



Peterborough Strategic Flood Risk Assessment Update – Level 1 Report

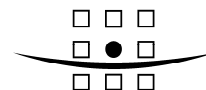
Peterborough City Council

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Final Report

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EXECUTIVE SUMMARY

Study Objectives

Following the recent issue of revised planning policy expressed in Planning Policy Statement 25 (PPS25) and its associated Practice Guide, the Peterborough City Council (Council) now wishes to review the previous Strategic Flood Risk Assessment (SFRA) completed in November 2005 and update it as appropriate. It aims to make optimum use of the previous SFRA, with data and findings being brought forward wherever they remain valid. The key objectives of the study are to:

- Provide a reference and policy document to inform preparation of the Local Development Framework (LDF) for the Peterborough City;
- Ensure that the Council meets its obligations under the Department of Communities and Local Government's (DCLG's) Planning Policy Statement 25 "Development and Flood Risk". The guidance note is referred to here as PPS25;
- Provide a reference and policy document to assist and inform private and commercial developers of their obligations under PPS25; and
- Present the outcome of the initial Level 1 update including recommendations for future work.

An increased scope Level 2 SFRA as per paragraph E6 of PPS25 will be required to facilitate possible application of the Exception Test and to address flood risk issues within the City, prior to the submission of emerging LDF documents if new development is proposed in flood risk areas depending on its vulnerability. This more detailed SFRA should consider the detailed nature of the flood hazard by building upon the findings of this Level 1 update and by fully taking account of the presence of flood management measures and climate change impacts through further detailed hydraulic modelling.

Outputs

The principal output from the study is a set of maps, which categorises the Peterborough City into Flood Zones according to PPS25. It depicts the presence of flood defences where they exist. These maps have been produced adopting a robust assessment to give the Council sufficient information so as to have an overall view of flood risk areas for strategic planning purposes.

Methods of assessment and limitations of the SFRA outputs, including further recommendations to address them, are also presented. The Level 1 SFRA evaluates the present-day (year 2007) situation and future implications with increased peak flood flows to allow for projected climate change.

The SFRA has considered all sources of flooding within the City, as explained in this report and related figures, although the accompanying 1 in 10,000 scale SFRA maps only show the Flood Zones as defined in PPS25.

Data Sources

Figure 5 and Appendix D show the extent of data that was made available for the study.

Co-operation

The SFRA was carried out with the co-operation and support of the Council, the Environment Agency, Internal Drainage Boards and Anglian Water.

GLOSSARY

Adoption of sewers	The transfer of responsibility for the maintenance of a system of sewers to a sewerage undertaker
Afflux	Increase in upstream flood level caused by an obstruction to flow in a watercourse or on a <i>floodplain</i> .
Annual flood probability	The estimated probability of a flood of given magnitude occurring or being exceeded in any year. Expressed as, for example, 1-in-100 chance or 1 per cent.
Antecedent conditions	The condition of a <i>catchment</i> area at the start of a rainfall event.
Artificial drainage system	A constructed drainage system such as a drain, sewer or ditch.
Attenuation	To reduce the peak flow and increase the duration of a flood event.
Balancing pond	A pond designed to attenuate flows by storing runoff during the peak flow and releasing it at a controlled rate during and after the storm. Also known as wet detention pond.
Basin	A ground depression acting as a flow control or water treatment structure that normally is dry and has a proper outfall, but which is designed to detain stormwater temporarily.
Boundary condition	A specified variable, typically water level or flow, which is defined at the edge of the spatial extent of a model to allow the model to solve its governing equations.
Brownfield site	Any land or site that has been previously developed.
Catchment	The area contributing flow or <i>runoff</i> to a particular point on a watercourse.
Catchment Flood Management Plan (CFMP)	A strategic planning tool through which the Environment Agency seeks 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 temperature and weather patterns both natural and as a result of human activity, primarily greenhouse gas emissions.
Coastal flooding	Flooding from the sea.

Commuted sum	A single payment made at the beginning of an agreement to cover maintenance for an agreed period of time.
Critical ordinary watercourse	An <i>Ordinary watercourse</i> which the Environment Agency and other operating authorities agree is critical because it has the potential to put at risk from flooding large numbers of people and property.
Culvert	Covered channel or pipe that forms a <i>watercourse</i> below ground level.
Design criteria	A set of standards agreed by the developer, planners and regulators that the proposed system should satisfy.
Design event	An historic or notional <i>flood event</i> of a given <i>annual flood probability</i> , against which the suitability of a proposed development is assessed and <i>mitigation measures</i> , if any, are designed.
Design flood level	The maximum estimated water level during the <i>design event</i> .
Detention basin	A vegetated depression that normally is dry except following storm events. It is constructed to store water temporarily to attenuate flows and may allow <i>infiltration</i> of water to the ground.
Development	The carrying out of building, engineering, mining or other operations in, on, over or under land or the making of any material change in the use of any buildings or other land.
Discharge	Rate of flow of water.
Extended detention basin	A detention basin where the runoff is stored beyond the time for <i>attenuation</i> . This provides extra time for natural processes to remove some of the pollutants in the water.
Field drainage	System of drains to control the <i>water table</i> in agricultural land.
Filter drain or filter trench	A linear drain consisting of a trench filled with a permeable material, often with a perforated pipe in the base of the trench to assist drainage. Its purpose is to store and conduct water, but may also permit <i>infiltration</i> .
Filter strip	A vegetated area of gently sloping ground designed to drain water evenly off impermeable areas and filter out silt and other particulates.
Filtration	The act of removing sediment or other particles from a fluid by passing it through a filter.

First flush	The initial <i>runoff</i> from a site/ <i>catchment</i> following the start of a rainfall event. As <i>runoff</i> travels over a catchment it will collect or dissolve pollutants and the “first flush” portion of the flow may be the most contaminated as a result. This is especially the case for intense storms and in small or more uniform catchments. In larger or more complex catchments pollution wash-off may contaminate runoff throughout a rainfall event.
Flap valve	A simple form of non-return valve, employing a hinged flap to prevent reverse flow.
Flood defence	Flood defence infrastructure, such as flood walls and embankments, intended to protect an area against flooding, to a specified <i>standard of protection</i> .
Flood defence crest level	The level to which flood defences are constructed, that is the level of the top of flood walls and embankments, expressed relative to Ordnance Datum.
Flood event	A flooding incident characterised by its level or <i>flow hydrograph</i> .
Flood probability	The estimated probability of a flood of given magnitude occurring or being exceeded in any specified time period. See also <i>annual flood probability</i> .
Flood risk	An expression of the combination of the <i>flood probability</i> and the magnitude of the potential consequences of the <i>flood event</i> .
Flood risk assessment	A study to assess the risk of a site or area flooding, and to assess the impact that any changes or development in the site or area will have on <i>flood risk</i> .
Flood storage	The temporary storage of excess runoff or river flow in ponds, basins, reservoirs or on the <i>floodplain</i> during a flood event.
Flood Zones	Flood Zones are defined in Table D.1 of Planning Policy Statement (PPS) 25: Development and Flood Risk. They indicate land at risk by referring to the probability of flooding from river and sea, ignoring the presence of defences. The fluvial Flood Zones are usually derived using a two-dimensional hydraulic model called JFLOW, into which a national coarse Digital Terrain Model is fed. However, in some instances, more detailed modelling can be undertaken, using refined information.

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.
Flow control device	A device used to manage the movement of surface water into an out of an <i>attenuation</i> facility, eg weirs.
Fluvial flooding	Flooding from a river or other <i>watercourse</i> .
Freeboard	The difference between the <i>flood defence crest level</i> and the <i>design flood level</i> .
Functional floodplain	Land where water has to flow or be stored in times of flood. It includes the land which would flood with an annual probability of 1 in 25 (4%) and the designated washland, as agreed between Peterborough City Council and the Environment Agency.
Greenfield runoff rate	The rate of <i>runoff</i> that would occur from the site in its undeveloped (and therefore undisturbed) state.
Greywater	Greywater is water from sinks, baths, showers and domestic appliances. Kitchen sink or dishwasher wastewater is not generally collected for use, as it has high levels of contamination from detergents, fats and food waste, making filtering and treatment difficult and costly.
Groundwater	Water in the ground, usually referring to water in the saturated zone below the <i>water table</i> .
Groundwater flooding	Flooding caused by <i>groundwater</i> escaping from the ground when the <i>water table</i> rises to or above ground level.
Highway authority	A local authority with responsibility for the maintenance and drainage of highways maintainable at public expense.
Hydrograph	A graph that shows the variation with time of the level or discharge in a <i>watercourse</i> .
Impermeable surface	An artificial non-porous surface that generates a surface <i>water runoff</i> after rainfall.
Infiltration (to the ground)	The passage of surface water through the surface of the ground.
Infiltration basin	A dry basin designed to promote <i>infiltration</i> of surface water to the ground.
Infiltration capacity	A soil characteristic determining or describing the maximum rate at which water can enter the soil.

Infiltration trench	A trench, usually filled with permeable granular material, designed to promote infiltration of surface water to the ground.
Land drain	Drain used in agriculture to control the <i>water table</i> and reduce the frequency with which land becomes waterlogged.
Local Development Documents	Documents that set out the spatial strategy for local planning authorities which comprise development plan documents.
Local Development Framework	Framework which forms part of the statutory development plan and supplementary planning documents which expand policies in a development plan document or provide additional detail.
Local planning authority	Body responsible for planning and controlling development, through the planning system.
Main River	A watercourse designated on a statutory map of Main rivers, maintained by Department for Environment, Food and Rural Affairs (DEFRA).
Material consideration	Matters which need to be taken into account by a planning authority when determining an application for planning permission.
Mitigation measure	A generic term used in this guide to refer to an element of <i>development</i> design which may be used to manage <i>flood risk</i> to the <i>development</i> , or to avoid an increase in <i>flood risk</i> elsewhere.
Model Agreement	A legal document that can be completed to form the basis of an agreement between two or more parties regarding the maintenance and operation of sustainable water management systems.
Ordinary watercourse	A watercourse which is not a private drain and is not designated a <i>Main river</i> .
Overland flow flooding	Flooding caused by surface water <i>runoff</i> when rainfall intensity exceeds the infiltration capacity of the ground, or when the soil is so saturated that it cannot accept any more water.
Passive flood plain	Areas that are within the “natural” <i>floodplain</i> but are not now subject to frequent flooding, because of the presence of flood alleviation measures.

Permeable surface	A surface that is formed of material that is itself impervious to water but, by virtue of voids formed through the surface, allows infiltration of water to the sub-base – for example, concrete block paving.
Pond	Permanently wet depression designed to retain stormwater above the permanent pool and permit settlement of suspended solids and biological removal of pollutants.
Precautionary principle	The approach, to be used in the assessment of <i>flood risk</i> , which requires that lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to avoid or manage <i>flood risk</i> .
Rainwater use systems	A system that collects rainwater from where it falls rather than allowing it to drain away, treats and stores it and then distributes it for use. This includes water that is collected within the boundaries of a property, from roofs and surrounding surfaces, including areas of hardstanding and pervious paving.
Rapid Inundation Zone	For this project, rapid inundation zone was defined as an area that can be expected to flood to a depth of 0.3metres within half an hour of a possible breach in a relevant raised defence.
Retention pond	A pond where runoff is detained for a sufficient time to allow settlement and possibly biological treatment of some pollutants.
Return period	A term sometimes used to express <i>flood probability</i> . It refers to the estimated average time gap between floods of a given magnitude, but as such floods are likely to occur very irregularly, an expression of the <i>annual flood probability</i> is to be preferred.
River flooding	See <i>fluvial flooding</i> .
Runoff	Water flow over the ground surface to the drainage system. This occurs if the ground is impermeable or saturated, or if rainfall is particularly intense.
Sequential Approach	A risk avoidance approach to ensure that sites at little or no risk of flooding are developed in preference to areas at higher risk. It should be applied at all levels and scales of the planning process both between and within <i>Flood Zones</i> .
Sequential test	Application of a <i>sequential approach</i> when allocating new development by Local Planning Authorities, to demonstrate that there are no reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed. It should first direct development to <i>Flood Zone 1</i> , where possible, and then

sequentially to *Flood Zones 2* and *3*, and to the areas of least flood risk within *Flood Zones 2* and *3*. Flood vulnerability of any proposed development should also match the expected degree of flood risk.

Sewerage undertaker	This is a collective term relating to the statutory undertaking of water companies that are responsible for sewerage and sewage disposal, including surface water from roofs and yards draining through public sewers.
Soakaway	A subsurface structure into which surface water is conveyed to allow infiltration into the ground.
Source control	The control of runoff or pollution at or near its source.
Standard of protection	The estimated probability of a <i>design event</i> occurring, or being exceeded, in any year. Thus it is the estimated probability of an event occurring which is more severe than those against which an area is protected by <i>flood defences</i> .
Strategic flood risk assessment	A study to examine <i>flood risk</i> issues on a sub-regional scale, typically for a river <i>catchment</i> or local authority area during the preparation of a development plan.
Sustainable drainage systems (SUDS)	A sequence of management practices and control structures, often referred to as SUDS, designed to drain surface water in a more sustainable manner. Typically, these techniques are used to attenuate rates of <i>runoff</i> from <i>development sites</i> .
Swale	A shallow vegetated channel designed to conduct and retain water, but may also permit infiltration; the vegetation filters particulate matter.
Treatment	Improving the quality of water by physical, chemical and/or biological means.
Water table	The level of <i>groundwater</i> in soil and rock, below which the ground is saturated.
Watercourse	Any natural or artificial channel that conveys surface water.
Wetlands	An area where saturation or repeated inundation of water is the determining factor in the nature of the plants and animals living there.
Whole-life costing	Accounting system that considers all the costs (private and social) that accrue to the initiation, provision, operation, maintenance, servicing and decommissioning over the useful life of an asset or a service.

ABBREVIATIONS

AAP	Area Action Plan
AEP	Annual Event Probability
AMP	Asset Management Plan
AVM	Automatic Voice Messaging
CAD	Computer Aided Drawing
CFMP	Catchment Flood Management Plan
CIRIA	Construction Industry Research and Information Association
DCLG	Department for Communities and Local Government
COW	Critical Ordinary Watercourse
DEFRA	Department for Environment, Food and Rural Affairs
DPD	Development Plan Document
DTM	Digital Terrain Model
EA	Environment Agency
EERA	East of England Regional Assembly
EFO	Extreme Flood Outline
FAS	Flood Alleviation Scheme
FEH	Flood Estimation Handbook
FRA	Flood Risk Assessment
FRC	Flood Risk Consultees
FSR	Flood Studies Report
FZ	Flood Zone
GIS	Geographical Information System
IDB	Internal Drainage Board
IGS	Integrated Growth Study
LDD	Local Development Documents
LDF	Local Development Framework
LDS	Local Development Scheme
LiDAR	Light Detection And Ranging
LPA	Local Planning Authority
NFCDD	National Flood and Coastal Defence Database
Ofwat	Office of Water Services
OP	Opportunity Peterborough
OS	Ordnance Survey
OST	Office of Science and Technology
PPG25	Planning Policy Guidance Note 25 – Development and Flood Risk
PPS25	Planning Policy Statement 25 – Development and Flood Risk
RFRA	Regional Flood Risk Assessment
RPB	Regional Planning Body
RSS	Regional Spatial Strategy
SA	Sustainability Appraisal
SAR	Synthetic Aperture Radar
SFRA	Strategic Flood Risk Assessment
SoP	Standard of Protection
SUDS	Sustainable Drainage Systems
WCS	Water Cycle Strategy

1 BACKGROUND

1.1 General Overview

In December 2004 Royal Haskoning was appointed by Peterborough City Council (Council) to produce a Strategic Flood Risk Assessment (SFRA) under the framework of Planning Policy Guidance Note 25¹ (PPG25). The SFRA² was then completed in November 2005. Following the recent issue of revised planning policy expressed in Planning Policy Statement 25³ (PPS25) and its associated Practice Guide⁴, the Council now wishes to review the previous SFRA and update it as appropriate. It aims to make optimum use of the previous SFRA, with data and findings being brought forward wherever they remain valid.

This Level 1 SFRA report presents the outcome of the initial update including further recommendations for future work.

1.2 Scope

The scope for this SFRA update is in accordance with the Royal Haskoning proposal dated June 2007.

The Council is in the process of preparing its Local Development Framework (LDF) as required by the Planning and Compulsory Purchase Act 2004. The Regional Spatial Strategy (RSS) for the East of England⁵ has provided Peterborough with high figures for housing and employment growth. This will require the uptake of land in the Peterborough area, which will need to be informed by the most accurate picture of flood risk possible to enable development to be sited in appropriate locations, minimising damage to property and threat to life. Flood risk is a key consideration in the allocation of land for development especially with the current concerns of climate change.

To allow the most suitable locations for this growth, the Council, in conjunction with Opportunity Peterborough (OP), has commissioned an Integrated Growth Study (IGS). This will identify and evaluate options for the future growth of Peterborough and contribute towards preparation of the Core Strategy 'Preferred Options Report'.

In accordance with the Council's brief, the key aim of the SFRA update is to provide relevant Flood Zone information to inform their IGS. In addition, this Level 1 SFRA report takes advantage of the improved technical data and the development proposals now available since 2005. It broadly assesses all sources of flooding and the other key flood risk considerations expected by PPS25 across entire Council's area.

Royal Haskoning produced this Level 1 report in close consultation with the Council, the Environment Agency, Anglian Water and the Internal Drainage Boards (IDBs).

1.3 Study Area

Peterborough is now a Unitary Authority bounded by six planning authority areas:

- Rutland ;
- South Kesteven District;

- South Holland District;
- Fenland District;
- Huntingdonshire District; and
- East Northamptonshire District.

Peterborough is a thriving city - a regional centre for commerce, industry, transport and leisure. It is rapidly expanding to meet the demand for new houses, and is home to a community of diverse cultures. The city, already home to some 163,300 people (mid 2006 count), continues to expand with new housing developments, the largest of which is Hampton, south of the city. Many of the surrounding villages, such as Eye, Yaxley and Ginton, have also seen great expansion to accommodate the demand for new homes.

Figure 1 shows the study area including key features such as main villages, watercourses, roads and railways.

The city is surrounded by contrasting countryside - gently undulating limestone and clay hills to the west, and the flat expanse of the Fens to the east. Solid geology is exposed at the western portion of the study area where geological boundaries exist between the Northampton sands, Lincolnshire limestone and Blisworth Limestone. There is also significant faulting in this area resulting in a non-uniform groundwater flow.

Peterborough is one of the UK's four Environment Cities and is now aiming to become the UK's Environmental Capital by exceeding normal environmental standards. To help achieving Peterborough's this aspiration, the SFRA will identify opportunities to reduce flood risk and for good practice in sustainable management of the water environment.

1.4 Data Used

The data used in the study derives from several sources, most notably the Environment Agency and the Council. The data register provided in **Appendix D** was prepared in accordance with Royal Haskoning's quality management system.

The key types of data obtained include:

- OS background mapping;
- Topographic survey – LiDAR, ground surveys and watercourse surveys;
- National Flood Zones and historic flooding records from all sources of flooding ;
- Flood defences, structures and flood alleviation measures;
- Flood risk studies and modelling reports;
- Catchment Flood Management Plans;
- Flood warning and Flood watch areas;
- Local plan and LDF documents and development proposals; and
- Guidance on flood risk management and climate change.

1.5 Limitations and Assumptions

The conclusions of this SFRA are based on information currently available. The areas of the proposed potential development sites are indicative only. The final sites will be subject to the outcome of several ongoing studies by the Council that will provide the evidence base for the emerging Local Development Framework.

The Level 1 SFRA maps (1 in 10,000 scale) for the entire Peterborough City are based on the Environment Agency's Flood Zones data supplied to Royal Haskoning, as per PPS25 Table D.1 from their latest modelling information.

The effects of possible climate change over the next 50 to 100 years have been represented for the Flood Zone 3a (annual probability >1% for river flooding or >0.5% for flooding from the sea) in the SFRA maps by the use of the present day Flood Zone 2 (annual probability 1% - 0.1% for river flooding or 0.5% - 0.1% of sea flooding). Although it provides a broad indication of climate change impacts based on this simplified approach, the users should treat the Level 1 SFRA outputs with a precautionary proviso in particular within low-lying areas in eastern parts of the City where tidal influence is dominant as a long-term minimum duration of 100yrs is preferential for strategic development planning purposes to address climate change issues. In any case, a Level 2 SFRA should further investigate climate change impacts using the latest government guidance whilst considering the presence of existing flood defences, prior to considering any new significant development locations within the areas that may be subject to possible flooding.

2 CATCHMENT DESCRIPTION AND CAUSES OF FLOODING

2.1.1 General

Figure 2 illustrates the river system within the Peterborough City which largely falls within the following two main river catchments:

- River Nene; and
- River Welland.

2.1.2 River Nene Catchment

The River Nene passes through Wansford village prior to entering the western boundary of the Peterborough City and flows at the southern parts of the City in an easterly direction, and then the city centre and finally leaves the City at the eastern side passing through the Whittlesey Washes and Dog-in-a-Doublet sluice.

Through Peterborough it carries extreme flows of about $150\text{m}^3/\text{s}$ in a 1 in 100 year event. The River Nene drains a natural catchment of 1711km^2 to Peterborough and a further catchment of 556km^2 giving a total catchment of 2267km^2 to the Wash. The River Nene ultimately flows into the Wash at Sutton Bridge. The tidal limit is now the Dog in Doublet Sluice built in 1936, 9km east (downstream) of the Town Bridge. Prior to this the tidal limit was in Peterborough.

North Level IDB's and Middle Level Commissioners IDB's drainage catchments also drain into the River Nene catchment within the eastern parts of the City.

The main river tributaries in the River Nene catchment that fall within the Peterborough City are:

- Billing Brook
- Castor Splash
- Orton Dyke
- Fletton Spring
- Stanground Lode
- Padholme Drain
- Morton's Leam
- Thorpe Meadows

2.1.3 River Welland Catchment

The River Welland passes through Stamford prior to entering the north-western boundary of the Peterborough City and flows at the northern parts of the City in an easterly direction, and then south of Market Deeping and finally alongside the Crowland Wash at the north-eastern side. The River Welland finally discharges into The Wash and it has a total catchment of 1600km^2 which includes a pumped catchment of 463km^2 . The tidal limit is at Spalding approximately 30km downstream of the Peterborough City.

Welland and Deeping IDB's and North Level IDB's drainage catchments also drain into the River Welland catchment.

The main river tributaries in the River Welland catchment within the Peterborough City are:

- Maxey Cut
- Peterborough Brooks System
 - Folley River
 - Car Dyke
 - Brook Drain
 - Werrington Brook
 - Paston Brook
 - Marholm Brook

Maxey Cut is an artificial embanked river channel which now forms the primary flow route for the River Welland east of Tallington village until it rejoins with the River Welland downstream of the Peakirk Pumping Station.

Peterborough Brooks catchment covers an area of approximately 74km² and consists of the northern part of the city of Peterborough and a rural area to the northwest of the city. It includes 52km² of pumped catchment that drains to Peakirk Pumping Station.

The urban sub-catchment comprises the Werrington, Gunthorpe, Walton, New England, Bretton, Ravensthorpe and Westwood. Public surface water sewers discharge into the Werrington Brook, Paston Brook and Brook Drain. This urban sub-catchment is essentially flat and is principally drained by the Werrington and Paston Brooks. Some sections of these watercourses are contained in concrete lined channels and flows are influenced by several culverts and other hydraulic structures as described in Section 3.4.

The rural sub-catchment covers approximately 54km² which drains the low hills to the north-west of Peterborough and a small rural catchment to the east of the city that drains into Car Dyke.

2.2 Causes of Flooding

The possible causes of flooding within Peterborough City include:

- i. Overflow of watercourses and existing flood defences including water retention facilities such as flood storage reservoirs/washlands and storm water balancing ponds;
- ii. Breaching of flood defences (including flood storage areas);
- iii. Mechanical, structural or operational failure (including due to blockages) of hydraulic structures, pumps etc;
- iv. Localised surface water flooding (including sewer flooding, highway drainage flooding and overland flooding); and
- v. Groundwater flooding.

3 DATA COLLECTION AND REVIEW

3.1 Historic Flooding

3.1.1 General

Historical flood information from all sources of flooding has been collected from the previous SFRA and any new information received from Environment Agency, Council, IDBs and Anglian Water.

One of the key sources of flooding within the City is from the Environment Agency's main river network shown in **Figure 2**.

Figure 3 indicates the locations that are known to have flooded from all forms of flooding within Peterborough City. **Table B1** in **Appendix B** summarises the different historic flood events including an indication of causes of flooding (if known).

3.1.2 Flooding from watercourses

Appendix B indicates that main watercourses (e.g. River Nene, Thorpe Meadows and Peterborough Brooks) have caused some flooding incidents in the City.

3.1.3 Sewer flooding

Anglian Water, Council and Environment Agency Area staff were consulted and asked to provide information on previous sewer flooding and those areas deemed to be at potential risk.

Anglian Water reports the properties that are affected by sewer flooding to the Office of Water Services (Ofwat) as part of Director General Performance Measure 5 (known as DG5).

DG5 is the performance measure that Ofwat judges water companies by for sewer flooding. It covers two measures:

- The number of properties at risk of internal flooding from sewers due to hydraulic overloading within last ten years; and
- Properties which are internally flooded. Sewer flooding can be caused by temporary problems, such as blockages or sewer collapses, or because of hydraulic overloading.

The locations of previously flooded properties are covered by the Data Protection Act. For this reason Anglian Water is unable to supply a map indicating properties at risk of sewer flooding but they agreed to supply this information in an alternative less detailed format such as truncated post codes. This made it possible to broadly identify where sewer flooding has been occurred.

Table B1 includes the locations that have been subject to some localised sewer flooding (both surface and foul) according to the information released by Anglian Water. They are also mapped in **Figure 3** and **Figure 4**. The Anglian Water sewer system (surface, Foul and combined) which can affect the Peterborough City is also shown in **Figure 4**.

Anglian Water is currently investigating the entries on the DG5 register to identify the cause of flooding and to decide if an engineering solution is required. Delivery of any engineering solution will be determined by the severity and frequency of the flooding and also by the cost/ benefit of the solution. **Table B1** shows that following further locations also known to have issues that may be related to surface water sewers according to the information received from the Environment Agency and the Council:

- Corfe Avenue, Rockingham Grove and Cisbury Ring (south of Werrington);
- Merlin Business Park (east of Peterborough);
- Welland Close, Dogsthorpe; and
- Celta Road, Woodston.

Therefore, development that can adversely affect the above locations should be restricted until the cause of flooding has been fully identified and any engineering solutions to reduce the risk of flooding have been implemented. Also, upgrading of the existing Anglian Water Flag Fen Waste Water Treatment Works and Pumping Stations (e.g. Paston Reserve, Stanground Whittlesey Road, Yaxley Windsor Road and Castor Peterborough Road) may be required to accommodate the proposed major expansions of the City although this will be dependent on the chosen final preferred option in the emerging Core Strategy.

Anglian Water has indicated that they are happy to work closer with the Council through a wider Water Cycle Strategy (WCS) study to confirm which proposed development sites require off site network and pumping station upgrades including its implications (e.g. financial, environmental and timing constraints). For the WCS study, the results from an enhanced sewer model that is currently being developed would be available. Therefore, it is essential that Anglian Water is closely involved in the selection of Preferred Options and site allocations (including their phasing plans) to achieve the most beneficial outcome for the City. It is also important that the developers of major sites to inform their Flood Risk Assessments with the results of consultations with Anglian Water and where necessary the Environment Agency, in respect of sewerage flooding in all parts of the network. This is because sewer flooding can arise in new areas with no historical issues, in particular with the cumulative impact of climate change and new development. As DG5 data is simply a snapshot in time, Anglian Water would be able to update and advise on a site by site basis.

3.1.4 Highway drainage and overland flooding

Highways section of the Council has been consulted to obtain highway flooding related incidents. The Council has reported that there are no major issues other than the minor incidents that are routinely addressed by their drainage contractor based on the entries in their "Reactive Gully Hotspots Quarterly List". Nevertheless, **Table B1** includes two locations (i.e. Welland Close in Dogsthorpe and Celta Road in Woodston) from this list as they may be also related to capacity issues of the Anglian Water sewer system according to the Council but this may need further investigation.

Ashton Village (North East of Peterborough) is also known to have highway flooding problems largely due to overland runoff from adjacent high ground following heavy rainfall according to the Welland and Deepings IDB and the Council.

3.1.5 Groundwater flooding

Groundwater flooding is most likely to occur in low-lying areas underlain by permeable rocks (aquifers). These may be extensive regional aquifers, such as Chalk or sandstone, or may be localised sands or river gravels in valley bottoms underlain by less permeable rocks. Groundwater flooding takes longer to dissipate because groundwater moves much

more slowly than surface water and will take time to flow away underground. Groundwater flood events are the result of prolonged and extreme recharge events causing localised flooding to a population centre. However, there needs to be a clear distinction between normal groundwater discharge (springs) and a groundwater-flooding event.

The Environment Agency's Groundwater Team was consulted to obtain any information records of previous ground water flooding incidents in the area. In addition, Defra funded groundwater flooding scoping report⁶ and associated maps were reviewed. From this information no records of previous groundwater flooding was noted within the City.

According to the advice received from the Environment Agency and the information gleaned from the geological and OS maps, the following observations can be made.

In general, to identify potential Groundwater flooding risk areas consideration should be given to the following:

- Solid and drift Geology (BGS Sheet 157 Stamford and sheet 158 Peterborough);
- Geological features such as faulting, geological boundaries both solid and drift;
- Current River and drainage networks;
- Minor tributaries and dried river valleys - these can be identified on the solid drift maps as river terrace deposits, alluvium, extending from existing river system, good indication of historical river network;
- Hydrogeological features such as swallow holes;
- Population centres close to or built on the features identified in this section;
- Groundwater flow; and
- Groundwater levels.

Further consideration will be needed on:

- Quarrying and open cast mineral workings as they may affect localised groundwater flow;
- Historical mine dewatering as groundwater levels may recover over time;
- Large abstractions and localised groundwater depression as groundwater level will recover if a licence is revoked; and
- New Localised developments in existing development areas where groundwater levels are close to the surface as foundations of new developments may re-route groundwater flow.

Solid geology is exposed at the western portion of the study area where geological boundaries exist between the Northampton sands, Lincolnshire limestone and Blisworth Limestone. There is also significant faulting in this area resulting in a non-uniformed groundwater flow. There are a number of springs present on the OS base maps, and the BGS solid and drift geology maps indicate historical tributaries and river networks.

There is a network of boreholes that the Environment Agency uses for monitoring ground water levels within the Anglian Region, Northern Area. Originally, these boreholes were mainly used for water resources purpose but they are now also used for monitoring flood risk from groundwater. **Figure 8** shows the locations of the monitoring boreholes relevant to the City and the recorded levels to date show very little groundwater flood risk.

Potential new development areas coincide with the features identified in this section of the report will need further review through site-specific FRAs.

3.2 Topographical Data

The Environment Agency has LiDAR (Light Detection And Ranging) and SAR data for the City and they also have several watercourse surveys – see **Table C1 in Appendix C**. The IDBs also have carried out several watercourse surveys. The Council can obtain this information from the Environment Agency and the IDBs for producing an updated Level 2 SFRA at a future date.

The LiDAR spatial resolution in this area is 2m. Taken together with the generally accepted vertical accuracy of $\pm 11\text{cm}$ to 25cm , this indicates that in the areas covered by the LiDAR data would provide a good representation of ground surface for the required flood risk mapping where modifications to the current Flood Zones are required.

The vertical accuracy of NEXTMAP SAR data quoted by the suppliers, Intermap, for the study area is $\pm 0.5\text{m}$ for the Surface Model and $\pm 0.7\text{m}$ for the DTM at a positional accuracy of up to $\pm 1.25\text{m}$. SAR data is provided at a spatial resolution of 5m covering the whole of City (i.e. includes outside LiDAR coverage).

Figure 5 graphically shows the extent of LiDAR and other watercourse surveys currently available within the City.

3.3 Existing Studies and Hydraulic Models

Table C1 summarises the key existing flood risk and drainage studies and hydraulic models within the City. This information is also graphically presented in **Figure 5**.

The data register in Appendix D gives the data collected during this Level 1 SFRA update and the key studies since the completion of previous SFRA in November 2005. These include:

- Welland Catchment Strategic Model Final Report⁷, Environment Agency, January 2007;
- River Nene Models Report⁸, Environment Agency, May 2007;
- Appraisal of Flood Risk at Peterborough Riverside Regeneration Area⁹, Opportunity Peterborough, May 2007
- River Nene Catchment Flood Management Plan (Draft Plan – Main Stage)¹⁰, Environment Agency; and
- River Welland Catchment Flood Management Plan (Draft Plan – Scoping Stage)¹¹, Environment Agency.

3.4 Land at Flood Risk

The land at risk is depicted in terms of Environment Agency's Flood Zones, historic flood outlines and the locations known to have some flooding problems. This includes floodplain of the River Nene and River Welland including their tributaries. Table D.1 and Table D.2 of PPS25 define the Environment Agency's Flood Zones and provide flood risk vulnerability classification, including policy aims and Flood Risk Assessment (FRA) requirements.

The sources of flooding and historic flooding information are identified above. **Figure 6** shows the Flood Zones and allocated sites in Peterborough City. **Figure 9** shows similar information on flood risk including the proposed potential key development sites. Therefore,

the land at risk of flooding shown in these figure should be considered in conjunction with historic flooding information given in **Figure 3**, **Figure 4** and Section 3.1.

The non main rivers marked in 'orange line' in **Figure 7** are managed by IDBs. There are no historical flooding records associated with these drains other than at Ashton and Woodcroft Castle villages, that are located within the Welland and Deepings IDB. However, it is believed that flooding at Ashton was largely due to surface water runoff from adjacent high ground, while Woodcroft Castle flooding was due to general backing up of water levels from the Brook Drain.

According to the IDB, the drains provide a Standard of Protection (SoP) of 1 in 100 years. In accordance with the IDB policy statements and the consultations carried out during the previous SFRA, it has been assumed that the IDB drains in both Welland and Deepings and North Level drainage districts are generally at bankfull capacity for the 100 year return period and the IDBs will continue to maintain this standard when considering the effects of climate change. However, further consultation with the IDBs will be required to assess the actual standards and surface water management needs when proposing new development areas within their districts. In addition, impacts of other forms of flooding (including from the Environment Agency main rivers and sea) and residual flood risk management will need further consideration.

3.5 Existing Flood Management Measures

3.5.1 General

Figure 7 identifies the key flood risk management structures in the City as agreed with the Environment Agency. They comprise:

- Raised flood embankments and flood walls;
- Designated flood storage areas/ washlands;
- Sluices; and
- Pumping Stations.

In addition to the measures shown in **Figure 7** there may be several further defacto defences (i.e. major infrastructure such as road and railway embankments that perform a secondary flood defence function). **Figure 8** shows such defences that have been identified during this Level 1 SFRA update and which will need further assessment and confirmation through a future Level 2 SFRA update. It is important to identify defacto defences as future changes to them can affect any flood risk areas protected by them. This figure also shows the locations of groundwater monitoring boreholes in the area.

The Environment Agency has the responsibility for looking after the formal defences that are owned by them. In addition to inspection and routine maintenance of their formal defences and other structures, the Environment Agency carries out the routine maintenance, such as bank clearance or in-channel work to remove weed growth and silt, and non-routine maintenance (e.g. removal of blockages) of the designated main rivers.

The maintenance and operation of all key hydraulic structures including flood defences has a significant impact upon flood risk management and it is therefore critical to identify the owners as well as the condition of such structures during Level 2 SFRA update.

A brief description of the existing flood risk management measures managed by various organisations is given below.

3.5.2 Environment Agency

River Nene

The Dog in a Doublet Sluice structure provides a flood defence against the tidal inflow from the Wash and water retention through the city centre. Orton Sluice structure also retains water levels within the Nene system upstream of the city centre. A flood defence embankment commences downstream of the A1139 Fletton Parkway on the left bank (known as North Barrier Bank). Stanground Sluice structure diverts flood water into the Nene Wash via Mortons Leam during large events. The South Barrier Bank that ties into high ground near Stanground contains the flood water within the Nene Wash during floods as it takes several days to discharge flood water into the tidal section of the River Nene.

There is a raised flood bank on the left bank, west of Water Newton, but this bank may be privately owned and maintained according to NFCDD.

The Padholme catchment is drained to the non-tidal section of the River Nene via the Environment Agency's pumping station which has a catchment area of 610ha. This catchment is also benefiting from a small off-line flood storage area maintained by the Environment Agency.

Fletton Spring also has a small off-line flood storage area near Fletton Fields.

River Welland (including Peterborough Brooks)

Maxey Cut is an artificial river channel which now forms the primary flow route for the River Welland east of Tallington village until it rejoins with the River Welland downstream of the Peakirk Pumping Station. It prevents larger flood flows entering the original course of the River Welland through Market Deeping and Deeping St James. Maxey cut has raised embankments along its entire length. The Crowland Wash is located downstream of the confluence of the Maxey Cut and the River Welland at the north-eastern boundary of the City although it has not been used in practice for flood storage since it was built.

There are sections of raised defences along the original course of the River Welland, most notably downstream of Market Deeping.

There has been a considerable amount of urbanisation in the Peterborough Brooks catchment (74km²) since 1970s which has led to the following improvement works:

- Installation of the automated Werrington Penstock (also known as Dukesmead Penstock) on the Marholm Brook;
- Installation of a pumping station at Peakirk draining a pumped catchment of 52km²; and
- Channel enlargement in Brook Drain.

The Werrington Brook drains the heavily urbanised north eastern parts of Peterborough and the Marholm Brook rural subcatchment east of the East Coast railwayline. Flow into the Werrington Brook is controlled by an automated penstock, Werrington Penstock. This

penstock automatically shuts when the water levels in Marholm Brook exceed a threshold level at Corfe Avenue further downstream. Small lengths of Paston Brook and Werrington Brook have raised flood embankments. At the downstream end of Werrington Brook a large balancing pond (Cuckoos Hollow Lake) controls outflows into the Car Dyke.

Certain sections of the Car Dyke and the whole length of the Folley River have raised flood embankments.

3.5.3 Internal Drainage Boards (IDBs)

Welland and Deeping IDB

The only embanked watercourse within the study area is Maxey Outgang Drain at its eastern end where it crosses the Fen. The only pumping station within the area is Maxey North Fen where two small pumps are housed. The remaining catchment drains by gravity to the River Welland, Maxey Cut and Brook Drain, through the IDB system.

North Level IDB

There are no raised defences within the study area although drainage is heavily managed with several pumping stations:

Pumping Station	Catchment Area	Completion Date
Dog-in-a Doublet	2484	1983 and recently improved to allow for the planned development
Cross Guns	6640	1977
Peakirk	89	1980
Newborough	3320	1973
Hundreds	822	1988

3.5.4 Peterborough City Council

At present, the Peterborough City Council (Council) does not maintain any raised defences within the City other than fulfilling general drainage aspects of non-main river watercourses and associated surface water balancing features.

In addition, the Council and the English Partnerships developed a strategy in 2004 for mitigating flood risk that aims to provide appropriate flood defence standards to the Padholme Drain catchment, enabling proposed development (as detailed in the Peterborough Local Plan 1st Replacement) to be undertaken. However, all improvement works originally planned as part of the strategy have not been implemented according to information from the Council. Phase 1 of the strategy has been completed which involves the reversal of the Adderly Drain (maintained by the North Level IDB) to the IDB's Dog in a Doublet catchment. The remaining works are planned to be completed by January/February 2008 which aim to improve Padholme Drain and the Pumping Station (maintained by the Environment Agency) and the Racecourse Drain (maintained by the Council).

3.6 Flood Warning and Emergency Response

3.6.1 Flood Warning

Within Peterborough City, as elsewhere in England, the responsibility for flood warning rests primarily within the Environment Agency. It provides flood warnings for designated Flood Warning Areas that are based on risk categories, which take into account factors such as the likelihood and impact of flooding, and the resulting risk for each area. The Environment Agency has supplied the details of present flood warning arrangements for the City, however, the Environment Agency continuously updates its flood warning system and therefore the relevant Agency Area staff should be contacted for the latest information. Currently flood warnings cover all main river reaches within the City.

3.6.2 Warning Dissemination

Flood Warnings are disseminated by the Environment Agency via a system known as Floodline Warning's Direct. The service is a free flood warning service that provides warnings directly to customers 24 hours a day by telephone, mobile, fax or pager. It replaces the older Automatic Voice Messaging System which was used to send out flood warnings direct to the public since 1996. The message details the level of warning issued, the area for which the warning is in force and advice on what action to take. As flood events develop the public is encouraged to phone Floodline for updates. This system requires residents of "at risk property" to register their telephone numbers with the Environment Agency. Concerned parties are able to obtain current flood warning information according to a particular river or Flood Warning Risk Area.

Other current methods of warning dissemination include:

- The media – warnings are issued through the media; they are broadcast on TV weather bulletins and on radio weather and travel reports. Flood warnings are also displayed on ITV Teletext regional weather pages (page 154) and on the BBC Ceefax (page 419).
- **Floodline 0845 988 1188** – offers callers the option to listen to recorded flood warning information 24 hours a day and speak to a trained operator for more advice.
- Internet – The EA's website www.environment-agency.gov.uk/flood contains live warning information.

If anyone has not currently registered their phone number but is at risk of flooding, they should consider contacting the Environment Agency.

The EA issues flood warnings using a set of four easily recognisable codes which include:

- **Flood Watch**, where flooding of low-lying land and roads is possible;
- **Flood Warning**, where flooding of homes, businesses and main roads is expected;
- **Severe Flood Warning**, where severe flooding is expected. Extreme danger to life and property; and
- **All Clear**, where flood watches or warnings are no longer in force.

A **Flood Watch** would be issued when water levels along the river are forecast to cause out-of-bank flooding of low-lying land and roads.

A **Flood Warning** is issued when the Environment Agency anticipate flooding to property. The trigger levels currently set for this are based on the levels of permanent dwellings.

The trigger for issue of a **Severe Flood Warning** is dependent on a number of factors, but is essentially used when there is thought to be extreme danger to life.

The Environment Agency generally aims to give a two-hour minimum lead time for all of the above levels of warning prior to any properties being flooded. However in certain cases of severe or “flash flooding” this may not always be possible. The Environment Agency can not provide flood warnings for surface water, road drains, sewer flooding and burst drains. The information on these will come from the IDBs, Highways Agency, Council, Anglian Water and the public. Certain areas may be at additional risk due to their location downstream of heavily urbanised areas and urban areas that have the potential for “flash flooding”, surcharging the capacity of existing sewers and watercourses.

3.6.3 Emergency Response

The Council has an emergency planning team but they have no formal responsibility or system for providing flood warning. During severe events they work within the general procedures set out in “**River (Fluvial) & Tidal - Flood Plan**”¹² that has been developed by the Cambridgeshire and Peterborough Resilience Forum to liaise with the emergency services, other Local Authorities and other partner Agencies such as the Environment Agency. The Flood Plan aims to provide a framework of procedures and guidelines in order to provide a flexible co-ordinated response to manage and alleviate the worst effects of flooding within Cambridgeshire and Peterborough. It covers the River Nene but little mention is given to the River Welland. Therefore, current Flood Plan needs updating to clarify that it fully covers the River Welland catchment within the City including the Peterborough Brooks system.

The Civil Contingencies Act 2004 places a duty on Category 1 Responders, namely, Local Authorities, Emergency Services and other Partner Agencies, to assess the risk of an emergency within, or affecting a geographical area. The risk of flooding in Cambridgeshire and Peterborough is regularly reviewed and risk assessed through the Community Risk Management Sub Group, which forms part of the Cambridgeshire and Peterborough Resilience Forum. Having identified the risk of flooding full impact and likelihood risk assessments will be undertaken and they will be included in the Community Risk Register. Details of specific Flood Risk Assessments for Cambridgeshire and Peterborough can be found by visiting the Cambridgeshire County Council website at: www.cambridgeshire.gov.uk/policing/civil/about/risks/register.

The only site-specific plan the Council has is for the North Bank Road (alongside the River Nene to the east of Peterborough and west of the Dog-in-a- Doublet sluice) as this road is subject to frequent flooding. For example, during this year this road has been closed about 10 times according to the Council.

The Council normally obtain the latest information of vulnerable groups from their records and their partners during an emergency event in order to deliver the required emergency response. The Council is currently working on a long-term project to encourage parish councils to establish ‘neighbourhood watch’ schemes to deal with flooding incidents. In some cases, flood wardens appointed by community group already work directly with the Environment Agency where flood risk is known (e.g. Thorpe Meadows).

The 'Command and Control' structure for a Cambridgeshire and Peterborough flood response will follow the existing model agreed within the County between all Responders and Partner Agencies as well as that contained within the Major Incident Plan. Emergency Services and other Partner Agencies will first decide where Operational Controls (Bronze) will be based. The Operational Controls (Bronze) will pass their exact positions to the relevant Tactical Commands (Silver), who will tell the Strategic Co-ordinating Group (Gold) as required.

In exceptional circumstances, having undertaken the Sequential Test and the Exception Test according to PPS25, if any development is allowed then emergency plans are to be prepared at a site-specific level. Evacuation plans should be in place in those areas known to be at risk of flooding and should make provision for:

- i. How flood warning is to be provided;
 - Availability of existing flood warning systems;
 - Rate of onset of flooding and available flood warning time; and
 - Method of dissemination of flood warning.
- ii. What will be done to protect the infrastructure of the development and contents, such as:
 - How more easily damaged items (including parked cars) will be relocated;
 - The potential availability of staff/occupants/users to respond to a flood warning; and
 - The potential time taken to respond to a flood warning.
- iii. Ensuring safe occupancy and access to and from the development, such as:
 - Occupant awareness of the potential frequency and duration of flood events;
 - Provision of safe access to and from the development;
 - Ability to maintain key services during an event;
 - Vulnerability of occupants, and whether rescue by emergency services will be necessary and feasible; and
 - Expected time taken to re-establish normal practices following a flood event (clean-up times, time to re-establish services etc.).

Where evacuation plans are required they need to consider the lifetime of the development by fully taking into account the prospective climate change impacts.

4 DEVELOPMENT AND FLOOD RISK ISSUES

4.1 PPS25

4.1.1 Overview

PPS25 is a new-style PPS reflecting the expectations of the Government's Planning Green Paper, *Planning: delivering a fundamental change*. It focuses on national policy and provides clarity on what is required at regional and local levels to ensure that decisions are made at the most appropriate level and in a timely fashion to deliver sustainable planning for development and flood risk. Some of the key requirements of PPS25 and their relevance to development planning and development control within Peterborough City are outlined below.

4.1.2 Sequential Test

PPS25 requires that planners and developers do not simply match land use types to areas or zones with an 'acceptable' degree of flood risk. Rather, a risk avoidance sequential approach to location of new development is required, by application of the Sequential Test as defined in paragraphs 16 and 17 and paragraphs D1 to D8 of Annex D of PPS25.

The application of the Sequential Test requires the identification of Flood Zones as defined in Table D.1 of PPS25, by referring to the latest Flood Zones published by the Environment Agency. Also, it will require LPAs to demonstrate that there are no reasonable available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed, by considering all forms of flooding based on a Level 1 SFRA (i.e. as reported in this report and accompanying maps). Development should be directed to Flood Zone 1, where possible and then sequentially to Flood Zone 2 and 3, and to the areas of least risk within Flood Zones 2 and 3.

It is the responsibility of the decision-maker (i.e. the Local Planning Authority) to undertake the Sequential Test (Paragraph 3.2, PPS25 Practice Guide). However, for individual developments and development control purposes where there is no sequentially tested LDD policies the responsibility to provide the evidence for the Local Planning Authority to carry out the Sequential Test lies with the developer (Paragraph 3.4, PPS25 Practice Guide).

4.1.3 Exception Test

If, following the application of the Sequential Test, it is not possible for a development to be located in a zone with a lower probability of flooding, the Exception Test should be applied as defined in Paragraphs 18 to 21 and paragraphs D9 to D14 Annex D to assess its suitability for development.

The Exception Test makes provision for sites where flood risk is outweighed by wider sustainability considerations and is designed to ensure that the flood risk posed to such sites is reduced, controlled and mitigated to an acceptable level, taking account of climate change, without increasing flood risk elsewhere. Therefore, the Exception Test ensures reasoned justifications are provided for any decision to allocate land in areas at high risk.

An increased scope Level 2 SFRA as per paragraph E6 of PPS25 will be required to facilitate possible application of Exception Test and to address flood risk issues within the City, prior to the submission of emerging LDF documents if new development is proposed in flood risk areas depending on its vulnerability. This more detailed SFRA should consider the detailed nature of the flood hazard by building upon the findings of this Level 1 update and by fully taking account of the presence of flood management measures and climate change impacts through further detailed hydraulic modeling.

4.1.4 Functional Flood Plain

The Functional Floodplain (i.e. Zone 3b) comprises land where water has to flow or be stored in times of flood. Within Peterborough City, it includes the land which would flood with an annual probability of 1 in 25 (4%) and the designated washland as agreed with the Council and the Environment Agency in August 2007.

As part of this Level 1 SFRA this zone has been identified and mapped in agreement with the Environment Agency. It takes into account the effect of existing flood risk management measures and other infrastructure in accordance with the guidance given in the 'Living Draft' Practice Guide. Due to the absence of sufficient modelling data, Functional Floodplain is still to be identified for the following main rivers as part of a future Level 2 SFRA update:

- Castor Splash;
- Thorpe Meadows;
- Fletton Spring; and
- Orton Dyke.

Until the Level 2 SFRA is updated or appropriate site specific FRA show this zone for the above named watercourses to the Satisfaction of the Environment Agency, all areas within the Flood Zone 3a should be considered as the Functional Floodplain.

4.1.5 Flood Risk Assessment

Properly prepared assessments of flood risk will inform the decision-making process at all stages of development planning. Annex E of PPS25 stipulates requirements for three levels of flood risk assessment:

- Regional Flood Risk Assessments (RFRA);
- Strategic Flood risk Assessments (SFRAs); and
- Site-specific Flood Risk Assessments (FRAs).

The responsibility for preparing RFRA's will remain with Regional Planning Bodies and Local Planning Authorities are responsible for preparing SFRAs. According to the advice received from the East of England Regional Assembly (EERA) a RFRA for the East of England region is yet to be carried out.

In order to provide relevant information and to steer the planning-process in the right direction, the minimum requirements for flood risk assessments are that they should:

- consider the vulnerability of those that could occupy and use the development, taking account of the Sequential and Exception Tests and the vulnerability classification as per Annex D of PPS25, including arrangements for safe access;
- be proportionate to the risk and appropriate to the scale, nature and location of the development;

- consider the risk of flooding arising from the development in addition to the risk of flooding to the development;
- take the impacts of climate change into account as per Annex B of PPS25;
- be undertaken by competent people, as early as possible in the particular planning process, to avoid misplaced effort and raising landowner expectations where land is unsuitable for development;
- consider both the potential adverse and beneficial effects of flood risk management infrastructure including raised defences, flow channels, flood storage areas and other artificial features together with the consequences of their failure;
- consider and quantify the different types of flooding (whether from natural and human sources and including joint and cumulative effects) and identify flood risk reduction measures, so that assessments are fit for the purpose of the decisions being made;
- consider the effects of a range of flooding events including extreme events on people, property, the natural and historic environment and river and coastal processes;
- include the assessment of the residual risk after risk reduction measures have been taken into account and demonstrate that this is acceptable for the particular development or land use;
- consider how the development will modify run-off and promote the use of Sustainable Drainage Systems (SUDS) to mitigate that impact; and
- be supported by appropriate data and information, including historical information on previous events.

At the planning application stage, an appropriate site-specific FRA should be carried out to demonstrate how flood risk from all sources of flooding to the development itself and flood risk to others would be managed by fully taking into account climate change impacts. Table D.1 of PPS25 defines the requirements for carrying out FRAs for development sites depending on their location within each type of Flood Zone. It is important that the FRAs consider the vulnerability of those that could occupy and use the development, taking account of the Sequential and Exception Tests and the vulnerability classification as per Annex D of PPS25, including arrangements for safe access.

Therefore, planning applications for development proposals of 1 hectare or greater in Flood Zone 1 and all proposals for new development located in Flood Zones 2 and 3 should be accompanied by an FRA, which satisfies the above minimum requirements. Further guidance on FRAs is given in the PPS25 Practice Guide and developer guidance included within the previous SFRA.

4.1.6 Climate Change

PPS25 clearly emphasis the need for addressing climate change impacts to deal with the increased and new risks of flooding within lifetime of planned development. Also, Planning Policy Statement 1: Delivering Sustainable Development and its supplementary draft Planning Statement on Planning and Climate Change (consultation completed in March 2007) provide further guidance on how to address the new thereat of climate change within the planning system.

The Level 1 SFRA has broadly assessed the possible impacts of climate change by producing Flood Zone 3a outline for 50 year's time (2057) taking into account the impact of climate change on river flows and sea level rise. In the absence of modelled Flood Zones

(i.e. ignoring the presence of defences) as per PPS25 allowances over a long-term duration and as a conservative approach, it was considered that Flood Zone 3a in 2057 is to be identical to the present-day Flood Zone 2. Using this approach, the currently allocated sites have been broadly assessed against the potential risk from climate change (see **Table 2** and Section 4.2). In a similar way, potential new development sites can be assessed as shown in Table 4. However, they will need further assessment as per the guidance in Annex B of PPS25 by fully taking into account the presence of existing flood defences through an updated Level 2 SFRA or site-specific FRAs over the expected design life of proposed development (residential 100 years; commercial 60 years - based on the current Environment Agency guidance although this will need confirmation through the final PPS25 Practice Guide expected in spring 2008). As the interaction between fluvial and tidal flooding sources will become more significant overtime, sensitivity testing for long term horizons (at least 100 years) is recommended when significant development or regeneration options are considered in, or adjacent to Flood Zones 2 or 3.

Following the Sequential and Exception Test (if applicable), if new sites are located within Flood Zones 2 or 3 then the climate change impacts will need further assessment and sensitive testing through a Level 2 SFRA update and site-specific SFRAs by taking into account the presence of existing flood defences (e.g. within the eastern parts of the City and along the Nene corridor).

4.1.7 Surface Water Management

Historically, surface water drainage systems have been designed to remove surface water from a site as quickly as possible by means of underground piped systems. This has the potential to increase flooding problems downstream and does not contribute to the natural recharge of groundwater levels. Such systems contribute to the transport of pollutants from urban areas to watercourses and groundwater.

With concerns surrounding the impacts of climate change and the requirements of the PPS25 and Water Framework Directive, a more sustainable approach to drainage is required to reduce flood risk, manage water quality and provide integrated amenity benefits. The effective disposal of surface water from development is a material planning consideration in determining proposals for the development and use of land. It will always be much more effective to manage surface water flooding at and from new development early in the land acquisition and design process rather than to resolve problems after development.

Regional planning bodies and local authorities are encouraged to promote the use of SUDS for the management of run-off. SUDS aim to mimic natural drainage processes and remove pollutants from urban run-off at source. They comprise a wide range of techniques, including green roofs, permeable paving, rainwater harvesting, swales, detention basins, ponds and wetlands. To realize the greatest improvement in water quality and flood risk management these components can be used in combination. The surface water drainage arrangements for any development site should be such that the volumes and peak flow rates of surface water leaving a developed site are no greater than the rates prior to the proposed development, unless specific off-site arrangements are made and result in the same net effect.

Successful implementation of SUDS will require the early consideration of a wide range of issues surrounding their management, long-term adoption and maintenance. The design

team and stakeholders should take every opportunity for early discussion about SUDS and should consider them at the feasibility stage of a development, to realize the optimum contribution.

All growth sites can increase flood risk on the receiving watercourses (e.g. Peterborough Brooks System and Stanground Lode) unless the additional runoff from the future development is adequately managed.

4.1.8 Flood Warning and Emergency Planning

As discussed in Section 3.6, new developments should consider the role of flood warning.

The Environment Agency operates a national flood warning system for a large number of existing properties currently at risk of flooding in order to enable householders to protect life or take early action to manage the effect of flooding on property. New developments should consider the role of flood warning in managing residual risks although they should not rely solely on them. Section 3.6 discussed the present availability of flood warning and emergency response arrangements within the Peterborough City.

The Environment Agency generally aims to give a two-hour lead time for giving warning where it has a flood warning coverage within the City. However, in certain cases of severe or “flash flooding” this may not always be possible and can experience at both urbanised and rural parts of the City.

In addition, developments which include areas likely to flood will need to provide appropriate flood warning and formulate appropriate emergency plans to ensure their safe occupancy in the future. As a minimum, where any such development takes place in flood risk areas it is important that there is adequate passive flood warning in place, with signs highlighting the susceptibility to flooding and clearly signed evacuation routes where necessary.

4.1.9 Residual Risk Management

Flood risk to people and property associated with new developments can be managed but it can never be completely removed; a residual risk will always remain after flood management or mitigation measures have been put in place. Residual risk can be defined as the risk remaining after applying the sequential approach and taking mitigating actions.

Local Planning Authorities and developers should always consider residual flood risk issues relating to a development. The potential sources of this residual risk will need to be identified in the FRA, along with their potential impacts, and the most significant will have to be mitigated through flood risk management measures. The costs of such measures may be low compared to the damages they avoid and may enhance the value of the development.

As with all aspects of development and flood risk, it is best to consider residual flood risk early in the planning process, as measures to manage it may impact on site layout and the extent of developable land.

Although flooding cannot be wholly prevented, its impacts can be reduced through good planning and management. Thus it is vital to make the most of opportunities to reduce

existing flood risk to communities. For instance, opportunities to re-create and safeguard functional flood plain and washlands and to design more liveable developments combining sustainable defences, green/recreational space and increased flood storage should be investigated as early as possible when planning new developments.

Residual flood risk management needs to be coordinated with emergency procedures.

4.1.10 Developer Guidance

General guidance to developers on preparation of FRAs and the likely applicability of different SUDS techniques for managing surface runoff at key development sites should be prepared by the Local Planning Authorities when undertaking Level 1 SFRA.

Detailed guidance has already been produced as part of the previous SFRA for Peterborough (Appendix 3) under PPG25 guidance but a review will be now needed to take into account the updated information and additional requirements of PPS25 (e.g. Exception Test and Residual Risk Management). Therefore, it is recommended that the Council address this requirement during a future Level 2 SFRA update when more information on the proposed key development site locations is available.

4.1.11 SFRA Mapping

The key results from the SFRA are shown on the accompanying 1: 10,000 scale maps.

Maps show the three Flood Risk Zones for the present day conditions (2007). It also shows Flood Zone 3a for 50 year's time (2057) taking into account the impact of climate change on river flows which, in the absence of modelling studies available and as a conservative approach, was considered to be identical to the present-day Flood Zone 2. These maps show OS grid co-ordinates and include a legend and title block; additional notes are given to aid the interpretation of the mapped data. Based on the best available information to date, the maps indicate areas at risk of flooding within the study area. Special attention is needed when maps are used for the areas at the study boundary as the data has been cut to the study boundary and potential flooding outside the study boundary has not been shown.

Colour hatching delineates the Flood Zones, as agreed with the Council and the Environment Agency.

Also included on the maps are the locations of the key flood risk management measures within the City. The locations of the raised defences were taken directly from the Environment Agency's NFCDD data. Where the Environment Agency's data (e.g. raised defences, main river centre lines, flood storage areas etc.) is used directly for mapping purpose no attempt was made to edit the data supplied.

In addition, GIS data has been prepared showing the location of historic flood locations and key water storage facilities. These have not been included in the SFRA maps but are shown in the figures included within the **Appendix A** of this report.

4.2 Current Local Plan Allocated Sites

This Level 1 SFRA update has reviewed existing land allocations in the Peterborough Local Plan – First Replacement (Adopted July 2005) for the Peterborough City in order to identify the key development issues, in terms of flood risk. The updated draft Flood Zones now available from the Environment Agency has been used in this review.

Table 2 indicates the details of the currently allocated development sites within the City and whether they are located within Flood Zones 2 and 3. As highlighted in Section 4.1.5, all planning applications for development proposals of 1 hectare or greater in Flood Zone 1 and all proposals for new development located in Flood Zones 2 and 3 should be accompanied by a FRA to satisfy the requirements of PPS25. As described in Section 4.1.6, Flood Zone 2 present day outline also demotes the Flood Zone 3a with the climate change allowance and therefore all sites within this zone need further investigation either through an updated Level 2 SFRA or site-specific FRAs to address climate change implications as per Annex B of PPS25.

Table 2: Allocated development sites in Peterborough City

Policy Reference	Location	Total residential land (ha) and/or Employment Land (ha)	Within Flood Zone 2	Within Flood Zone 3a	Within Flood Zone 3b	Current Status ²
H3.01	North Westgate, Peterborough	1.25 ha	-	-	-	Undeveloped – without permission
H3.02	103 Oxney Road, Peterborough	1.99 ha	-	-	-	Completed
H3.03	Land North of 103 Oxney Road, Peterborough	1.94 ha	-	-	-	Undeveloped – with planning permission
H3.04	Potters Way, Peterborough	9.20 ha	Yes	Yes	-	Undeveloped – without permission
H3.05	Riverside Place (Formerly British Sugar), Peterborough	44.73 ha	Yes	Yes	-	Partly completed – with planning permission
H3.06	South Bank Opportunity Area, Peterborough	7.00 ha	Yes	Yes	-	Undeveloped – without permission
H3.07	Land off Oundle Road (Galvanising Works), Peterborough	1.44 ha	Yes	Yes	-	Undeveloped – without permission
H3.08	Land off Oundle Road	1.60 ha	Yes	-	-	Under Construction

Policy Reference	Location	Total residential land (ha) and/or Employment Land (ha)	Within Flood Zone 2	Within Flood Zone 3a	Within Flood Zone 3b	Current Status ²
	(Marshalls), Peterborough					
H3.09	Land off Oundle Road (Cherry Tree PH), Peterborough	0.37 ha	-	-	-	Undeveloped – without permission
H3.10	London Road Opportunity Area, Peterborough	17.80ha (residential)/ 10ha (employment)	-	-	-	Undeveloped – with outline permission
H3.11	Land North of Wesleyan Road, Peterborough	1.67 ha	Yes	Yes	Yes	Undeveloped – without permission
H3.12	Land North of Dunblane Drive, Peterborough	11.55 ha	Yes	Yes	-	Undeveloped – with planning permission
H3.13	Land off Oundle Road (EoE Showground), Peterborough	6.20 ha	-	-	-	Undeveloped – with planning permission
H3.14	Dogsthorpe Road (PFS), Peterborough	0.57 ha	-	-	-	Undeveloped – without permission
H3.15	Land at Manor Drive, Paston Reserve, Peterborough	8.20 ha	Yes	Yes	Yes	Undeveloped – with outline permission
H3.16	Land South of Manor Drive, Paston Reserve, Peterborough	37.34 ha	Yes	Yes	Yes	Undeveloped – with outline permission
H3.17	Westwood Local Centre, Peterborough	0.44 ha	-	-	-	Undeveloped – without permission
H3.18	Land West of Monarch Ave, Fletton, Peterborough	1.00 ha	-	-	-	Undeveloped – without permission
H3.19	Former Fletton Goods Yard, Peterborough	1.28 ha	-	-	-	Undeveloped – without permission
H3.20	Land west of Dearleap, Bretton, Peterborough	3.10 ha	-	-	-	Under Construction

Policy Reference	Location	Total residential land (ha) and/or Employment Land (ha)	Within Flood Zone 2	Within Flood Zone 3a	Within Flood Zone 3b	Current Status ²
H3.21	Land off Itter Crescent, Peterborough	1.90 ha	-	-	-	Undeveloped – without permission
H3.22	Barbers Hill Phase 2, Peterborough	0.93 ha	-	-	-	Completed
H3.23	Land R/O 467 Fulbridge Road, Werrington	1.67 ha	-	-	-	Undeveloped – without permission
H3.24	Land at The Grange, Netherton, Peterborough	2.50 ha	-	-	-	Undeveloped – without permission
H3.25	Fellowes Road, Fletton, Peterborough	1.22 ha	-	-	-	Completed
H3.26	Land South of Stanground	70.30 ha	-	-	-	Undeveloped – without permission
H4	Hampton Township	6900 Nr	-	-	-	Under Construction
H9.01	Thorney Road, Eye	4.34 ha	-	-	-	Part Under Construction/ Part Undeveloped
H9.02	Land R/O 2-40 High Street, Eye	4.90 ha	-	-	-	Under Construction
H9.03	Tasman Caravan Park, Eye	0.70 ha	Yes	Yes	-	Undeveloped – without permission
H9.04	Land South of Nature Reserve, Eye Green	1.48 ha	-	-	-	Undeveloped – without permission
H9.05	Land South and West of Crowland Road, Eye Green	0.93 ha	Yes	Yes	-	Undeveloped – without permission
H9.06	Land off London Road, Yaxley	1.67 ha	-	-	-	Completed
H10.01	Station Road, Ailsworth	1.42 ha	-	-	-	Under Construction
H10.02	Uffington Road, Barnack	1.50 ha	-	-	-	Undeveloped – without permission
H10.03	Clay Lane, Castor	1.67 ha	-	-	-	Undeveloped – without permission
H10.04	Land Adjacent to the surgery,	0.93 ha	-	-	-	Undeveloped – without permission

Policy Reference	Location	Total residential land (ha) and/or Employment Land (ha)	Within Flood Zone 2	Within Flood Zone 3a	Within Flood Zone 3b	Current Status ²
	Glington					
H10.05	Land North of Deeping St James Road, Northborough (Deeping Gate Parish)	1.02 ha	Yes	Yes	-	Undeveloped – with outline permission
H10.06	Old Manor Farm Yard, Wittering	1.65 ha	-	-	-	Under Construction
H10.07	Land rear of Boxer Road, Wittering	0.44 ha	-	-	-	Undeveloped – without permission
H11.01	Land R/O 35 St Pegas Road, Peakirk	0.60 ha	-	-	-	Undeveloped – with outline permission
OIW 2.01	Stirling Way (North)	6.7 ha	Yes	Yes	Yes	Undeveloped (without any permission)
OIW 2.02	Stirling Way (Extension)	5.3 ha	-	-	-	Undeveloped (without any permission)
OIW 2.03	Ederly Drain Road	4.7 ha	-	-	-	Developed
OIW 2.04	Fengate	0.20 ha	Yes	Yes	-	Developed
OIW 2.05	First Drove	2.2 ha	Yes	Yes	-	Undeveloped (without any permission)
OIW 2.06	Flag Fen Farm	2.3 ha	-	-	-	Undeveloped
OIW 2.07	Murdens, Fengate	3.4 ha	Yes	Yes	-	Part Developed/ Part Under Construction/ Part Undeveloped
OIW 2.08	Newark Road	0.7 ha	-	-	-	Undeveloped
OIW 2.09	Perkins (North)	5.1 ha	-	-	-	Undeveloped (without any permission)
OIW 2.10	Perkins (South)	2.4 ha	-	-	-	Undeveloped (without any permission)
OIW 2.11	Perkins (West)	3.0 ha	-	-	-	Undeveloped
OIW 2.12	Third Drove (North)	7.9 ha	Yes	Yes	-	Undeveloped
OIW 2.13	Third Drove (South)	4.6 ha	Yes	Yes	-	Part Under Construction/ Part Undeveloped (without

Policy Reference	Location	Total residential land (ha) and/or Employment Land (ha)	Within Flood Zone 2	Within Flood Zone 3a	Within Flood Zone 3b	Current Status ²
						any permission)
OIW 2.14	Mallory Road	3.4 ha	-	-	-	Developed
OIW 2.15	Cygnets Park	26.7 ha	-	-	-	Part Developed/ Part Under Construction/ Part Undeveloped
OIW 2.16	Hampton (East)	58.3 ha	Yes	Yes	-	Part Developed/ Part Under Construction/ Part Undeveloped
OIW 2.17	Bakewell Rd	7.4 ha	-	-	-	Part Developed/ Part Under Construction/ Part Undeveloped (without any permission)
OIW 2.18	Bakewell Rd (South)	0.6 ha	-	-	-	Under Construction or Completed
OIW 2.19	Oxney (East)	2.1 ha	-	-	-	Undeveloped
OIW 2.20	Oxney (North)	20.6 ha	Yes	-	-	Part Under construction/ Part Undeveloped ²
OIW 2.21	Oxney (South)	6.8 ha	-	-	-	Part Developed/ Part Undeveloped (without any permission)
OIW 2.22	Dukesmead	0.8 ha	-	-	-	Developed
OIW 2.23	Papyrus Road (North)	1.7 ha	-	-	-	Part Developed/ Part Undeveloped
OIW 2.24	Saville Road	0.9 ha	-	-	-	Undeveloped
OIW 2.25	Shrewsbury Avenue	1.0 ha	-	-	-	Undeveloped (without any permission)
OIW 4.01	Oak Tree Site	1.3 ha	-	-	-	Undeveloped (without any permission)
OIW 4.02	Lynch Wood 1	1.0 ha	-	-	-	Undeveloped (without any permission)
OIW 4.03	Lynch Wood 2	1.3 ha	-	-	-	Undeveloped (without any permission)
OIW 4.04	Lynch Wood 3	5.1 ha	-	-	-	Part Developed/ Part Under Construction/ Part Undeveloped (without

Policy Reference	Location	Total residential land (ha) and/or Employment Land (ha)	Within Flood Zone 2	Within Flood Zone 3a	Within Flood Zone 3b	Current Status ²
						permission)
OIW 4.05	Thomas Cook	1.1 ha	-	-	-	Undeveloped
OIW 4.06	Thorpe Wood	2.7 ha	-	-	-	Undeveloped
OIW 9.01	Northam Works, Eye Green	2.2 ha	-	-	-	Undeveloped (without any permission)
OIW 9.02	Station Road, Thorney	1.0 ha	Yes	Yes	-	Undeveloped (without any permission)

Notes:

1. Sites for residential development have been shaded in grey.
2. Data source: Housing Report 2007 and OIW Monitoring Report 2006 (Peterborough City Council)
3. Hampton Township Development Area (HTDA) exclusive of OIW 2.15 and OIW2.16 also include General Employment Area, of which 23.8 ha with outline permission and 1.2 ha with full planning permission, but site works are yet to be started.

As can be seen from the above table, there are number of allocated sites that are within Flood Zones 3a which will require passing the Exception Test (depending on their flood risk vulnerability) following the application of Sequential Test under PPS25 guidance. The Council will need to clarify with the Environment Agency how to handle these sites when determining planning permission.

Also, under the PPS25 guidance all sites that are larger than 1ha and the sites that are within Flood Zones 2, 3a and 3b will require a Flood Risk Assessment prior to granting planning permission.

4.3 Regional Spatial Strategy – East of England Plan

The East of England Plan is the term for the formal Regional Spatial Strategy (RSS14) for the East of England which will cover the period between 2001 and 2021. It covers economic development, housing, the environment, transport, waste management, culture, sport and recreation, mineral extraction and more.

The Plan seeks to take a longer-term view of development needs, in a manner that is consistent with principles of sustainable development. The East of England Regional Assembly (EERA) is the body responsible for producing this Plan and the draft Plan was submitted to the Government for approval in November 2004. It was examined in public between December 2005 and March 2006. It is expected that the final Plan will become adopted in the autumn of 2007. According to the advice received from EERA during this SFRA update a Regional Flood Risk Appraisal (RFRA) has not been yet undertaken in accordance with PPS25 requirements although it is likely that it will be undertaken during the review period once the Plan has been formally adopted.

The Plan however has provided Peterborough with higher figures for housing and employment growth than originally proposed. This will require the uptake of land in the Peterborough City, which will need to be informed by the most accurate picture of flood risk possible to enable development to be sited in appropriate locations minimising damage to property and threat to life. To allow the most suitable locations for this growth, the Council, in conjunction with Opportunity Peterborough (OP), has commissioned an Integrated Growth Study (IGS). This will identify and evaluate options for the future growth of Peterborough and contribute towards preparation of the Core Strategy 'Preferred Options Report'.

4.4 Local Development Framework (LDF)

4.4.1 General

As part of the new planning system in England, local authorities have had to prepare a LDF, replacing existing local plans, which provides the basis for determining planning applications and future development for local areas.

The LDF has to include policies, proposals and other documents about land use and spatial planning and seeks to shape those aspects of quality of life that can be improved by the way land is used. It guides how much development there is in the area, and where it is located. Development can be encouraged in the places where it will do the most good, and discouraged where it would cause harm. Developments are also expected to contribute to the economic, social and environmental well being of the area.

The framework system strives to:

- Protect the character and tranquility of the countryside ;
- Conserve and enhance the historic and natural environment ;
- Give new life to previously used land and buildings so as to trigger urban renewal ;
- Promote good design to reinforce the distinctiveness of each place; and
- Require development to be sustainable (including surface water and flood risk management).

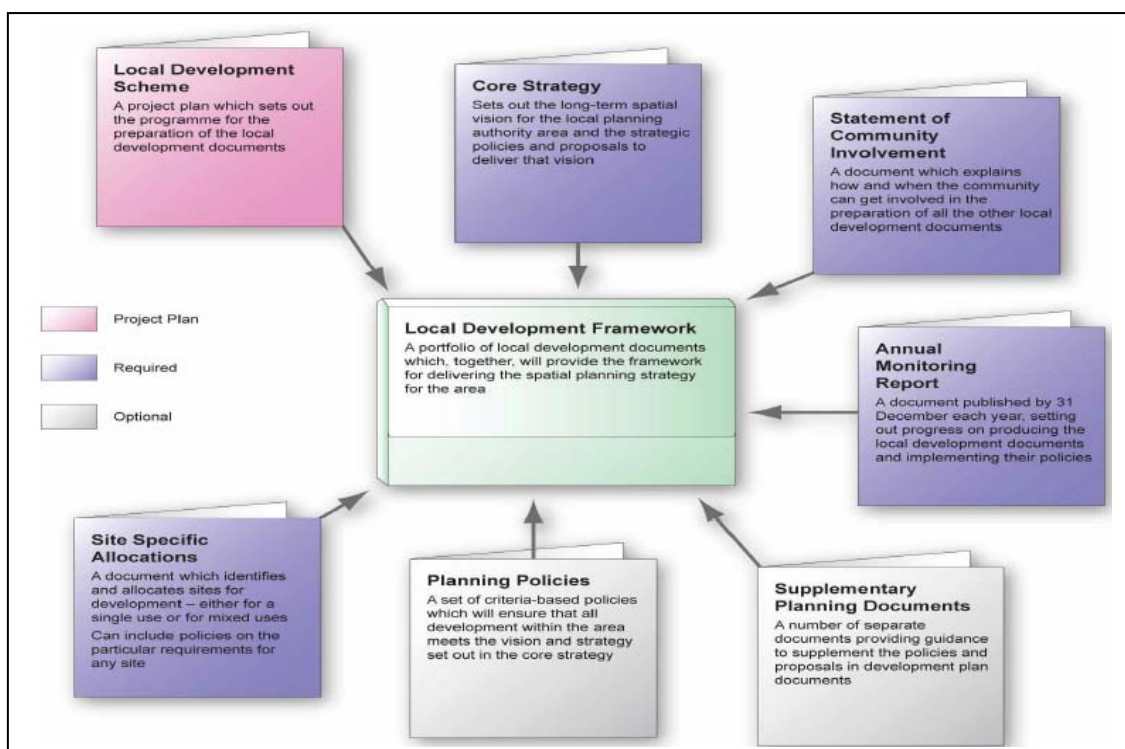
The first part of the LDF for Peterborough is the Local Development Scheme, covering the period 2007 - 2010. It is effectively a timetable for the new LDF, setting out how and when the different parts of the LDF will be produced, as well as what resources and background work will be required. **The Box 1** overleaf demonstrates how the LDF will be put in place and the different documents that need to be issued.

The first two Development Plan Documents (DPDs) to be produced as part of the Peterborough LDF are:

- Core Strategy DPD (public consultation in January 2008 and submission in October 2008); and
- City Centre Area Action Plan DPD (public consultation in June 08 and submission in May 2009).

The remaining DPDs are:

- Site Specific Allocations DPD (public consultation in October 2008 and submission in May 2009); and
- Planning Policies DPD (public consultation in October 2008 and submission in May 2009).



Box 1 Peterborough Local Development Framework (Source: Peterborough LDF Scheme 2007 – 2010)

4.4.2 Core Strategy

The Core Strategy will set out the overall approach of the Peterborough LDF based on the Regional Spatial Strategy (i.e. East of England Plan).

The Core Strategy will establish a long term vision with broad policies and proposals to deliver that vision over the period up to 2021. The Core Strategy will not deal with site-specific issues. More detailed policies based on the Core Strategy will be prepared in future documents.

In preparing the Core Strategy, the opportunities for reducing the existing flood risk within the City should be explored where possible, for example, through careful interventions and planning of growth sites. Sound policies for dealing with flood risk, climate change, water cycle management (including uptake of Sustainable Drainage Systems) should be in place.

Royal Haskoning has carried out this Level 1 SFRA in line with PPS25 requirements to inform the Sustainability Appraisal and the emerging LDF documents such as, Core Strategy, so that the Council can perform the Sequential Test and Exception Test if needed.

An Integrated Growth Study (IGS) will identify and evaluate options for the future growth of Peterborough and contribute towards preparation of the Core Strategy 'Preferred Options Report'. IGS study has considered the following three options for future growth:

- Option 1 - Focuses on mainly the City Centre and its wider area with some sustainable growth in rural villages (e.g. Thorney, Eye and Whittering). This could benefit existing communities close to the City Centre and those in the villages, and may reduce greenfield land-take although it may result in a slower rate of development;
- Option 2 - Considers intensification of the City Centre and its wider area, but to a lesser extent than Option 1, with more growth located at the fringes of the urban area (e.g. north of Werrington, east of Paston and south of Hampton). This would provide the opportunity to build a range of house types and could speed-up development, but may provide fewer opportunities for regeneration; and
- Option 3 – Incorporates the greatest intensification of the City Centre and its wider area along with the intensification of the City and local centres (e.g. Werrington, Bretton, Hampton and Orton Southgate).

The preferred option for growth is yet to be confirmed by the IGS. The findings of this Level 1 SFRA will need to be incorporated into the IGS and the Sustainability Appraisal to inform the Core Strategy. According to the advice given in PPS25 and Practice Guide, the SFRA should be used to identify where development can be located in areas with a lower probability of flooding (i.e. Flood Zone 1 whilst avoiding risk from other sources of flooding). If this is not entirely possible, then the Exception Test should be applied following application of the Sequential Test, for example, if new residential development can impact on Flood Zone 3a. Table D.3 of PPS25 (reproduced as **Table 3** below) clearly defines where development is allowed and the requirements for Exception Test depending on the Flood Risk Vulnerability and Flood Zone Compatibility.

Table 3: Flood Risk Vulnerability and Flood Zone Compatibility (Source: Table D.2 PPS25, Dec 06)

Flood Risk Vulnerability classification (see Table D2)		Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone (see Table D.1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	x	Exception Test required	✓
	Zone 3b 'Functional Floodplain'	Exception Test required	✓	x	x	x

Key:

✓ Development is appropriate

x Development should not be permitted

The SFRA provides information that will inform allocation of land in accordance with the sequential test. The detailed allocation of future development sites are not currently known,

so it is therefore not known to what degree Flood Zones 3a or 3b will be affected. However, for Peterborough if the Exception Test is a possibility from the work done to date on the IGS and the Sustainability Appraisal then an update of Level 2 SFRA is recommended to avoid delays to the LDF Scheme. For example, Option 2 is fairly likely to affect Flood Zones 3a because of the likelihood of development north of Werrington and east of Paston. Option 3 can also affect Flood Zone 3a around Eye and Thorney depending on the final locations chosen for development. Also all three options may affect the River Nene flood corridor through the town centre.

The flood risk from other forms (e.g. sewer, highway, overland and groundwater) as well as the impact of development on surface water and wider water cycle management will need consideration. For example, intensification of City Centre and wider area may raise sewer capacity issues. Also, Eye and Yaxley villages have suffered from sewer capacity problems in the past. Proposed growth will require upgrades to existing Flag Fen Sewage Treatment Works (STW) and pumping stations (e.g. Paston Reserve, Stanground and Yaxley) within Asset Management Plan 5 (AMP5) which covers the period 2011 - 15. The increased flood risk due to this additional flow and cost and timing implications will need consideration according to the currently available information from Anglian Water.

Also note that some minor tributaries may flow through or adjacent to the proposed growth sites for which potential risk areas are not identified within the Environment Agency's current Flood Zones. These tributaries may have catchments less than 3km² and therefore any risk areas are likely to be fairly localised. Nevertheless, no inappropriate development should take place in such areas following further investigation and additional runoff into these watercourses will need careful consideration to avoid flood risk elsewhere.

The Council provided some details of potential housing development sites and they are shown on **Figure 8**. Flood risk issues related to these sites are summarised in **Table 4** below.

Table 4: Proposed Potential Housing Development Sites and Flood Risk Issues

Site Reference	Description	Site Area (ha)	Area within Flood Zones			Other Issues and comments
			2 (ha & %)	3a (ha & %)	3b (ha & %)	
1	Hurn Road, Werrington	56.1	11.0 (19%)	2.1 (4%)	8.3 (15%)	Foul Drainage Capacity – Capacity within local sewers STW Capacity - Flag Fen at capacity - extensions required in AMP5 Historic Flooding – Waterworks Lane, Glinton, Woodcroft; Localised overtopping of banks due to high water levels.
2	North Werrington	62.1	N/A	N/A	N/A	Foul Drainage Capacity – Capacity within local sewers STW Capacity - Flag Fen at capacity - extensions required in AMP5 Historic Flooding – Waterworks Lane, Glinton, Woodcroft;

Site Reference	Description	Site Area (ha)	Area within Flood Zones			Other Issues and comments
			2 (ha & %)	3a (ha & %)	3b (ha & %)	
						<i>Localised overtopping of banks due to high water levels.</i>
3	Werrington Bridge	234.0	22.8 (9%)	105.7 (45%)	1.2 (1%)	Foul Drainage Capacity – Capacity within local sewers STW Capacity - Flag Fen at capacity - extensions required in AMP5 Historic Flooding – Local Areas along Werrington Brook; Return period of approximately 1 in 5 yrs event.
4	Norwood Farm	68.8	3.1 (4%)	19.9 (29%)	N/A	Foul Drainage Capacity – Capacity within local sewers STW Capacity - Flag Fen at capacity - extensions required in AMP5
5a	Norwood & Dogsthorpe	96.7	1.3 (1%)	0.1 (0.5%)	0.8 (0.5%)	Foul Drainage Capacity – Capacity within local sewers STW Capacity - Flag Fen at capacity - extensions required AMP5
5b	Red Brick Farm	59.4	6.2 (10%)	34.6 (58%)	N/A	Foul Drainage Capacity – Capacity within local sewers STW Capacity - Flag Fen at capacity - extensions required in AMP5
6	Eyebury Farm	22.9	0.9 (4%)	1.8 (8%)	N/A	Foul Drainage Capacity – Capacity within local sewers STW Capacity - Flag Fen at capacity - extensions required in AMP5
7	Horseley Grange	29.0	0.3 (0.5%)	0.1 (0.5%)	N/A	Foul Drainage Capacity – Capacity within local sewers STW Capacity - Flag Fen at capacity - extensions required in AMP5
8	Southern Expansion	445.1	N/A	4.5 (1%)	19.2 (4%)	Foul Drainage Capacity - No capacity in Yaxley system - current flooding problems. Bypass system required. STW Capacity - Flag Fen at capacity - extensions required in AMP5

Site Reference	Description	Site Area (ha)	Area within Flood Zones			Other Issues and comments
			2 (ha & %)	3a (ha & %)	3b (ha & %)	
9	Spendelows Farm	66.9	N/A	N/A	N/A	Foul Drainage Capacity - No capacity in Yaxley system - current flooding problems. Bypass system required. STW Capacity - Flag Fen at capacity - extensions required in AMP5
10	Land South of Peterborough	36.7	N/A	2.9 (8%)	6.2 (17%)	Foul Drainage Capacity - No capacity in Yaxley system - current flooding problems. Bypass system required. STW Capacity - Flag Fen at capacity - extensions required in AMP5
11	Castor & Ailsworth	352.4	N/A	N/A	N/A	Foul Drainage Capacity – Sewers at capacity upgrade required. STW Capacity - Flag Fen at capacity - extensions required in AMP5
13	Stanground (Allocation)	70.3	N/A	N/A	N/A	
14	Paston Reserve (Allocation)	45.7	0.3 (1%)	0.05 (0.1%)	0.05 (0.1%)	

From **Table 4**, it can be seen that sites 1, 3, 5a, 8, 10 and 14 are within the Functional Floodplain and therefore no residential development should be allowed within the affected Flood Zone 3b.

The sites 1, 3, 4, 5a, 5b, 6, 7, 8, 10, and 14 will impact on High Probability Flood Zone 3a and no residential development should be allowed in such areas unless the Exception Test is passed following the Sequential Test.

The sites, 1, 3, 4, 5a, 5b, 6, 7, 8, 10 and 14 will impact on Medium Probability Flood Zone 2 and the impact of climate change will need some consideration.

The sites 2, 9, 11 and 13 are located entirely within the Low Probability Flood Zone 1 and hence fully satisfy the Sequential Test criteria unless there are flooding issues related to other forms of flooding.

Local flooding issues are known around the sites 1, 2 and 3; also, sewer capacity issues are known around the sites 8, 9, 10 and 11. Therefore these sites in particular need careful attention when dealing with surface water and drainage issues.

4.4.3 Other Development Plan Documents

No information is yet available from the Council regarding these documents (e.g. City Centre Area Action Plan).

Any development proposal that may fall within Flood Zones 2 and 3a (e.g. River Nene frontage through the town centre) will require careful assessment of flood risk having considered climate change impacts. It will be subject to the application of the Sequential Test and the Exception Test through a detailed Level 2 SFRA update to assess the nature of flood risk hazard. The information in the previous SFRA (e.g. modelled water levels and breach risk areas) now needs review as the Environment Agency's latest predicted levels are generally higher than the levels supplied before. For example between the main railway bridge and Fitzwilliam Footbridge, the present day 100 year and 1000 year levels are generally higher by 0.3m to 0.15m and 0.55m to 0.3m respectively. However, the flood defences still have some freeboard giving flood protection up to a 200 year event even with the climate change impact. For a 1000 year event the defences will be overtopped when climate change is taken into consideration. Therefore, it is important that a Level 2 assessment determines the condition of the existing defences by examining the records in NFCDD and further consultation with the Environment Agency staff.

Royal Haskoning carried out a flood risk appraisal¹⁰ in May 2007 on behalf of Opportunity Peterborough focussing on the river frontage between Rivergate and Fitzwilliam Footbridge. This appraisal identified that the present Environment Agency Flood Zones 2 and 3 are too large, in particular, around The Embankment area between Town Bridge and Fitzwilliam Bridge (on the left bank) and this will need amending to exclude high ground. Despite the discussions held with the Environment Agency, the latest release of draft Flood Zones still contains this anomaly and therefore needs urgent attention. The flood risk appraisal also identified some good opportunities to enhance the flood conveyance and flood storage through the regeneration proposals of the river frontage; these need further investigation through a Level 2 update.

4.4.4 Flood Risk Management Strategy

A robust flood risk management strategy should be developed for the City by incorporating the findings of this study, and the Catchment Flood Management Plans for the River Nene¹¹ and the Welland¹². This strategy should aim to address the existing flood risk issues in the City whilst accommodating the additional needs of future growth planned by the East of England Plan⁵ (November 2004).

It is recommended that the flood risk management strategy consists of the following key aspects:

- Policies;
- Planning conditions;
- Physical flood risk management measures (including their operation and maintenance);
- Flood warning and emergency planning; and
- Guidance.

The strategy should explore the opportunities to reduce the existing flood risk in the City through a combination of the above elements and suitable planning interventions by collaborative working with all parties involved (e.g. planners, developers, regulators and community groups).

Physical measures will involve both local and strategic options to manage flood risk within the City in a sustainable fashion over the next 50 to 100 years. Nevertheless the success of these measures will be dependant on securing funds from the central government and prospective developers and other crucial factors such as planning, phasing, monitoring and long-term management of these measures.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The City of Peterborough is likely to undergo significant expansion as part of the government's growth proposals. Flooding is a key issue in the City and one of the key sources of flooding is from the Environment Agency's main river network due to its low-lying nature at the eastern parts. Surface water run-off management in the City is clearly an important issue for new developments, in particular, where capacity and pollution problems of watercourses and sewers are already known, clearly highlighting the need for SUDS that maximise source control measures.

The information and knowledge gathered through this Level 1 SFRA update will inform the emerging LDF and future flood risk management needs of the City. The Level 2 SFRA will inform the detailed policies, allocations, exception tests, phasing and financial contributions mechanisms, where appropriate. The Level 1 SFRA will also provide a sound basis for a future Level 2 SFRA update for the City. This Level 1 SFRA considers all sources of flooding within the City based on a desktop study and consultation carried out with the Environment Agency, the Council, IDBs and Anglian Water. It broadly satisfies the requirements for SFRAs and more specifically the amplified guidance given in paragraphs 2.32 to 2.35 of PPS25 Practice Guide Companion for preparing Level 1 SFRAs. This information should be read in conjunction with the previously completed SFRA for the City in November 2005 until it is updated through detailed hydraulic modelling to bring it more inline with PPS25 Level 2 SFRA standard incorporating the latest guidance and studies.

The findings of the Level 1 SFRA are given in the form of this report and the accompanying 1 in 10,000 scale SFRA Flood Zone maps (as per Table D.1 of PPS25) covering the entire City. These maps provide the basis for the application of Sequential Test when preparing the emerging LDF documents for Peterborough. However, the Flood Zones for The Embankment area (between Town Bridge and Fitzwilliam Bridge on the left bank where there are no formal flood defences) needs revising as they clearly include large parts of raised ground that is above the currently estimated extreme flood levels and historic flood levels for this area. If the Exception Test is to be applied when identifying the Preferred Options and allocating development sites, then the Council will have to carry out a Level 2 SFRA update to fully consider the effectiveness and standard of protection provided by the existing flood defences. The previous SFRA has considered the presence of flood defences through modelling and breach analysis although it now requires a review due to the new water levels and survey data now available from the Environment Agency. Currently there is insufficient information from the Council and Opportunity Peterborough with regard to their preferred development locations, to confirm the urgency of the required Level 2 update.

The current SFRA broadly assesses the possible climate change impacts over a 50 years period although further sensitivity testing over a 100 years period will be essential if new development is planned in, or adjacent to Flood Zones 2 or 3.

5.2 Recommendations

A sequential test must be undertaken by the Council for all growth sites and other sites in accordance with this report finding when preparing the emerging LDF documents for Peterborough. An update of the existing SFRA (including a review of developer guidance) will be needed to bring it more inline with PPS25 Level 2 SFRA standard incorporating the latest guidance and studies. The Functional Floodplain for some main rivers (e.g. Castor Spash and Thorpe Meadows) will need mapping during this update.

Management of surface runoff from the proposed sites should use a combination of site specific and strategic SUDS measures encouraging 'source control' where possible. These measures should be developed with a strategic approach to flood management in mind. An integrated flood risk management strategy, which considers all sources of flooding within the City, has to be developed to enable future development to be planned, implemented and monitored in accordance with this strategy.

The Level 2 SFRA should also cover:

- Climate change over 100 years (residential) and 60 years (commercial);
- Policy options for LDF detailed development control policies and site allocations;
- Policy for areas if new defences appear to increase risks;
- Identify opportunities to reduce flood risk through strategic measures such as washlands or reconfiguring waterfront uses; and
- Recommendations for investigating Sustainable Drainage Systems (SUDS) partnerships, to include, where possible protocols for ways of working between Highways Authorities, Environment Agency, Water Companies, Internal Drainage Boards and open space management contractors.

6 REFERENCES

1. Planning Policy Guidance Note 25: Development and Flood Risk, Department for Transport, Local Government and Regions, July 2001
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7. Welland Catchment Strategic Model Final Report, Environment Agency, January 2007
8. River Nene Models Report, Environment Agency, May 2007
9. Appraisal of Flood Risk at Peterborough Riverside Regeneration Area, Opportunity Peterborough, May 2007
10. River Nene Catchment Flood Management Plan (Draft Plan – Main Stage), Environment Agency
11. River Welland Catchment Flood Management Plan (Draft Plan – Scoping Stage), Environment Agency
12. River (Fluvial) and Tidal Flood Plan, Cambridgeshire and Peterborough Resilience Forum, January 2007

APPENDICES

Appendix A – Figures

