to 40 properties has occurred during times of heavy rainfall. This is related to the amount of water entering the sewerage network. Northumbrian Water are planning on,

"Investing £2.5 million to upgrade 1.2 kilometres of sewer pipe and install a tank to store more water during heavy rainfall. Work to upgrade 800 metres of sewer pipe in the Brierdene area, which will protect 21 properties from flooding, is underway and will be complete by June 2009. The work in Monkseaton will begin in June 2009 and take up to five months. This will reduce the risk of flooding to19 properties in Fairfield Green, Eastward Green, St Ronans Road, Kensington Close, Marmion Terrace and Waverley Avenue. In the Fairfield Green and St Ronans Road areas, 560metres of sewer pipe will be improved and a 742,000 litre storage tank will be built inland east of Marmion Terrace."[10]

4.5.1 NWL Consultation

On completion of a draft version of this SFRA, a meeting was held on the 15/10/2009 between NTC and NWL to discuss flood risk within the council area and the findings of this SFRA. The Environment Agency was also invited but due to timetable issues could not attend. A brief copy of the meeting notes are provided in Appendix C for reference. Issues discussed in the meeting involved:

- Data sharing of NWL information
- Flooding within NTC
- Flood Risk Management

One of the main outcomes of the meeting was a review of flood risk known to NWL within North Tyneside. Two key areas discussed included Whitley Bay and the area of Benton surrounding the two Letches. NWL were extremely helpful in identifying the key flooding hotspots and highlighting the root cause of the problem. Issues included:

1. **Whitley Bay** – NWL agreed with the Environment Agency national Areas Susceptible to Surface Water Flooding map and historically flooded properties identified in this area. NWL accounted this risk to strong surface water flow paths flowing into the residential area from Greenfield land to the west. A number of culverts at the edge of the fields also exacerbate the issue. Due to these issues NWL stated that Denton Growth Point site will find it difficult to proceed as it is located upstream of Whitley Bay which has a strong history of surface water/drainage flooding. Whilst the information collected in this SFRA has identified the history of flooding to Whitley Bay, NWL have carried out a number of improvement schemes in the area, removing the risk of sewer flooding (see schemes listed above). However, there could still potentially be a risk of surface water flooding from neighbouring field or if the sewer system becomes overwhelmed during intense rainfall events.
2. **Benton** – The area of Benton has the highest risk of flooding according to NWL, confirming the data collected in this SFRA. The cause of flooding in this area is due to the interaction between a number of sources. Benton is at risk from surface water as indentified in Environment Agency national Areas Susceptible to Surface Water Flooding map which was validated by historically flooded properties collected. NWL also have a high number of properties on their DG5 register. Flooding also occurs from Forest Hall and Longbenton Letch. This is a combination of both fluvial flooding as well as surface water drainage. Flood risk along Longbenton Letch is exacerbated further as it enters a 42 inch culvert at the edge of the cemetery before travelling underneath the neighbouring residential area. The culvert is known to be under capacity resulting in flooding to properties along Granville Drive and Mead Way. NWL have already acknowledged this issue and are at the phase of considering available options. As flood risk is a result of a number of sources combining, a SWMP could be beneficial. Large developments have also been identified in this area by NTC which find it difficult to progress until flood risk is reduced.

[10] Northumbrian Water (2009) Property Protection, found at http://www.nwl.co.uk/newsreleases_8880.aspx [12/05/2009]

4.6 Critical Drainage Areas

The correlation between clusters of historically flooded properties and large surface water zones are a good indication of key flooding hotspots known as Critical Flood Areas (CFA). CFA can help identify Critical Drainage Areas (CDA), which are identified as the contributing catchments upstream of CFA.

CDAs were initially proposed in the North Tyneside area by combining NWL drainage areas at high risk of flooding (see Table 4-2) and their contributing natural catchments. Natural catchments were derived from the FEH CD-ROM. There are some overlaps between different natural catchments identified and NWL drainage areas; however this shows the presence of hydraulic linkages between the two catchments.

Proposed CDAs included:

1. **Benton**
2. **Brierdene**
3. **Whitley Bay**

CDAs were sent to NTC, the Environment Agency and NWL for comments and acceptance. Whilst NTC and the Environment Agency provided these and accepted their location, NWL have not provided any further comments. The decision was therefore made to accept that areas identified above as final CDAs for North Tyneside. If NTC carry out a Level 2 SFRA or SWMP these areas should provide a focus for an initial screening study, in which NWL must be consulted.

CDAs have been provided on map 2009s0059-D018. This map and their intended use/interpretation are further discussed in Section 5.8. Final CDAs have also been used within Section 7.3 to identify the requirement for FRAs, Drainage Impact Assessments (DIAs) and high Level Surface Water Management Plans (SWMPs)

4.7 Flooding from Groundwater

There are no flood defences along the River Tyne through North Tyneside to elevate the river level above the floodplain; it is therefore unlikely that alluvial groundwater flooding will occur. Tides are the main control on the River Tyne and this will also limit the possibility of groundwater flooding as the diurnal tide duration means that it is unlikely that there will be a period of extended high in bank river levels. However there is the small possibility that multi peak events could sustain a high in bank river level for up to twelve hours. Overall the risk of alluvial groundwater flooding is small for a river of this size.

Other rivers in the North Tyneside area, such as Seaton Burn and Brierdene Burn, are smaller with narrow floodplains. Floodplains surrounding smaller rivers are less prone to groundwater flooding as the rivers tend to be of a flashier nature and are less likely to have extended periods of high in-bank river levels.

It is recommended that the risk of groundwater flooding be investigated at a site-specific FRA level.

4.8 Flooding from Reservoirs & other Artificial Sources

According to the Environment Agency's Register of Reservoirs, there are no 'large raised reservoirs' directly located within the boundaries of North Tyneside or surrounding Councils. Whilst large reservoirs provide the obvious source of residual risk from artificial sources, there could potentially be a number of smaller water bodies within the area. These could provide a greater risk as they are potentially ownership issues and are not regularly inspected. Whilst these have not been picked up within this SFRA, FRAs should assess the residual risk associated with them if they are located within the vicinity of the development.

4.9 Effects of Climate Change

Peak tidal levels from a range of return periods were extracted from the 2005 River Tyne model provided below. Table B.1 of PPS25 gives recommended contingencies for net sea level rise up to 2115.

The 2005 levels were extrapolated using the Defra guidance provided in PPS25 to 2009, 2050 and 2100.

Table 4-3: Effect of sea level rise on water levels in the Tyne Estuary

Return Period	Tidal Levels (mAOD)			
	2005	2009	2050	2100
1 in 10 years	3.56	3.57	3.79	4.37
1 in 25 years	3.71	3.72	3.94	4.52
1 in 50 years	3.80	3.81	4.03	4.61
1 in 100 years	3.94	3.95	4.17	4.75
1 in 200 years	4.01	4.02	4.24	4.82
1 in 1000 years	4.27	4.28	4.50	5.08

Note: 2005 levels were obtained from Tyne & Derwent HEC-RAS model (2005). Climate change levels calculated using values from Table B.1 of PPS25 as a basic assessment of the potential effect of climate change.

UKCIP02 scenarios also suggest that winters will become wetter over the whole of England, by as much as 20% by the 2050s. A shift in the seasonal pattern of rainfall is also expected, with summers and autumn becoming much drier than at present. Snowfall amounts will decrease significantly throughout the UK, but the number of rain-days and the average intensity of rainfall are expected to increase.

UKIP09 research has recently been published however, its recommendations have not been transferred to guidance or more specifically sensitivity ranges within flood risk modelling. Until, new scenarios are provided to take account of climate change within flood risk modelling, the current ranges should be used.

Rainfall intensity and the increase in the number of rain-days could have significant implications for surface water flooding and should be considered when designing drainage systems for new developments.

Peak flow increase by around 20% over the next 50 years will translate into higher water levels. In North Tyneside, the extent of flooding does not increase significantly along most of the watercourses, as can be seen in the current difference between flood Zone 3 and 2. The hazard to people associated with higher depths and velocities will however increase.

Increases in sea level also have an impact on fluvial flooding. It is probable that there will be an increase in the instances of fluvial flooding occurring on Willington Gut and the downstream extent of Brierdene Burn as a result of prolonged tide locking.

Table B.2 Recommended national precautionary sensitivity ranges for peak rainfall intensities, peak river flows, offshore wind speeds and wave heights.

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	+5%	+10%	+20%	+30%
Peak river flow	+10%	+20%		
Offshore wind speed	+5%		+10%	
Extreme wave height	+5%		+10%	

4.10 Geology & Soils

The geology and soils of North Tyneside were investigated using a strategic scale (1:250,000) map available from the National Soil Research Institute and can be viewed at: **http://www.landis.org.uk/soilscapes/**

According to the soils map the northern section of North Tyneside is covered by grass and arable land. This is slowly permeable seasonally wet clay soils which will impede natural drainage. However the southern and coastal areas are heavily urbanised and it is difficult to investigate soils at such a high level.

Unfortunately the scale of this data makes it not particularly reliable at a local level; therefore it should be used only as an indication of the potential for groundwater and surface water flooding and a generalised dataset for the implementation of source control and infiltration sustainable drainage techniques (SUDS)

Therefore, geology and soils should also be investigated at a site level during a FRA. Their characteristics are not the only considerations when designing SUDS. It is recommended (refer to Volume I of this SFRA Section 7) that the application of SUDS should be explored at an early stage of new development projects and design requirements documents within any FRA produced.

More detail on the application of SUDS and the SUDS "Management Train" is also provided in Volume I Section 7.

4.11 Flood Defences

The Environment Agency maintains records of all flood risk management assets using the National Flood and Coastal Defence Database (NFCDD) and this has been made available for this SFRA.

According to the database there are no raised defences within North Tyneside. However, there is however a number of coastal and tidal defences as discussed in the Northumberland & North Tyneside SMP2 (outlined below).

Flood defences and flood warning areas have been provided in map 2009s0059-D10 and are discussed further in Section 5.5.

Whitley Bay

"This frontage extends between Curry's Point and Brown's Point and is defended along almost all of its length, mainly by concrete or masonry seawalls but also with a short section of rip rap. There remains a short section of undefended cliff backed by a pitch-and-put golf course."

Brown's Point to Tynemouth North Pier

"Along this frontage there is a series of three bays, namely Cullercoats Bay, Tynemouth Longsands and King Edward's Bay (sometime known as Tynemouth Shortsands), extending between harder rock headlands. It is mostly defended but has a short section of undefended sea cliff.

The northern section of Longsands has defences protecting the cliff/slope, and the dunes further south, covering much of the bay, are managed. Tynemouth North Pier is a massive masonry structure that provides protection to areas of both North and South Tyneside and is the outer navigation structure to the River Tyne."

Tynemouth North Pier to Fish Quay

"The frontage is heavily defended by concrete and masonry walls below the slopes of Collingwood's Monument and Knotts Flats and there is a rip rap defence fronting Low Lights Car Park."

Flood Defence Condition

Most of the coastal defences are in good or fair condition with a life expectancy of 50 years or more.

4.12 Flood Warning Areas

There are a number of Flood Warning and Flood Watch Areas that cover NTC, some of which cross over its administrative boundaries. They include:

1. 121FWTNWT40 - Whitley Bay, Whitley Sands Cafe
2. 121FWTNWT41 - Cullercoats Bay
3. 121FWTNWT42 - Tynemouth Longsands
4. 121FWTNWT43 - Tynemouth Sailing Club
5. 121FWTNWT44 - North Shields, Fish Quay
6. 121FWTNWT45 - North Shields, Western Quay Promenade
7. 121FWTNWT49 - Tyne Estuary Riverside
8. 121FWTNST50 - Tyne Estuary
9. 121FWTNWT70 - Cullercoats Bay

Flood Warning Areas are is covered by Floodline Warnings Direct. Flood Warning Areas have been provide in the Flood Risk Management Measures Map discussed in the next chapter.

Flood defences and flood warning areas have been provided in map 2009s0059-D10 and are discussed further in Section 5.5.

5. Strategic Flood Risk Mapping

5.1 Introduction

The investigation and identification of the extent and level of flood risk to an area is assessed primarily geographically. Whilst the Environment Agency's Flood Maps are very useful in this respect in showing indicative land use planning zones as required by PPS25, they are only a starting point in the consideration of flood risk in a particular area.

PPS25 Flood Zone Maps should be used primarily to enable the Sequential Test to be carried out, firstly in avoiding inappropriate development and then secondly, to seek compatibility between flood risk vulnerability and Flood Zones as required in Table D3 of PPS25.

However, more detailed analysis is often needed to gain a greater understanding of the varying degree of flood risk at a district level.

At a Level 1 SFRA, it is not appropriate to look at flood risks in detail for individual proposed development sites, as this is a requirement of a Level 2 SFRA and a site specific FRA which will be undertaken by developers in respect of specific development proposal and prior to submitting a planning application.

However, there is a need to undertake a broad assessment of flood risk issues to assist the LPA in making the spatial planning decisions required. This will enable a degree of certainty that the proposed development allocated in the LDD, allow compliance with the Sequential and Exception Tests in PPS25 and importantly provide information to test whether the developments should be safe for occupants and users.

This broad assessment is assisted greatly by the use of "Strategic Flood Risk Maps" produced in the Level 1 SFRA to convey information on flood risk factors needing to be taken into account. These maps have been produced as a complementary suite of Council scale flood risk information and include the PPS25 Flood Zone Maps. No one map should be considered in isolation without reference to the others.

The set of Strategic Flood Risk Maps provided in the North Tyneside Level 1 SFRA include:

SET	Map Title	Map Reference Number
SET A	PPS25 Flood Zones	2009s0059-D01 to D06
SET B	Strategic 1 in 100 year Fluvial Depths	2009s0059-D07
SET C	Strategic 1 in 100 year Fluvial Hazards	2009s0059-D08
SET D	Tidal Climate Change Sensitivity	2009s0059-D09
SET E	Flood Risk Management Measures	2009s0059-D10
SET F	Areas Susceptible to Surface Water Flooding	2009s0059-D11 to D16
SET G	NWL Drainage Areas	2009s0059-D17
SET H	Critical Drainage Areas	2009s0059-D18

After the PPS25 Flood Zone Map has been used to carry out the first sweep of the Sequential Test for various proposed development locations, all sets of maps need to be interpreted consistently in order to complete the second or third pass of the sequential approach sieving process. They can also be used "outside" of the sieving process to gain an understanding of various flood risk factors within North Tyneside.

The detail provided in the Strategic Flood Risk Maps may also provide enough information to test the likelihood of those sites passing the Exceptions Test where applicable. These maps should be used in sequence as shown in the Sequential Test sieving process as shown in Volume I of the SFRA.

5.2 PPS25 Flood Zones Maps

The PPS25 Flood Zones have been produced on a set of six maps covering NTC, and is largely based on information provided in the Environment Agency Flood Map. Version 3.14 of the Environment Agency Flood Zones issued in June 2009 has been used as the latest flood zones in this area, whilst the functional floodplain has been delineated using the method outline below.

This map illustrates:

- Main Rivers
- Ordinary watercourses
- Flood Zone 2
- Flood Zone 3a
- Flood Zone 3b (Functional Floodplain)
- Candidate Flood Zone 3b
- North Tyneside SHLAA Database (sites over 1ha)
- North Tyneside Growth Point Sites

This key map should be used for the facilitating the undertaking of the Sequential Test by Spatial Planners, Development Control officers and individual developers according to PPS25, as discussed previously in Section Volume I and illustrated within stage 1 of the Sequential Test sieving process.

The further suite of Strategic Flood Risk Maps discussed below should be used to support the PPS25 Flood Zone Maps in Sequential Testing as a second or third pass of the sieving process. They will also be useful when applying the Exceptions Test especially when considering other sources of flood risk and assessing whether the development site would be safe now and in the future.

5.2.1 Functional Floodplain

The Functional Floodplain (Flood Zone 3b) in North Tyneside has been defined using modelled 1 in 25 year outlines where available. The modelled outlines were then edited using the following methodology:

Inclusion of land which provides a function for flood conveyance or flood storage (e.g. washlands)

Removal of areas benefitting from defences (ABDs)

Removal of developed (Brownfield) land

Removal of major transport infrastructure (e.g. motorways and railways)

Removal of 'dry islands' defined using the 'size standards' within the Environment Agency SFRM Specification for Flood Risk Mapping[11]

The river centreline has been included within the Flood Zone 3b which was extracted from OS MasterMap data. It has also been acknowledged by the Environment Agency, during the preparation of recent SFRAs by JBA Consulting in the North East, that there is the potential for some inaccuracies in Flood Zone 3 on minor watercourses, in particular non-main rivers due to scale and misalignment issues. As it is critical that the outline for the functional floodplain is as accurate as possible, non-main rivers should be excluded unless modelled outlines are available.

The approach used to define the functional floodplain for each watercourse is summarised in Table 5-1.

[11] Environment Agency (2006) *Strategic Flood Risk Management Specification for Flood Risk Mapping* release 1.2

Table 5-1: Functional Floodplain (Flood Zone 3b) Mapping

Watercourse	Extent	Data Source
Brierdene Burn	Fluvial 1 in 25 year outline	Brierdene Burn SFRM Study (2005)
Forest Hall Letch	Fluvial 1 in 25 year outline	Ouseburn Flood Study (2002)
Longbenton Letch	Fluvial 1 in 25 year outline	Ouseburn Flood Study (2002)
Redburn Dene	River centreline	OS MasterMap river centreline
River Tyne	Tidal 1 in 25 year outline	River Tyne & Derwent FRM Study (2005)
Seaton Burn*	River centreline	OS MasterMap river centreline
Sandy's Letch*	River centreline	OS MasterMap river centreline
Wallsend Burn	River centreline	OS MasterMap river centreline
*1 in 25 year modelled outlines was not created during the Seaton Burn S105 Phase 1 Study in 2001.		

For those watercourses that have not been modelled "Candidate Flood Zone 3b" areas have been identified based on the Environment Agency Flood Zone 3 outlines. These outlines identify sufficient Greenfield areas within Flood Zone 3 which should be safeguarded from future development. In doing so by storing flood waters during an event could potential reduce risk downstream at urban areas in the future. However, as these areas have not been explicitly modelled and are partly based on professional judgement, it is important that they are assessed in more detail at a site-specific FRA level if development is planned in the future. However it is recommended in this SFRA that they are left as open Greenfield for future flood storage or as flood compensation needed to allow other development.

5.3 Strategic 1 in 100 year Fluvial Depth & Hazard Maps

A depth map of a 1 in 100 year flood event has been provided for North Tyneside. The depth grid was obtained from the Environment Agency North East Broad Scale modelling work for CFMPs undertaken by JBA Consulting in 2008. The methodology is based on the original methodology used in creating the original Environment Agency Flood Map using an overland routing model JFLOW. However, the map was improved by:

- Updating the hydrology of inflows into the model, and
- Updating the topographical data from NEXTMAP to LIDAR data. Flow paths under structures were also included to provide a more realist result.

Whilst the extent of the depths grids cannot be directly compared to the current Flood Zones in North Tyneside (as Flood Zones are now mainly based on detail hydraulic models) they do provide a useful indication of potential scale of flood inundation during a 1 in 100 year event. The depth map has been categorised in depth ranges using the scaling below:


0.0 -0.5m depth


0.5 -1.0m depth


1.0 -1.5m depth


1.5m + depth

A hazard map was also created using the same outputs from the Environment Agency work. This shows potential hazards using the Environment Agency flood hazard formula proposed in Phase 2 of the Risks to People Project:

Flood hazard = d (v+0.5) +DF

The depth grid created has been categorised and coloured in accordance to current guidance as described in Table 5-2 below:

Table 5-2: Flood Hazard Rating

Flood Hazard Rating	Hazard to People	Colouring
0	No Hazard	
0 to 0.75	Very Low Hazard	
0.75 to 1.25	Dangerous for some	
1.25 to 2.0	Dangerous for most	
Over 2.0	Dangerous for all	

These maps are extremely helpful in supporting the PPS25 Flood Zone Maps during the Sequential Test, especially during Stage 5 of the Sequential Test sieving process. They would particularly be useful as an early indication that a development could be safe during times of flood (hazard is a relationship between depth and velocity) whilst the depth map could help during the master planning and sequential layout of a development, by placing higher vulnerable development in areas at risk from shallow depths of flooding.

5.4 Climate Change Sensitivity Maps

A 2D TUFLOW model of the River Tyne Estuary was produced for the NE RFRA to investigate tidal flood extents and depths. These outputs have been provided showing the impact of climate change on the 1 in 200 year tidal event by increasing tidal levels identified in Section 4.9 on the River Tyne.

The sequential approach requires early consideration of the effects climate change on flood risk and these maps help greatly in this respect.

No climate change outlines were available for fluvial flood modelling within the area and therefore were not able to be mapped.

5.5 Flood Risk Management Measures Maps

Residual risks are the risks that remain after all risk avoidance, substitution and mitigation measures have been taken. The residual risks in North Tyneside are therefore related to the occurrence of events of low probability, such as extreme flood events greater than the design capacity of the constrained river/coastal system or where the design standard of these flood defences is exceeded. These also include the possibility of storm surges or waves overtopping coastal defences.

A map of flood risk management measures has been produced for North Tyneside. The map includes the:

- Location of Environment Agency river flood defences
- Location of coastal defences
- Coverage of Environment Agency Flood Warning Areas

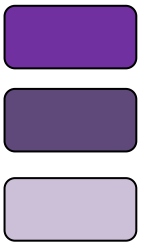
This map is very important when considering the residual risks associated with flood. These residual risks must be investigated within any Level 2 SFRA or site-specific FRA as relevant.

5.6 Areas Susceptible to Surface Water Flooding Maps

The Areas Susceptible to Surface Water Flooding maps show surface water flood extents assuming a 1 in 200 year rainfall event.

The areas susceptible to surface water flooding zones have been provided on a set of six maps covering NTC, and are based on information provided in the Environment Agency national Surface Water Map. Historically flooded properties have also been provided on this map and generally show a good correlation between properties flooded and key surface water flow paths.

The susceptibility zones are split between three zones:



These maps are extremely helpful in supplementing the PPS25 Flood Zone Maps as they show where localised, flash flooding can cause problems, even if the Main Rivers are not overflowing. This is often due to high intensity rainfall events, which exceed the capacity of sewer systems. As a result, surface water is unable to drain away safely and flooding results.

The maps typically show less susceptible areas on tributaries and feeder streams to Main Rivers, where steeper sloping valleys exist and on the edge of the natural floodplain of Main Rivers, again where land levels tend to rise more steeply. The more susceptible areas are predominantly in valley bottoms, in the Main River floodplain or on low lying Greenfield land. From the maps it can be seen that there are many areas of land outside Flood Zone 3, that are susceptible to surface water flooding and this needs to be considered as an integral part of the assessment.

These maps are also excellent in identifying major flow routes due to the topography of the land which may intercept critical infrastructure or travel through major developments.

These maps are helpful in supporting the Flood Zone Maps during the Sequential Test as indicated above to assess the relative degree of susceptibility and where surface water flooding is sufficiently hazardous to jeopardise the principle of development. In particular they show where susceptible areas are and if development allocations are proposed in these susceptible areas then appropriate avoidance, substitution and mitigation measures are needed.

It must be noted that these maps were created at a national level. Where possible flow routes underneath structures (i.e. railway embankments, motorways, bridges etc.) have been including in the underlying topography, but it was not possible at national scale to define all such openings. The capacity of the sewer system in removing a volume of the rainfall or infiltration rates on Greenfield land has not been included.

The map therefore takes a ‘worst case’ conservative approach in that it assumes that the sewer system is already full, blocked or has failed and that the ground is already saturated prior to rainfall. In such extreme events as summer 2007, it was seen that the drainage system had a limited effect on the location of flooding and saturated ground conditions increased the intensity of the flooding.

5.7 NWL Drainage Areas Maps

NWL drainage areas have been provided on one map for North Tyneside, and show the risk of flooding for each area as High, Medium and Low.

The risk rating of each drainage area has been calculated by NWL using DG5 records and supplied as a high level strategic dataset (see Section 4.5).

The categories, suggested by NWL, listed below have been used for this rating:

- Low Risk < 10 properties on internal register
- Medium Risk < 10 properties on internal register and some on external register
- High Risk > 10 properties on internal register and some on external register

This map should be used to identify those locations where there may be a high number of historical flood records within each drainage area. These high risk areas could be connected to drainage related issues such as blockage as well as an overloading of the networks or inadequate drainage capacity.

Whilst this map does not necessarily mean that there are drainage problems within the area (as DG5s are historically flooded properties not current risk areas) it should be used as a starting point for further consultation with NWL, NTC and the Environment Agency.

New large scale development will need to connect to the current drainage network, which could already have capacity issues. Adding further pressure on the system could place that new development site at risk of flooding and exacerbate the issue to the surround community.

NWL drainage areas are also not all entirely within North Tyneside and flow into Newcastle and Northumberland. If the drainage area is at risk, then further development could exacerbate the risk further downstream outside of the administrative boundary of North Tyneside.

As this map is purely based on NWL drainage areas (underground), it should be used in conjunction with the Areas Susceptible to Surface Water Flooding Map (overland) discussed in Section 5.6 and Proposed Critical Drainage Areas identified in Section 4.6 and 5.8 to obtain a full appreciation of surface water and drainage flooding and their interactions.

5.8 Critical Drainage Areas Maps

This map has been produced by data collected from the Environment Agency (EA), Northumbrian Water (NWL), North Tyneside Council (NTC) and the Tyne and Wear Fire and Rescue Service (TWFRS).

CDAs have been proposed by combining NWL drainage areas at high risk and their contributing natural catchments. It must be noted that there will be some overlap and linkages between different natural catchments and drainage areas, however they have been combined using the location of the main outfall of the catchment.

Within CDAs, an increase in the rate of surface water runoff and/or volume from a new development may exacerbate the degree of flood risk to CFAs downstream or to the surrounding community. In these areas, a detailed FRA would be expected regardless of which Flood Zone that applies. This should demonstrate that new development is not at risk from flooding from existing drainage systems. It should also demonstrate that the development will not adversely affect existing flooding conditions by the use of appropriate mitigation measures and should define and address the constraints that will govern the design of the drainage system and layout of the development site.

Ideally, NTC should work closely with the EA, NWL and individual developers to ensure surface water runoff is controlled as near to the source as possible which will include the application of SUDs.

6. Site Specific Development Sites

6.1 Introduction

A Level 1 SFRA should enable NTC to carry out the Sequential Test as outlined in Annex D of PPS25.

The Sequential Test is based on proposed development sites, their situation in regards to flood risk, that level of risk and also the developments vulnerability to that risk. When allocating or approving land for development in flood risk areas, those responsible for making development decisions are expected to demonstrate that there are no suitable alternative development sites located in lower flood risk areas.

Volume I Section 4 introduces the Sequential Test and Volume II provides further guidance for spatial planners, development control and developers and both should be referred to. The following section provides summary tables of sites assessed in NTC as part of their Level 1 SFRA. One of the main outputs of this assessment is the Sequential Test Spreadsheet.

A Sequential Test spreadsheet has been produced showing the results of all proposed development sites identified by NTC against PPS25 Flood Zones and as an extra layer of information against the surface water susceptibility zones. Area (ha) and percentage cover of each Flood Zone is provided. A screenshot of the spreadsheet is provided below.

Figure 6-1: Screenshot of Sequential Test Spreadsheet

North Tyneside Council Strategic Flood Risk Assessment

North Tyneside Council Sequential Test

Summary Table

		Flood Zone Coverage								Surface Water Vulnerability					
		Flood Zone 1		Flood Zone 2		Flood Zone 3a		Flood Zone 3b		Low Vulnerability		Intermediate Vulnerability		High Vulnerability	
	Number of Sites	Area (ha)	Area (ha)	# 100%	Area (ha)	#	Area (ha)	#	Area (ha)	#	Area (ha)	#	Area (ha)	#	Area (ha)	#
Growth Point Site	11	153.37	147.76	9	3.38	2	0.80	3	1.43	2	13.40	11	7.86	9	0.83	5
SHLAA Sites	79	1164.79	1133.35	63	10.06	18	13.38	15	8.00	17	84.17	76	47.04	58	5.41	25
Total	11	153.37	147.76	9	3.38	2	0.80	3	1.43	2	13.40	11	7.86	9	0.83	5

Main Table

					Flood Zone Coverage								Surface Water Vulnerability					
					Flood Zone 1		Flood Zone 2		Flood Zone 3a		Flood Zone 3b		Low Vulnerability		Intermediate Vulnerability		High Vulnerability	
Site ID	Name	Ward	Development Type	Area (ha)	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
S11	Wellfield		Growth Point Site	12.02	12.00	100	0.00	0	0.00	0	0.02	0	1.34	11	0.71	6	0.03	0
S4	East Benton Farm, Station Road		Growth Point Site	24.90	24.90	100	0.00	0	0.00	0	0.00	0	0.61	2	0.15	1	0.00	0
S6	East Benton farm South Benton		Growth Point Site	9.93	9.93	100	0.00	0	0.00	0	0.00	0	0.37	4	0.00	0	0.00	0
E9	West Chirton South Trading Estate		Growth Point Site	23.92	23.92	100	0.00	0	0.00	0	0.00	0	5.09	21	0.81	3	0.03	0
E3	Balliol Business Park East		Growth Point Site	25.92	24.05	93	0.32	1	0.14	1	1.41	5	2.13	8	3.17	12	0.35	1
S5	South Station Road Benton (East)		Growth Point Site	28.82	28.82	100	0.00	0	0.00	0	0.00	0	0.92	3	0.67	2	0.00	0
S1	Annitsford Farm		Growth Point Site	16.98	13.26	78	3.06	18	0.66	4	0.00	0	2.16	13	1.34	8	0.00	0
E12	Backworth Business Park		Growth Point Site	4.52	4.52	100	0.00	0	0.00	0	0.00	0	0.32	7	0.10	2	0.00	0
E2	West Moor		Growth Point Site	2.55	2.55	100	0.00	0	0.00	0	0.00	0	0.22	9	0.79	31	0.00	0
E6	Marine House		Growth Point Site	0.89	0.89	100	0.00	0	0.00	0	0.00	0	0.01	1	0.00	0	0.00	0
E4	Howdon Green		Growth Point Site	2.92	2.92	100	0.00	0	0.00	0	0.00	0	0.20	7	0.13	4	0.42	14
NT067	Foxhunters Industrial Site	MONKSEATON SOUTH	SHLAA	2.72	2.72	100	0.00	0	0.00	0	0.00	0	0.43	16	0.01	0	0.00	0
NT066	Backworth Business Park	VALLEY	SHLAA	5.09	5.09	100	0.00	0	0.00	0	0.00	0	0.33	6	0.10	2	0.00	0
NT061	Wallsend Road Industrial Area		SHLAA	5.09	5.09	100	0.00	0	0.00	0	0.00	0	0.58	11	0.20	4	0.00	0
NT065	Shiremoor West	VALLEY	SHLAA	16.53	16.10	97	0.08	1	0.00	0	0.35	2	1.87	11	0.84	5	0.10	1
NT056	West Moor	LONGBENTON	SHLAA	2.55	2.55	100	0.00	0	0.00	0	0.00	0	0.22	9	0.78	31	0.00	0
NT057	Balliol Business Park East		SHLAA	25.92	24.05	93	0.32	1	0.14	1	1.41	5	2.13	8	3.17	12	0.35	1
NT068	Annitsford Farm		SHLAA	17.54	13.26	76	3.14	18	1.12	6	0.02	0	2.19	12	1.60	9	0.09	1
NT070	Tyneview Park		SHLAA	3.82	3.82	100	0.00	0	0.00	0	0.00	0	0.01	0	0.07	2	0.00	0
NT069	Whitehouse Farm	LONGBENTON	SHLAA	32.45	32.20	99	0.04	0	0.10	0	0.10	0	3.15	10	2.60	8	0.04	0
NT075	High Farm	KILLINGWORTH	SHLAA	40.83	40.83	100	0.00	0	0.00	0	0.00	0	1.77	4	2.04	5	0.00	0
NT077	Shiremoor West (North)	VALLEY	SHLAA	11.57	11.56	100	0.00	0	0.00	0	0.01	0	0.47	4	0.23	2	0.00	0
NT071	Land Opposite Proctor and Gamble	NORTHUMBERLAND	SHLAA	24.90	24.90	100	0.00	0	0.00	0	0.00	0	0.61	2	0.15	1	0.00	0

NTC Spatial Planners should use this information to carry out the first sieve of the Sequential Test, by identifying and removing those sites at greatest risk. Once a decision has been made by NTC to remove or keep (due to wider social/economic reasons) those sites at higher risk, they should then carry out a second or third pass of the Sequential Test against the wider suite of Strategic Flood Risk Maps produced within this SFRA. This information should provide a stronger case whether flood risk is acceptable by looking at all sources of flooding or those sites highlighted as higher flood risk in the first instance should actually have been removed.

It is recommended that the Sequential Test process is carried out at a local or community level especially when it comes to identifying and substituting more vulnerable development in land outside of flood risk areas. By doing this the aim of the Sequential Test can still be achieved as well as the NTC meeting their own relevant objectives in the RSS or LDF i.e. a local need for affordable housing within a town centre may restrict the area of search to within the regeneration area.

6.2 Current Development Site Sequential Test

Development sites identified by NTC include:

- Housing Growth Point Sites
- Strategic Housing Land Availability Assessment (SHLAA) sites over 1ha

Including Growth Point sites and North Tyneside's SHLAA dataset, the total developable area is around 1300ha. Table 6-1 and Table 6-2 provide a summary of sites at risk of fluvial, tidal and surface water flooding that are included in the Sequential Test spreadsheet.

6.2.1 Summary of sites at risk of fluvial flooding

Table 6-1: Summary of Development Sites at Risk of Fluvial & Tidal Flooding

Development Type	No. Sites	Total Area (ha)	Flood Zone 2		Flood Zone 3a		Flood Zone 3b	
			Area (ha)	No.	Area (ha)	No.	Area (ha)	No.
Growth Point Site	11	153.37	3.38	2	0.80	3	1.43	2
SHLAA Sites	79	1164.79	10.06	18	13.38	15	8.00	17
Total	90	1318.16	13.44	20	14.18	18	9.43	19

- 24ha of sites are at risk of flooding in the 1 in 100 year event (Flood Zone 3a+3b)
- Out of 18 sites in Flood Zone 3a on average only 6% of each site is at flood risk
- 37ha of sites are at risk of flooding in the 1 in 1000 year event (Flood Zone 2+3a+3b)
- Out of 20 sites in Flood Zone 2 on average only 8% of each site is at flood risk.
- 19 sites are situated in the Functional Floodplain and under PPS25 these will not be permitted. However the areas consider functional floodplain are relatively small at a total of 9ha and on average cover 3% of the site itself.

It should be possible to avoid development in these locations without losing significant developable area and affected yield numbers. These areas should be left as green open space (i.e. functional floodplain).

On review of the information provided in this SFRA, the Environment Agency recommended that the flowing text was added to this report regarding those development sites identified as being at risk from fluvial flooding.

- "*The Environment Agency consent any works within 5 metres of a main river. It is likely that we will object in principle to any development within this area. As such, we consider that this should be highlighted as a major constraint to be noted in individual site assessments. For example there are a few allocations SHLAA that are either very close to watercourses and/or in flood zones. Two that stood out were NT057-ES and NT074a.*"
- *Compensation storage is a requirement for any development within fluvial flood risk areas. We consider that this should be noted as a constraint within the individual site assessments as this requirement may have implication for the yields achievable for individual sites given the associated land take this may require. For example where sites are of a small size, within large flood zone coverage may cause difficulties in achieving compensatory storage and may therefore call into questions the developments design and viability.*"

6.2.2 Summary of sites at risk of surface water flooding

Table 6-2: Summary of Development Sites at Risk of Surface Water Flooding

Development Type	No. Sites	Total Area (ha)	Low		Medium		High	
			Area (ha)	No.	Area (ha)	No.	Area (ha)	No.
Growth Point Site	11	153.37	13.40	11	7.86	9	0.83	5
SHLAA Sites	79	1164.79	84.17	76	47.04	58	5.41	25
Total	90	1318.16	97.57	87	54.90	67	6.24	30

The risk of surface water flooding to Growth Point sites and North Tyneside's SHLAA dataset is potentially of a greater scale to fluvial and tidal flooding.

- 87 of the 90 designated sites are at some susceptibility to surface water flooding, however the total area at risk only constitutes around 12% of the designated footprint of development.
- A total of 30 sites have a high susceptibility of surface water flooding which must be considered within the Sequential Test sieving process. If these sites are allocated, a FRA must consider surface water mitigation techniques such as Sustainable Urban Drainage or lowering the density of development including green open spaces. A sequential approach to site layout must also be applied.

6.3 Current Development Site Exception Test

As discussed above the majority of current development sites within Flood Zone 3a and 3b have minor percentage cover.

It is firstly recommended that these sites are avoided if the percentage cover in these zones is greater than 20% in Flood Zone 3a and 3b and/or 40% in Flood Zone 2. If the development site is still required NTC should look at the vulnerability of the proposed development and substitute lower vulnerable development if appropriate within the site boundary. Only if is not achievable should the Exception Test be applied (if applicable).

If the percentage cover of the site at risk is lower than 20% in Flood Zone 3a and/or 40% in Flood Zone 2 it is expected that a sequential approach to site layout could be adopted to remove vulnerable development from flood risk areas. Open green space could also be placed within flood risk areas within the final master plan. This should be linked in with the risk of surface water flooding.

Those sites still allocated for development in flood risk areas must be accompanied by a site-specific FRA with the planning application. This will also be required for those sites required to pass the Exception Test. At this stage NTC will only be able to state the likelihood of sites passing the Exception Test. If it is unlikely that the site will pass Parts B) or C) using the information supplied in this SFRA or there is no planning justification to pass Part A), NTC should look to avoid the development at a high level before allocating inappropriate sites which may require large and expensive mitigation measures.

Figure 6-2 provides an example of where the Sequential Approach to site layout would be appropriate as the allocation follows the watercourse centreline.

Figure 6-2: Sequential Approach to Site Layout for Fluvial Flooding

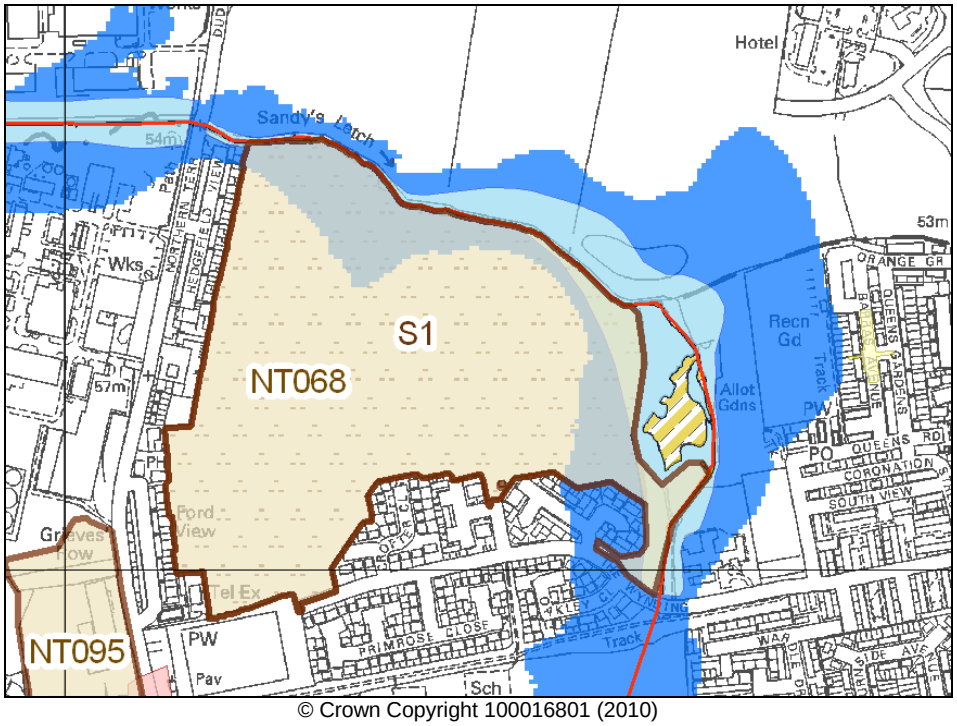
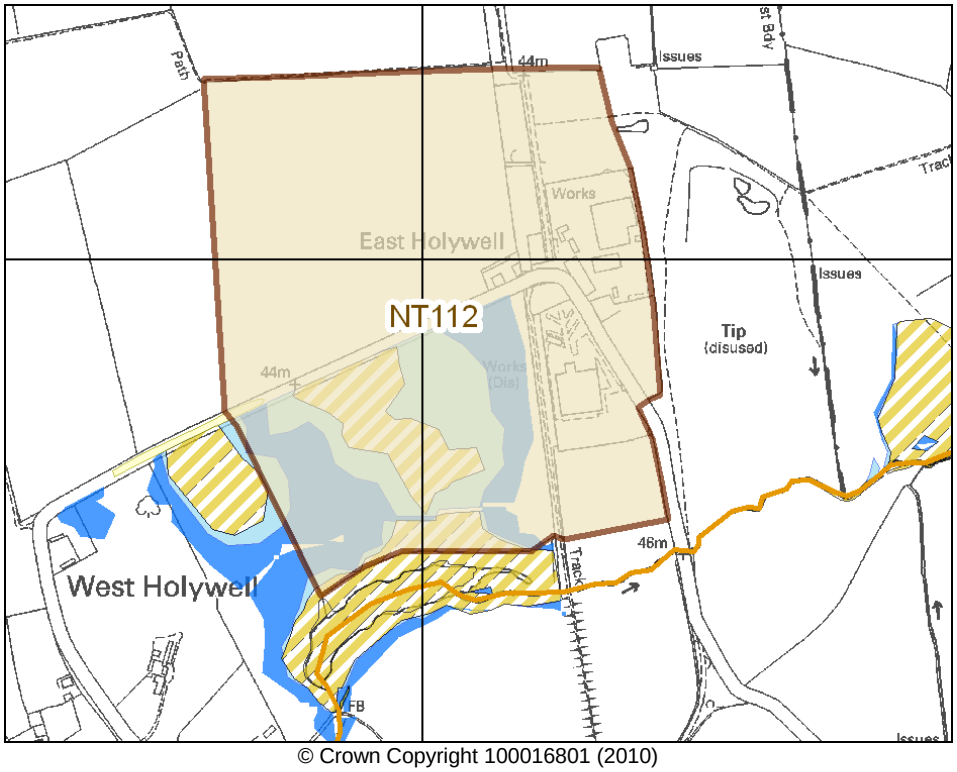


Figure 6-3 provides an example where the developable should firstly be avoided due to the risk of fluvial flooding. However, the north section of the site (north of the road) could still be developed once other sources of flooding are considered. In both cases it would be more appropriate the leave a green corridor for flood storage rather than maximising property numbers and incorporating unrealistic mitigation measures to remove the risk of flooding.

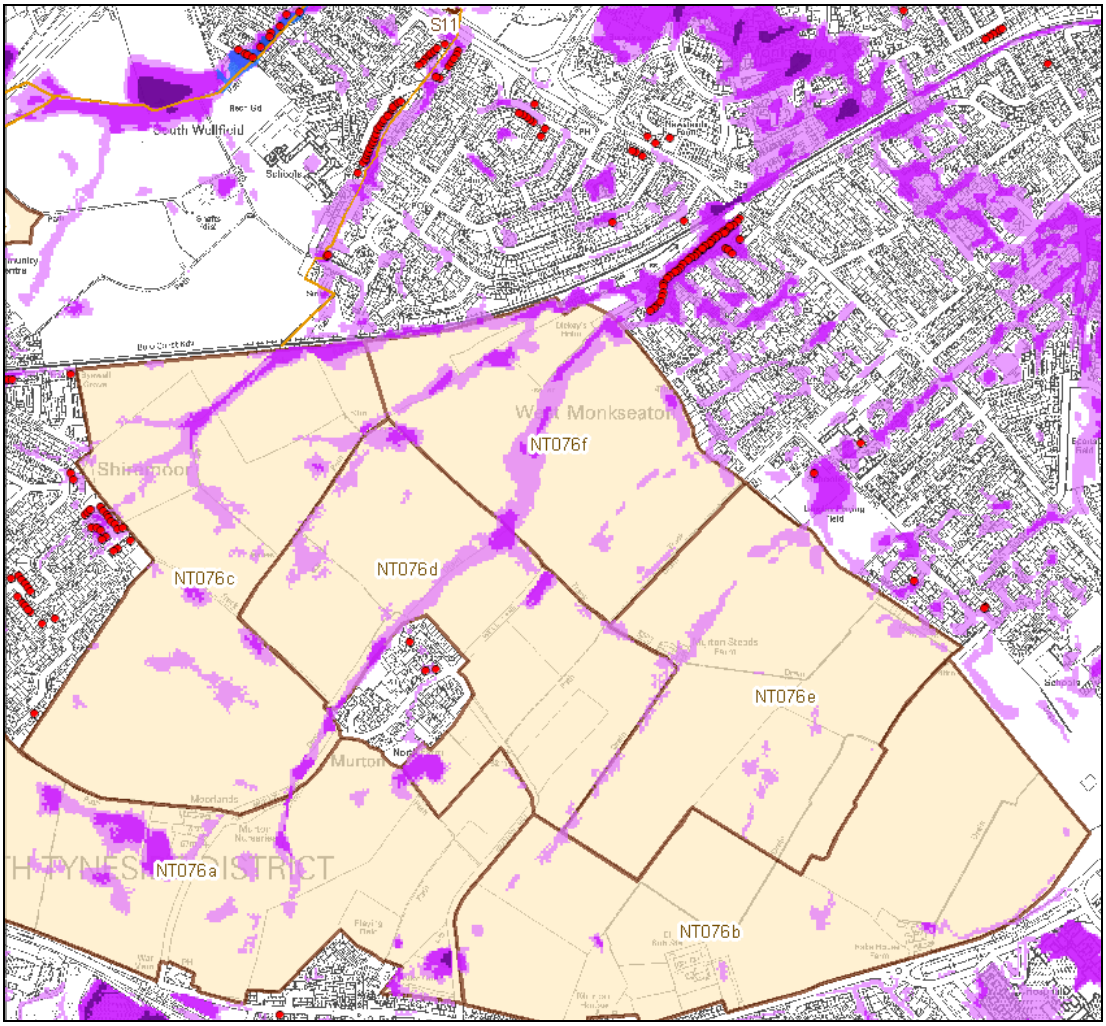
Figure 6-3: Removal of Fluvial Flood Risk Areas



Surface water flooding or the combination between watercourses and surface water drainage is the greatest risk with a number of sites situated on direct surface water flow paths, or within flood zones and Critical Drainage Areas (CDAs). Large dense developments could have significant implications on current risk to the surrounding community and further downstream if runoff is not controlled or current flood risk is not reduced. Whilst surface water susceptibility zones are not specifically included within the Sequential Test, it is recommended in this SFRA that the suite of SFRA maps produced should be used to carry out a sieving process to development sites identified at risk. Those sites situated on immediate flow paths should be removed or more open master planning of the site itself.

An example of this would be the SHLAA sites on Greenfield land around Murton (Figure 6-4). Whilst they are not identified at flood risk within the fluvial Flood Zones (2, 3a or 3b) they are situated upstream of areas at high risk of surface water and sewer flooding. Currently the Greenfield land has a natural drainage capacity but during extreme rainfall events can contribute to surface water flooding downstream, as noticeable by key flow paths identified in Figure 6-4. These flow paths also correlate with historically flooded properties identified by NTC and NWL.

Figure 6-4: Sequential Approach to site layout for Surface Water Flooding

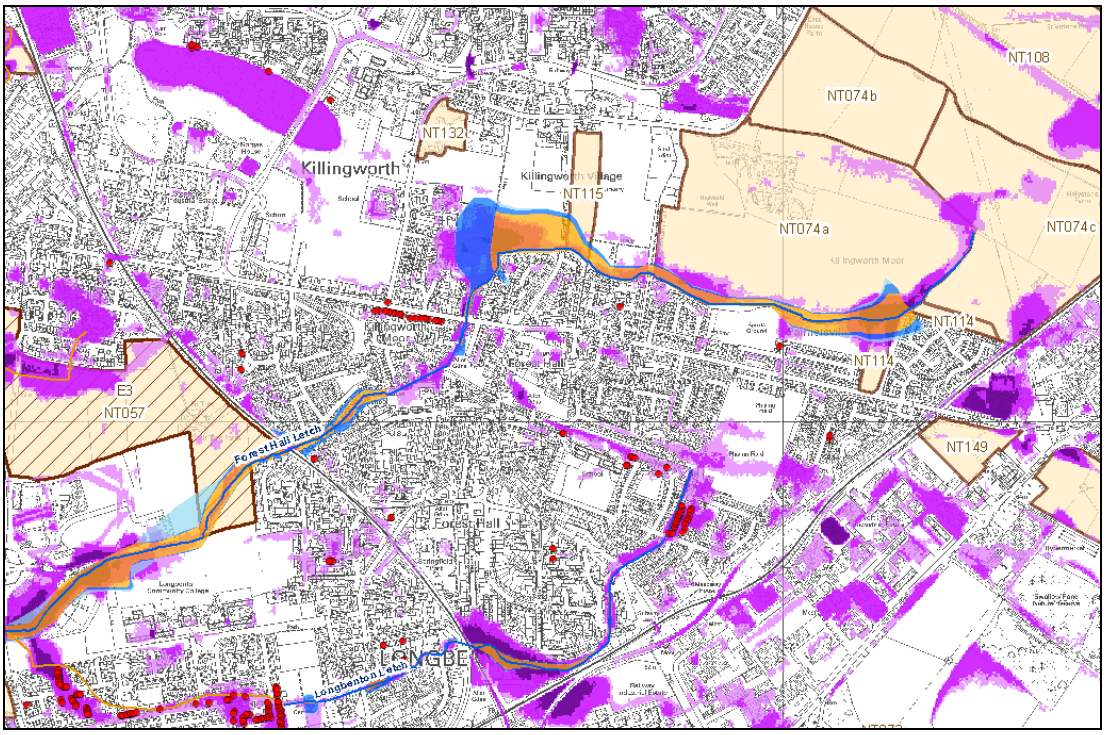


Proposed development sites like this should be flagged during the Sequential Test sieving process and avoided as they could significantly increase the amount of surface water runoff in the area by reverting Greenfield land to Brownfield and also place further pressure of the current drainage area.

If proposed development sites like these are allocated they should follow the same stringent recommendations as if they were at risk from fluvial or tidal flooding. Site-specific FRAs will be required for each site but a strategic drainage impact assessment will also be needed for the wider area. SUDs should also be considered at the earliest possible stage.

The area of Longbenton is consider as having the highest risk of flood in this SFRA as risk is associated with a number of sources which interact. Fluvial flood risk is associated with Forest Hall and Longbenton Letch. The area is also at considerable risk of surface water flooding and flooding from the drainage network. A significant amount of historical flooding incidents have been collected for this area and are associated with flooding from a number of sources as identified in Figure 6-5.

Figure 6-5: Fluvial and Surface Water Flood Risk Surrounding Longbenton



As discussed, while proposed development sites are not significantly covered by Flood Zones 2, 3a and 3b or within areas susceptible to surface water flooding, they are located within the CDA of Benton. Benton has been classified as a CDA due to the level of risk to current properties. Allocating and development further large scale developments upstream will significantly increase flood risk downstream to those properties already at risk. It is therefore recommended that these proposed development sites are not allocated until the flood risk issues surrounding this area is fully understood and has been mitigated.

7. Recommendations for Future Plans

7.1 Introduction

SFRAs are more than a land use planning tool, and can provide a much broader and inclusive vehicle for integrated, strategic and local Flood Risk Management (FRM) assessment and delivery. Since publication of the Pitt Review, it is apparent that SFRAs will provide the central holder for data, information and consideration for all flood risk issues relating to flooding from all sources at a local level; and provide the linkage between CFMPs, SMPs, RFRAs, SWMPs and appropriate sustainable land uses over a number of planning cycles.

The North Tyneside SFRA has provided this pivotal vehicle in the introduction and promotion of a local authority, post Pitt Review, role in local flood management. The SFRA has been produced to be fit for the future, to help communities meet the considerable FRM and climate change related challenges that lay ahead.

In order to achieve this NTC must take a lead role in FRM and continue the work of this Level 1 SFRA and increase the understanding and information available on flood risk issues. There are a number of future plans which could provide this comprehensive understanding and acknowledgement of flood risk from all sources. These are outlined below with recommendations of whether or not they would benefit NTC.

7.2 Level 2 SFRA

This North Tyneside Level 1 SFRA has provided the evidence base for NTC to apply the Sequential Test as set out in PPS25. Whilst the suite of Flood Risk Maps provided will help inform the decision making process and go some way in informing the likelihood of passing the Exception Test, they do not provide the local understanding and the level of detail required to carry out the Exception Test.

The aim of a Level 2 SFRA is to produce this greater understanding of the flood mechanisms and residual risks, concentrate on specific locations, and to provide the data needed to understand the likelihood that sites will pass part c) of the Exception Test – whether the development will be safe.

These specific locations should be apparent where flood risk has been identified within the Level 1 SFRA as a critical issue but development is still required to meet the wider sustainable objectives.

The investigations carried out within the level 2 SFRA will inform the flood risk balance sheet and confirm the sequential approach to site layout and the design of possible mitigation measures.

The scope of a Level 2 SFRA is provided in PPS25 and its Practice Guide. It should include the detailed nature of the flood hazard within a flood zone including:

- Flood probability
- Flood Depth
- Flood Velocity
- Rate of onset of flooding.

The Level 2 SFRA should also provide information on flood defences including their location, SoP, condition and an assessment of defences breaching and overtopping.

On review of flood risk information provided in this Level 1 SFRA, it is apparent that fluvial and tidal flooding is not a significant risk in North Tyneside. Almost all of the main rivers in the area have been specifically modelled and the outlines produced identify little urban areas and proposed development sites at significant risk. There are also no major raised defences along fluvial watercourses within the area.

There is a residual risk associated with tidal flooding due to the presence of tidal and coastal defences, but they are well maintained and offer a good standard of protection. Indicative flood depths and hazards have already been provided in this Level 1 SFRA from the NE RFRA dataset and it is presumed more detailed modelling will not provide a significant advantage.

It is therefore recommended that North Tyneside do not specifically carry out a Level 2 SFRA. However, NTC should continue to apply the sequential approach to its development sites and remove all sites which encroach on watercourses or alter their development footprint by identifying Green Infrastructure and public open space with Flood Zones to act as a functional floodplain.

For those site identified at flood risk from any source should be accompanied with a site-specific Flood Risk Assessment produce using the guidance set out in Volume III.

If NTC wanted to improve the confidence/understanding of fluvial flood risk information,

- Seaton Burn and Sandy's Letch could benefit from an updated detailed hydrodynamic model as Flood Zone 2 is still based on the IFM.
- Longbenton and Forest Hall Letch could also benefit from an updated hydrodynamic model (previous model is a steady state HEC-RAS model) and a review of the hydrology as the previous FRM study was carried out in 2002. However, flooding during the 1 in 100 year event in both cases is mainly on Greenfield land and with no raised fluvial defences in place there is little or no residual risk to investigate (defence overtopping/breaching). Priority of this work is not high as continued maintenance of structural pinch points discussed could help reduce flood risk.

7.3 Surface Water Management Plans (SWMPs)

The 'Pitt Review', 'PPS25', the 'Making Space for Water - Integrated Urban Drainage' pilots, the 'Draft Flood and Water Management Bill' and draft Surface Water Management Plan (SWMP) guidance recognise the need for clearer roles and responsibilities for different sources of flood risk, with the current legislative framework leading to a fragmented and piecemeal approach for managing urban flood risk. A local leadership role for local flood risk issues has emerged whereby local authorities will need to have in place a strategy to manage these risks, of which a SWMP is an integral part.

Surface water flooding is a major source of flood risk and as demonstrated by the summer 2007 floods can lead to serious flooding of property and possessions. These impacts can typically be mitigated through the implementation of established 'best practice' drainage techniques including Sustainable Urban Drainage Systems (SUDS) at the planning application stage. However, in some circumstances site constraints dictate that a catchment-wide, holistic approach to surface water flood management is required through urban catchment planning and strategic consideration of the design, construction, maintenance and improvement of sewers and watercourses. Local Authorities need to take a lead role with close liaison between Water Companies and the Environment Agency is essential to ensure a consistent and co-ordinated approach to surface water management and this may be best achieved by the production of appropriate Surface Water Management Plans (SWMPs).

SWMPs are developed by a partnership between a Local Authority, Water Company and the Environment Agency. They provide an opportunity to:

- Develop a framework for joint working and data sharing (which is a fundamental part of flood risk management under the draft Flood and Water Management Bill),
- Collate a central geographic database of drainage assets and flood risk issues,
- Assess the likelihood of surface water flooding through various modelling approaches,
- Assess the risk of surface water flooding to people, properties and the environment,
- Communicate this risk to local communities,

- Assess the costs and benefits of various flood risk reduction measures,
- Provide a drainage strategy for areas of significant development if appropriate, and
- Provide a framework for implementation and monitoring of the surface water strategy for a given area.

The Defra SWMP guidance is based on the Integrated Urban Drainage pilots undertaken as part of Making Space for Water and was recently tested by six national pilot studies. The government outlined its future intentions towards the development of SWMPs in the Government Response to the Pitt Review into the 2007 floods, setting aside £9.7m for the development of a further 50 SWMPs for high priority locations (which has been decided on a national basis). SWMPs should achieve the level of data sharing with water companies and analysis using detailed sewer network models that is the next stage down from the SFRA.

SFRAs provide the opportunity for local authorities to assess at a strategic level the risk from multiple sources of flooding, which can then feed into more detailed assessments where appropriate by both themselves and other operating authorities. This includes the identification of Critical Drainage Areas. Critical Drainage Areas are those identified from historical flood events and/ or modelled data as having a significant risk from surface water flooding and should include drainage catchments for the sewer network, where there is high risk of surface water flooding or the network is at capacity (these were not provided for the SFRA). Recommendations can then be made for the future provision of SWMPs in high risk locations or areas of significant development for which an integrated drainage solution is possible that can reduce flood risk both to the development and elsewhere

7.3.1 Water Cycle Studies

Water Cycle Studies (WCS) are an all encompassing study of the capacity in water supply, waste water infrastructure and water in the environment, aimed at those regions that are expecting growth. Its main aim is to ensure that new development can be supplied with the required water services it needs in a sustainable way.

To ensure that growth at a district scale can be supplied with sufficient water supply and wastewater treatment facilities, without detrimentally affecting the natural water cycle, it is essential to consider the water infrastructure needs as early in the planning process as possible. A WCS will provide NTC and development organisations with the necessary planning tool for this purpose and the planning base to support their LDF.

A SWMP and a WCS should be twin tracked when they are prepared for the areas of interest. Whilst the SWMP would address surface water management the remaining issues of water supply and sewage treatment should be included within the WCS. NTC will need to provide evidence that their Growth Point Sites can be sustainably delivered and that flood risk and water supply has been investigated. SWMPs and WCS would provide this information however; they will not automatically be required.

Until a WCS is carried out, all developers within NTC should apply for a Pre-Development Enquiry from Northumbrian Water. This enquiry will lead to a response detailing capacity studies in our water and sewerage networks and any other relevant issues. A Pre-Development Enquiry Application Form (June 2008) has been attached in E for reference.

7.3.2 Recommendations for CDAs

Future Water (Defra, 2008) sets out the role that SFRAs can have in identifying Critical Drainage Areas (CDAs) for which more detailed Surface Water Management studies can be developed. The recent Defra Surface Water Management Plan Guidance (2009) supports the use of SFRAs in providing the evidence base for where SWMPs are required.

The SFRA has identified CDAs based on natural catchments, NWL drainage areas and known flooding problems. The sewer network can have a significant impact on the location of surface water and sewer flooding for more frequent events. It can also affect the distribution of water throughout urban catchments during flood events, passing excess flows from the combined network into watercourses through combined sewer overflows.

The CDAs identified here should therefore only be taken as a starting point in the identification of areas for which a SWMP would be beneficial. Where sewer systems are interconnected across the boundaries of natural catchments, the additional catchments of the sewers should be taken into account when finalising SWMP boundaries in areas where there is a high risk of sewer flooding, known historic flooding incidents or the sewer network is at capacity. The catchments of sewers often encompass more than one local authority.

Using the information collated in this SFRA the following recommendations are made for future surface water management in Table 7-1. NTC have consulted with NWL and the Environment Agency, in finalising the CDAs and, to identify the potential locations of and priorities for SWMPs.

Table 7-1: CDA Recommendations

CDA	Recommendation
Benton	A SWMP should be undertaken for the Killingworth and Longbenton area that will look in detail at drainage assets and local flood risk and assess feasible options for reducing risk. There is significant interaction between a number of sources in this location which would benefit from an holistic study. This may include a drainage strategy for the collection of development sites to identify areas suitable for SUDS and where surface water flow paths could be opened up in new development. The Benton CDA will also be connected to Newcastle through the Ouseburn and any work will benefit from joint collaboration.
Brierdene and Whitley Bay	NWL have already completed an improvement scheme to reduce the risk of sewer flooding in Whitley Bay; however there is still a risk of surface water flooding from surrounding Greenfield land. There is also a risk from surface water culverts surrounding these fields. Any new large scale developments will benefit from a Drainage Strategy for the neighbourhood to identify areas suitable for SUDS, allowable discharges from sites and where surface water flow paths could be opened up in new development. It is important that future development does not increase surface water discharges to the area of Brierdene and Whitley Bay.

Until a SWMP has been completed, all developments identified at risk from surface water flooding should adhere to the guidance in PPS25 and the recommendations outlined in this SFRA. Integrated drainage solutions should be prepared for larger sites or areas. Where major flow paths have been identified these should be considered in the master planning of the site and the sequential placement of development. Where available, SUDS techniques should be identified within the development at the earliest possible stage.

7.4 Green Infrastructure Framework

The Green Infrastructure (GI) of North Tyneside is part of the council area's life support system. It is a planned and managed network of natural environmental components and green spaces that intersperse and connect the urban centres, suburbs and rural fringe. In general GI consists of:

- Open Spaces – parks, woodlands, nature reserves, lakes, etc
- Linkages – River corridors and canals, pathways and cycle routes and greenways
- Networks of "urban green" – private gardens, street trees, verges and green roofs.

The identification and planning of GI is critical to sustainable growth. It merits forward planning and investment as much as other socio-economic priorities such as health, transport, education and economic development.

GI is also central to climate change action and is recurring theme in planning policy statements, regional spatial strategy, the sub-regional action plan and the New Growth Point declaration of July 2008.

GI is recognised as having multiple benefits: environmental (biodiversity), social (health and well being) and economic (attractive places to live have higher value and attract more investment). With regards to flood risk, green spaces can be used to manage storm flows and free up water storage capacity in existing infrastructure to reduce risk of damage to urban property, particularly in city centres and vulnerable urban regeneration areas. In general it allows space for SUDs and promotes sustainable vegetation cover, which stores water, increasing surface roughness and improves permeability of soils. GI can also improve accessibility to waterways and improve water quality, supporting regeneration and improving opportunity for leisure, economic activity and biodiversity.

When considering the potential of GI to contribute to water management, it must also be understood that GI is a holistic approach with potential to provide many benefits. It is equally the case that water management benefits should not be sought without consideration for other issues such as biodiversity, or amenity and play value of landscapes.

The evidence base provided in this SFRA should be used to enhance North Tyneside's Green Infrastructure Framework. River corridors identified as functional floodplain or land identified in the Areas Susceptible to Surface Water Flooding Map are an excellent linkage of GI and can provide storage during a flood event. Areas identified at flood risk within the urban environment and within CDAs proposed should be incorporated in NTCs GI strategy, by opening up land to create flow paths or flood storage areas can help protect current and future property.

7.5 Summary

The above section has recommended a number of further studies within North Tyneside which could provide NTC with more detailing flood risk information within their Council area. This 'extra' level of detail would help inform the application of the Sequential and Exception Tests and go some way in outlining key FRM policy and mitigation approaches in reducing and controlling flood risk. The table below summaries these recommendations:

Table 7-2: Summary of Future Recommended Studies

Number	Study	Required	Area	Timetable
1	Level 2 SFRA	×	N/A	N/A
2	SWMP/WCS	✓	Benton	Short Term
3	Drainage Strategy for Large Development Sites/WCS	✓	Brierdene and Whitley Bay	Short Term
6	Flood Mapping Study	✓	Seaton Burn	Long Term
7	Flood Mapping Study	✓	Sandy Letch	Long Term
8	Flood Mapping Study	✓	Longbenton Letch	Long Term or incorporation with SWMP
9	Flood Mapping Study	✓	Forest Hall Letch	Long Term or incorporation with SWMP

Appendices

A. North Tyneside SFRA Data Register

B. Flooding Incident Register

C. NWL Meeting Notes (15/10/2009)

D. Sequential Test Spreadsheet

E. NWL Developer Pre-Development Enquiry Application Form

F. Glossary of Terms

Terms	Definition
Attenuation	Reduction of peak flow and increased duration of a flow event
Breach of Defences	A structural failure at a flood defence allowing water to flow through
Catchment Flood Management Plans (CFMP)	A strategic planning tool through which the Environment Agency will seek to work with other key decision-makers within a river catchment to identify and agree policies for sustainable flood risk management
Climate Change	Long-term variations in global temperatures and weather patterns, both natural and as a result of human activity
Consequence of flooding	Health, social, economic and environmental effects of flooding, of flooding, some of which can be assessed in monetary terms, while other less tangible impacts are more difficult to quantify. Consequences depend on the hazards associated with the flooding and the vulnerability of receptors
Compensation storage	A floodplain area introduced to compensate for the loss of storage as a result of land raising for development purposes
Conveyance	When a river overflows its banks, it continues to flow over the floodplain, conveying water down-stream, as well as storing water where the flood[lain may be obstructed and releasing it slowly
Design event	A historic or notional flood event of a given annual flood probability, against which the suitability of a proposed development is assessed and mitigation measures, if any, are designed
Design flood level	The maximum estimated water level during the design event
DG5 register	Register held by water companies on the location of properties at risk of sewage related flooding problems
Extreme Flood Outline	Flood 'zone' maps released by the Environment Agency to depict anticipated 0.1% (1 in 1000 year) flood extents in a consistent manner throughout the UK
Flooding (or inundation)	Flooding is the overflowing of water onto land that is normally dry. It may be caused by overtopping of breach of banks or defences, inadequate or slow drainage of rainfall, underlying groundwater levels or blocked drains and sewers. It presents a risk only when people, human assets and ecosystems are present in the areas that flood
Flood Alleviation Scheme (FAS)	A scheme designed to reduce the risk of flooding at a specific location
Flood defence	Flood defence infrastructure, such as flood walls and embankments, intended to protect an area against flooding to a specified standard of protection
Flooding from Artificial drainage systems	This occurs when flow entering a system, such as an urban storm water drainage system, exceeds its discharge capacity, becomes blocked or when the system cannot discharge due to a high water level in the receiving watercourse
Flood Hazard	The features of flooding which have harmful impacts on people, property or the environment (such as the depth of water, speed of flow, rate of onset, duration, water quality etc)
Flood Map	A map produced by the Environment Agency providing an indication of the likelihood of flooding within all areas of England and Wales, assuming there are no flood defences. Only covers river and sea flooding
Floodplain	Area of land that borders a watercourse, an estuary or the sea, over which water flows in time of flood, or would flow but for the presence of flood defences where they exist
Flood Risk	An expression of the combination of the flood probability or likelihood and the magnitude of the potential consequences of the flood event
Flood Risk Assessment (FRA)	A study to assess the risk to an area or site from flooding, now and in the future, and to assess the impact that any changes or development on the site or area will have on flood risk to the site and elsewhere. It may also identify, particularly at more local levels, how to manage those changes to ensure that flood risk is not increased. PPS25 differentiates between regional, sub-regional/strategic and site- specific flood risk assessments

Terms	Definition
Flood Risk Management (FRM)	The introduction of mitigation measures (or options) to reduce the risk posed to property and life as a result of flooding. It is not just the application of physical flood defence measures
Flood risk management measure	Any measure which reduces flood risk such as flood defences
Flood risk management strategy	A long-term approach setting out the objectives and options for managing flood risk, taking into account a broad range of technical, social, environmental and economic issues
Flood Storage	The temporary storage of excess runoff or river flow in ponds, basins, reservoirs or on the floodplain
Flood Zone	A geographic area within which the flood risk is in a particular range, as defined within PPS25
Fluvial	Flooding caused by overtopping of rivers or stream banks
Freeboard	The difference between the flood defence level and the design flood level, which includes a safety margin for residual uncertainties
Indicative Floodplain Map (IFM)	A map that delineates the areas estimated to be at risk of flooding during an event of specified flood probability. Being indicative, such maps only give an indication of the areas at risk but, due to the scale and complexity of the exercise, cannot be relied upon to give precise information in relation to individual sites
ISIS	ISIS is a software package used for 1-Dimensional river modelling. It is used as an analysis tool for flood risk mapping, flood forecasting and other aspects of flood risk management analysis
Likelihood (probability) of flooding	A general concept relating to the chance of an event occurring. Likelihood is generally expressed as a probability or a frequency of a flood of a given magnitude or severity occurring or being exceeded in any given year. It is based on the average frequency estimated, measured or extrapolated from records over a large number of years and is usually expressed as the chance of a particular flood level being exceeded in any one year. For example, a 1 in 100 or 1% flood is that which would, on average, be expected to occur once in 100 years, though it could happen at any time
Local Development Framework (LDF)	A non-statutory term used to describe a folder of documents which includes all the local planning authority's Local Development Documents (LDDs). The local development framework will also comprise the statement of community involvement, the local development scheme and the annual monitoring report
Local Development Documents (LDD)	All development plan documents which will form part of the statutory (LDDs) development plan, as well as supplementary planning documents which do not form part of the statutory development plan
Ordinary watercourse	All rivers, streams, ditches, drains, cuts, dykes, sluices, sewers (other than public sewer) and passages through which water flows which do not form part of a Main River. Local authorities and, where relevant, Internal Drainage Boards have similar permissive powers on ordinary watercourses, as the Environment Agency has on Main Rivers
Pathways	These provide the connection between a particular source (e.g. high river or tide level) and the receptor that may be harmed (e.g. property). In flood risk management, pathways are often 'blocked' by barriers, such as flood defences structures, or otherwise modified to reduce the incidence of flooding.
Pluvial flooding	Usually associated with convective summer thunderstorms or high intensity rainfall cells within longer duration events, pluvial flooding is a result of rainfall-generated overland flows which arise before runoff enters any watercourse or sewer.
Precautionary approach	The approach to be used in the assessment of flood risk which required that lack of full scientific certainty, shall not be used to assume flood hazard or risk does not exist, or as a reason for postponing cost-effective measures to avoid or manage flood risk
Resilience	Constructing the building in such a way that although flood water may enter the building, its impact is minimised, structural integrity is maintained and repair, drying & cleaning are facilitated

Terms	Definition
Resistance	Constructing a building in such a way as to prevent flood water entering the building or damaging its fabric. This has the same meaning as flood proof
Receptors	Things that may be harmed by flooding (e.g. people, houses, buildings or the environment)
Residual risk	The risk which remains after all risk avoidance, reduction and mitigation measures have been implemented
Runoff	The flow of water, caused by rainfall, from an area which depends on how permeable the land surface is. Runoff is greatest from impermeable areas such as roofs, roads and hard standings and less from vegetated areas - moors, agricultural and forestry land.
Sequential approach	The sequential approach is a risk-based method to guide development away from areas that have been identified through a flood risk assessment as being at risk from flooding. Sequential approaches area already established and working effectively in the plan-making and development management processes.
Source	Source refers to a source of hazard (e.g. the sea, heavy rainfall).
Source-pathway-receptor model	For there to be flood risk, the three components of flood risk - the source or the hazard, the receptors affects by the hazard and the mechanism of transfer between the two - must all exist.
Surface water management	This activity focuses on the assessment and management of flood risk within the urban environment from sources primarily resulting from intense rainfall. Surface water management should understand the performance of the urban drainage network, where exceedance flow routes would form and what impact this would have. Solutions to surface water flood risk can involve green infrastructure provision to capture and direct these exceedance flows to lower vulnerable areas or open space. New development can provide solutions to reducing runoff not only from the proposed development but also from existing areas. This should be considered in the SFRA in critical areas where development is planned upstream of flooding hotspots.
Sustainable Drainage Systems (SUDS)	A sequence of management practices and control structures, often referred to as SUDS, designed to drain water in a more sustainable manner than some conventional techniques. Typically these are used to attenuate runoff from development sites.
Sustainability Appraisal (SA)	An integral part of the plan-making process which seeks to appraise the economic, social and environmental effects of a plan in order to inform decision-making that aligns with sustainable development principles
TUFLOW	TUFLOW is a software package used for 2-Dimensional river modelling. It is used as an analysis tool for flood risk management analysis.
Vulnerability Classes	PPS25 provides a vulnerability classification to assess which uses of land maybe appropriate in each flood risk zone.

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