Wyre Forest District Council

Level 2 Strategic Flood Risk Assessment

Wyre Forest District Council

February 2010
Final Report
9T6121

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Study Objectives

This Level 2 Strategic Flood Risk Assessment (SFRA) for the Wyre Forest District Council (hereafter, 'the Council') considers the detailed nature of flood hazard across the District by taking into account the presence of flood risk management measures and has been undertaken with a principal purpose to facilitate application of the Sequential and Exception Tests. The key objectives of the study are to:

- Review the Flood Zones presented in the Level 1 SFRA, in particular the Functional Floodplain (Flood Zone 3b);
- Review flood defence infrastructure, including its present condition, maintenance and upgrading, consequences of overtopping or failure and the response to climate change;
- Model flood risk across the Flood Zones, including the identification of rapid inundation zones, risk to people behind defences and the effect of increased runoff from developments on flood risk; and
- Analyse site specific flood risk.

In addition guidance notes are provided for the execution of the Exception Test, the preparation of FRAs, Emergency Planning Measures and Dealing with Surface Water Drainage.

Outputs

This report focuses on development sites within Flood Zones 2 and 3, or sites that pose potential risk to un-modelled ordinary watercourses. A 1D hydraulic model was constructed of the Hoo Brook in order to address misalignments of the Flood Zones. TUFLOW 2D models were constructed to review breach scenarios in Kidderminster and Bewdley. Pluvial analysis was carried out for Kidderminster and Stourport. The Kidderminster dam was also reviewed and analysed for overtopping.

A detailed methodology of the Hoo Brook modelling is presented in *Appendix 3*, with results presented in the form of maps. Outputs from the TUFLOW models are presented in maps and colour–coded tables within the main body of the report. Due to the nature of the project requirements, all models within the study were constructed as new using data obtained from site investigations in conjunction with topographic data derived from LiDAR.

Data Sources

The data used within this SFRA was documented within the Level 1 SFRA and updated with the addition of new development sites provided after the completion of the Level 1. Supplementary data was collected during site visits undertaken at the end of August 2008 and May 2009.

Co-operation

This SFRA was carried out for the Council with the co-operation and support of the Environment Agency.

GLOSSARY

Brownfield site	Any land or site that has been previously developed.
Catchment	The area contributing flow or runoff to a particular point on a watercourse.
Climate change	Long-term variations in global temperature and weather patterns both natural and as a result of human activity, primarily greenhouse gas emissions.
Culvert	Covered channel or pipe that forms a watercourse below ground level.
Design flood level	The maximum estimated water level during the design event.
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.
Enmained	Watercourse designated as a Main River
Environment Agency	Government Agency charged with the protection of the environment
Exception Test	The final process of the PPS25 Sequential Test (TIERS 3 & 4). It is required when a development application is made for a site within Flood Zones 2 & 3 and no other site of lower flood risk is available.
Flood defence	Flood defence infrastructure, such as flood walls and embankments, intended to protect an area against flooding, to a specified standard of protection.
Flood event	A flooding incident characterised by its level or flow hydrograph.
Flood Hazard	The potential risk to life and potential damage to property resulting from flooding
Flood probability	The estimated probability of a flood of given magnitude occurring or being exceeded in any specified time period.
Flood risk	An expression of the combination of the flood probability and the magnitude of the potential consequences of the flood event.
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 flood risk.

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 see, 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.
Freeboard	Vertical distance from the normal water surface to the top of a flood defence or river/canal bank.
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 5% or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes.
Greenfield	Previously undeveloped land
Groundwater	Water in the ground, usually referring to water in the saturated zone below the water table.
Groundwater flooding	Flooding caused by groundwater escaping from the ground when the water table 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 watercourse.
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).
Mitigation measure	A generic term used in this guide to refer to an element of development design which may be used to manage flood risk to the development, or to avoid an increase in flood risk elsewhere.
Ordinary watercourse	A watercourse which is not a private drain and is not designated a Main river.
Overland flow flooding	Flooding caused by surface water runoff when rainfall intensity exceeds the infiltration capacity of the ground, or when the soil is so saturated that it cannot accept any more water.
Return period	A term sometimes used to express flood probability. 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 annual flood probability is to be preferred.
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 test	A risk-based approach to flood risk assessment in accordance with Planning Policy Statement 25, applied through the use of flood risk zoning, where the type of development that is acceptable in a given zone is dependent on the assessed flood risk of that zone and flood vulnerability of the proposed development.
Standard of protection	The estimated probability of a design event 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 flood defences.
Strategic flood risk assessment	A study to examine flood risk issues on a sub-regional scale, typically for a river catchment 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 runoff from development sites.
Watercourse	Any natural or artificial channel that conveys surface water.
Water Cycle Strategy	Provides a plan and programme of Water Services Infrastructure implementation

Z-Lines Z Lines are computer generated lines used within a TUFLOW model to model features such as a roads, railways, levees, creeks, drains, etc.

ABBREVIATIONS

AEP	Annual Exceedance Probability
mAOD	Metres Above Ordnance Datum
CFMP	Catchment Flood Management Plan
CLG	Communities and Local Government
DPD	Development Plan Document
EA	Environment Agency
FAS	Flood Alleviation Scheme
FD2320	Flood Risk Assessment Guidance for New Development Phase 2, Framework and Guidance for Assessing and Managing Flood Risk for New Development
FRA	Flood Risk Assessment
FZ	Flood Zone
iSIS	1-Dimensional modelling software
JFLOW	2-Dimensional modelling software
LDF	Local Development Framework
LDD	Local Development Document
LDS	Local Development Scheme
LiDAR	Light Detection And Ranging
LPA	Local Planning Authority
NFCDD	National Flood and Coastal Defence Database
OS	Ordnance Survey
PPS25	Planning Policy Statement 25 – Development and Flood Risk
SHLAA	Strategic Housing Land Availability Assessment
SFRA	Strategic Flood Risk Assessment
SUDS	Sustainable Drainage Systems
TUFLOW	2-Dimensional modelling software

WMRFRA	West Midlands Regional Flood Risk Appraisal
WMRSS	West Midlands Regional Spatial Strategy

1 INTRODUCTION

1.1 Commission Award

In July 2008, Royal Haskoning were commissioned by Wyre Forest District Council (hereafter, "the Council") to produce a Level 2 Strategic Flood Risk Assessment (SFRA) and Water Cycle Study (WCS). This commission followed the successful completion of a Level 1 SFRA by Royal Haskoning in January 2008 and the results and recommendations from that study have formed the basis of this Level 2 SFRA. The WCS will be presented in a separate report.

1.2 Background

'Making Space for Water' is the Government's strategy for flood and coastal erosion risk management in England. The aims of the strategy are:

> *"To manage the risks from flooding and coastal erosion by employing an integrated portfolio of approaches which reflect both national and local priorities, so as:*
>
> - *To reduce the threat to people and their property;*
> - *To deliver the greatest environmental, social and economic benefit, consistent with the Government's sustainable development principles; and*
> - *To secure efficient and reliable funding mechanisms that deliver the levels of investment required to achieve the vision of this strategy."*

(Defra, 2005)

Communities and Local Government (CLG) has the lead responsibility for development planning policy and discouraging inappropriate development which might increase flood risk. Their Planning Policy Statement; Development and Flood Risk (PPS25) was published in December 2006 and contains the essence of 'Making Space for Water', setting out Government policy on development and flood risk.

The aims of PPS25 are to:

- Ensure that flood risk is taken into account at all stages in the planning process;
- Avoid inappropriate development in areas at risk of flooding; and
- Direct development away from areas of high risk.

(PPS25, 2006: pp2)

This Level 2 SFRA has been carried out to satisfy the requirements of Annex E of PPS25[1] and in particular paragraphs 3.50 to 3.59 of the accompanying PPS25 Practice Guidance[2]. It corresponds to the 'increased scope' SFRA referred to in paragraph E6 of PPS25 and has the principal purpose of facilitating the application of the Exception Test, as outlined below.

[1] Planning Policy Statement 25: Development and Flood Risk, Communities and Local Government, December 2006

[2] Planning Policy Statement 25: Development and Flood Risk Practice Guide, Communities and Local Government, June 2008

By taking account of the presence of flood risk management measures, such as flood defences, this study considers the detailed nature of the flood hazard. The data held within this Level 2 SFRA can therefore assist planners to better balance risks against the need for development. Although the development of lower risk sites should normally be the preferred option, with suitable mitigation, following the Sequential Test and Exception Test appropriate development within high-risk areas may be acceptable.

Sequential Test

The Sequential Test is used to prioritise potential development sites in order of probability to flood risk and their acceptability in terms of allocation for development. When allocating or approving land for development in flood risk areas, Councils are expected to demonstrate that there are no suitable alternative development sites located in lower flood risk areas. The flood risk zones are defined in Annex D, Table D.1 as follows:

Zone 1: Area with low probability of flooding (less than 0.1% in any one year)

Zone 2: Area with medium probability of flooding (between 1% and 0.1% in any one year)

Zone 3a: Area with a high probability of flooding (greater than 1% in any one year)

Zone 3b: The Functional Floodplain – land where water has to flow or be stored in times of flood (probability of 5% or greater of flooding in any year or is designed to flood in an extreme (0.1%) flood)

(PPS25, 2006, Annex D, pp22-24)

When determining future development allocations the Sequential Test is used to direct planners towards the lower Flood Risk Zones in preference to high Flood Risk Zones. The Level 1 SFRA provides the relevant information to aid in the application of this test.

The Exception Test

In accordance with PPS25, the risk-based Sequential Test should be applied at all stages of planning. Its aim is to steer new development to areas at the lowest probability of flooding (Zone 1). It must always be adequately demonstrated that the Sequential Test has been correctly undertaken and that other reasonably available sites in lower flood risk zones have been considered. If however, 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 can be applied.

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 controlled and mitigated to an acceptable level, taking account of climate change, without increasing flood risk elsewhere.

The Council should adopt a sequential approach in order to direct strategically significant growth areas towards locations with the lowest probability of flooding, wherever possible. The Council should demonstrate, in broad terms, that they have

applied the sequential approach to managing flood risk as part of their site allocation process.

The Level 2 SFRA will assist decision makers in identifying whether new development will be able to pass the requirements of part c of the exception test. This document provides information on areas such as 'rapid inundation zones' where development should not be permitted and also includes information on the standard of protection provided by flood defences.

For the Exception Test to be passed, as outlined in PPS25:

a) It must be demonstrated that the development provides wider sustainability to the community that outweigh flood risk, informed by a SFRA where one has been prepared. If the DPD has reached the 'submission' stage – see Figure 4 of PPS25: *Local Development Frameworks* – the benefits of the development should contribute to the Core Strategy's Sustainability Appraisal;

b) the development should be on developable previously-developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable previously-developed land; and

c) An FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

(PPS25, 2006 Annex D, pp27)

In order to undertake the Exception Test for specific locations as identified necessary in the Level 1 SFRA, the Council needs further information to understand the flood risks at each site and the drainage requirements necessary within the key catchments. It is this information that is provided within this Level 2 SFRA.

The application of the Sequential Test is vital for the allocation of sites for the LDF process and therefore the importance of the Sequential Test and Exception Test where appropriate is paramount to future development within the District.

1.3 Study Area

Wyre Forest is a local government district in Worcestershire, England, covering the towns of Kidderminster, Stourport-on-Severn and Bewdley, and several civil parishes and their villages. **Figure 1** shows the District boundary along with the towns mentioned.

The District has a network of rivers, pools and Brooks which all have the potential to cause flooding. There is a large water supply reservoir located at Trimpley, which is situated to the North of Bewdley and in close proximity to the River Severn. The River Severn flows in a southerly direction through the District, and passes through the towns of Bewdley and Stourport-on-Severn. Due to the size of the catchment and the length of the watercourse, the critical storm duration for the River Severn is very long, approximately six days. The main tributaries of the River Severn within the Wyre Forest District are Dowles Brook, Snuffmill Brook, Riddings Brook, Burnthorpe Brook and the River Stour.

The River Stour passes through the urban areas of Cookley, Wolverley and Kidderminster before discharging into the River Severn. The main tributaries of the River Stour are Drakelow Brook (Hors Brook), Honey Brook, Blakedown Brook and Hoo Brook.

The Staffordshire and Worcestershire Canal runs parallel with the River Stour throughout the District, to its outfall into the River Severn via the Stourport Basin at Stourport-on-Severn.

1.4 Prospective Development in the Study Area

The Council is in the process of preparing its Local Development Framework (LDF) as required by the Planning and Compulsory Purchase Act 2004. Within the Consultation on the New Regional Competitiveness and Employment Programme 2007- 2013, Kidderminster is identified as a Local Regeneration Area as defined in Policy UR.2 of the Regional Spatial Strategy[3]. The Local Development Scheme (LDS, November 2006) sets out a three year programme to advance the Local Development Framework (LDF) for the District and the timetable for the production of new Local Development Documents (LDDs). The LDS was updated in August 2008[4] and outlines amendments to the Site Allocations and Policies DPD and Kidderminster Central Area Action Plan Development Plan Documents (DPDs), placing emphasis on the requirement to produce DPDs through evidence base production, of which this SFRA and the associated WCS form a part.

It is envisaged that Kidderminster Town Centre will continue to be a focus of change. With numerous possible opportunity sites, heritage assets and the need to continue economic diversification, the on-going renaissance of Kidderminster Town Centre is a major issue to be addressed in the Local Development Framework.

The West Midlands Regional Spatial Strategy (WMRSS) target for growth in the District, subject to the statutory regional and local planning process, includes:

- An additional 3,400 dwellings between 2001 and 2026, this equates to an annual build rate of 170 dwellings;
- Up to 35,000 m^2 of retail floor space and 40,000 m^2 of new office development;
- Strong support for emphasis on Brownfield development focussed on Kidderminster and Stourport-on-Severn;
- A general consensus against Greenfield development; and
- Support for focussing economic development on Kidderminster and the Stourport Road Employment Corridor.

However, the Phase 2 Revision of the WRMSS has not yet been finalised and, as a result of the Baroness Andrews Intervention, the Government Office for the West Midlands commissioned Nathanial Lichfield and Partners (NLP) to undertake a study to look at options for higher housing growth across the Region in order to meet the

[3] Regional Spatial Strategy for the West Midlands, Government Office for the West Midlands, January 2008

[4] The updated LDS can be viewed online from the WFDC website: http://www.wyreforestdc.gov.uk/e-dms/resources/includes/file.php?id=2026

aspirations set out in the 2007 Housing Green Paper. The results of the NLP study were published on 7th October 2008 and indicate the potential for the housing requirement in Wyre Forest District to increase. The report presents three potential growth scenarios representing housing allocations between 51,500 and 80,000 units higher than the draft WMRSS Phase 2 Revision. However in all three cases, the proposed increase within Wyre Forest District is 400 dwellings and the emphasis is placed upon the need for these dwellings to be located in rural areas.

In September 2009, the Panel report into the WMRSS was published. The report identified that for Wyre Forest the potential amount of new dwellings that will need to be planned for would be a total of 4,000 up until 2026. The final figure will not be decided upon until 2010 but it is considered realistic to plan for approximately 4,000 new dwellings to be built.

The Level 1 SFRA identified the potential development sites located in areas of flood risk (i.e. located either wholly or partially within the Environment Agency Flood Zones 2 or 3). All of these sites were located in the towns of Kidderminster, Stourport-on-Severn and Bewdley and in the village of Cookley. Since the completion of the Level 1 SFRA, the Council has updated the locations of the potential development sites within the District to fall in line with their latest Strategic Housing Land Availability Assessment (SHLAA). Section 2 of this report involves a comprehensive review of all the development sites to be considered within this study and includes updated versions of the concluding Level 1 SFRA report tables to account for the additional SHLAA designations. Most of these designations fall within, or around, the four main settlements listed above, although there are an additional couple which are located in more rural areas of the District.

Due to the locations of these settlements along two major watercourses within the District – the River Severn and River Stour - flood risk is a key consideration in the allocation of land for development especially with the current concerns over climate change. Therefore, to enable the developments to be sited in appropriate locations to minimise damage to property and threat to life, the Council needs to be informed by the most accurate picture of flood risk possible.

Some high level documents which discuss flood risk for the study area have been published in recent years, including the River Severn Catchment Flood Management Plan (CFMP), published by the Environment Agency in June 2005 and the West Midlands Regional Flood Risk Appraisal (WMRFRA), originally published in 2007 and updated in 2009. This CFMP provides guidance on flood risk policies for rivers in the catchment for the next 50 year and identifies the following for the Rivers Severn and Stour within the Wyre Forest District:

Table 1 – Severn Catchment Strategic Action Plan (Environment Agency, 2005)

Catchment Location		Short Term Policy (0 - 10 years)			Long Term Policy (11 – 50 years)				
		Do Nothing	Maintain current level of flood risk	Reduce level of flood risk	Maintain current level of flood risk	Maintain the reduced level of flood risk	Maintain current level of flood risk (for smaller communities)	Reduce level of flood risk (for larger communities)	Recognise the level of flood risk will increase (for agricultural and undeveloped land and isolated properties)
Worcestershire Stour	Kidderminster		✓		✓				
	Remainder of the Catchment	✓					✓	✓	✓
Middle Severn	Bewdley - Severnside North		✓		✓				
	Bewdley - Severnside South			✓		✓			
	Bewdley - Remainder of town							✓	

The Severn Catchment Strategic Action Plan highlights that the Severn and Stour catchments should aim at maintaining and/ or reducing the current levels of flood risk. The variations on the short term and long term policies will impact how the financial balance between the catchments should vary. This will ultimately determine the management of flood risk throughout the District.

The WMRFRA highlights the potential for flooding in Bewdley, Stourport on Severn and Kidderminster but does not consider the risk or proposed growth in the area to be sufficiently high, on a regional scale, to warrant detailed discussion. However, it is the potential for flooding identified within both the WMRFRA and CFMP that highlights the need for the Council to undertake this more detailed Level 2 analysis of the District to enable the correct placement of the required developments.

1.5 Scope

The scope for this SFRA is in accordance with PPS25 guidelines (Communities and Local Government, 2006, Planning Policy Statement 25: Development and Flood Risk), Development and Flood Risk a Practice Guide Companion to PPS25 and Royal Haskoning's proposal dated 20th June 2008.

The key aims of the Level 2 SFRA are to consider the detailed nature of the flood hazard by taking into account the presence of flood risk management measures. In particular this study focuses upon the proposed development sites located within zones of medium to high risk (Flood Zones 2 and 3 respectively) as identified in the Level 1 SFRA and Section 2 of this report. This Level 2 SFRA includes reviews of:

- the Flood Zones, in particular the Functional Floodplain (Flood Zone 3b) on the Hoo Brook and River Stour as specified in the Proposal, and the correction of misalignments on the former;
- defence infrastructure, including its present condition, maintenance and upgrading;
- consequences of overtopping or failure of the Kidderminster and Bewdley flood defences, including an allowance for climate change, and the production of Hazard Mapping;
- flood risk across the Flood Zones, including the identification of rapid inundation zones, residual risk to people and developments behind defences and the effect of increased runoff from developments on flood risk;
- In addition guidance notes are provided for the execution of the Exception test, on FRA Procedure and on ways in which new developments can reduce flood risk. In addition, recommendations are provided to assist the Council in writing policies for the removal of existing culverts, on the restoration of hard engineered watercourses with soft solutions and for the production of their final LDF.

As far as possible this Level 2 SFRA has utilised existing 1D models to calculate the Flood Zones along the River Severn and River Stour in the locations where potential development sites have been identified. In addition a new 1D ISIS model has been constructed for the Hoo Brook through Kidderminster. A detailed analysis of flood risk has then been undertaken for the towns of Bewdley, Kidderminster and Stourport-on-Severn with the 2D modelling software, TUFLOW, used to find the maximum flood extents and estimates of the likely depths and velocity of moving flood water. Using this information Flood Hazard maps have been created, providing an overview of flood risk across the urban area.

Flood Hazard Mapping brings information on flood depth and velocity (speed) of floodwater together to create a hazard rating to people within each area that could experience flooding. The hazard rating used is set out in the report Flood Risk Assessment Guidance for New Development Phase 2, Framework and Guidance for Assessing and Managing Flood Risk for New Development (FD2320/TR2) HR Wallingford (October 2005). Due to the high number of developments falling within high risk Flood Zones, the 'Complex' approach outlined in FD2320 was considered the most appropriate method for assessing the risk to people behind defences in both Kidderminster and Bewdley.

The hazard rating categorises flood risk in terms of Caution, Danger for Some, Danger for Most and Danger for All, with the hazard becoming dangerous to more people as depths and velocities increase. This is described in **Table 2** and **Table 3.** The equation used to calculate the Flood Hazard Matrix is presented in the *'Flood Risk to People'* project.

Table 2 – Flood Hazard Matrix*

Velocity (m/s)	Depth (m)											
	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.80	1.00	1.50	2.00	2.50
0.00												
0.10												
0.25												
0.50												
1.00												
1.50												
2.00												
2.50												
3.00												
3.50												
4.00												
4.50												
5.00												

* The green colour code is not specified in FD2320/TR2 and has been employed within this SFRA in order to show maximum flood extent.

Table 3 – Description of Hazard Categories

Degree of Flood Hazard	Colour Code	Description
Low		**Caution**
Moderate		**Danger for Some** Includes children, the elderly, and the infirm
Significant		**Danger for most** Includes the general public
Extreme		**Danger for All** Includes the emergency services

Using the Flood Hazard Mapping we have assessed the flood risk at each potential development site. In addition we have assessed the consequences of a breach in the Bewdley demountable flood defences at two locations and a breach in the Kidderminster flood defences at five locations, in addition to a simulation of catastrophic failure of the Kidderminster flood alleviation dam.

Royal Haskoning produced this Level 2 report in close consultation with the Council and the Environment Agency. Input to the SFRA, initially presented in the preceding Level 1 report, was also provided by Severn Trent Water, British Waterways and the Highways Agency.

1.6 Data Used

The data used within this report has primarily been obtained from the Council and the Environment Agency. All information regarding the potential development site locations and usage were provided by the Council. The original Flood Zones and information regarding the defence conditions and standards were obtained through the Environment Agency and NFCDD. Data regarding the height of flood defences through Kidderminster was obtained by Royal Haskoning during visits to the site.

2 UPDATES TO LEVEL 1 RESULTS

2.1 Potential Development Sites

This Level 2 SFRA considers all the sites identified in the Level 1 SFRA as falling within areas of fluvial flood risk (wholly or partially within the Environment Agency's Flood Zones 2 or 3). All these sites are numbered between D1 and D40 and are located within or around the towns of Kidderminster, Bewdley and Stourport on Severn and the village of Cookley. Following the completion of the Level 1 SFRA, the Council identified additional potential development sites for consideration in the Level 2 SFRA. These have been numbered between D41 and D54. All of these sites (D1-D54) are summarised below, with those falling within Flood Zones 2 and 3 highlighted in grey and therefore qualifying for analysis within this Level 2 SFRA. However, subsequent to the release of these potential development sites, the Council released the results from their Strategic Housing Land Availability Assessment (SHLAA) and thus additional potential development sites for consideration in this SFRA. These have been numbered between SH1 and SH163, but only those falling within Flood Zones 2 and 3 are included in the tables below. Where these sites overlap with the original potential development sites (D1-D54) it is stated in the Unique ID column.

All the potential development sites which have now been put forward for inclusion in this Level 2 SFRA are highlighted in grey in the tables in Section 2.2 and are shown with their Unique ID reference numbers on **Figure 1**.

2.2 Fluvial Flood Risk, Climate Change, Flood Risk Management Infrastructure and Flood Warning

Tables 4 – 7 below summarise all of the potential development sites put forward by the Council. The impact of Climate Change is shown by a number index, the key to which is presented. The sites highlighted in grey are those located within Flood Zones 2 and 3 and thus requiring further consideration within this Level 2 SFRA.

2.2.1 Kidderminster

Climate Change Key

NB Any increases in the 1% AEP flood levels due to climate change do not take into account the effect of breaching or overtopping of the defences.

1 This site is currently protected by the FAS. The potential impact is dependent upon the capacity of the flood storage reservoir.

2 Outside Flood Zone 2 (0.1% AEP) and therefore the risk of flooding is not directly affected by climate change. However, the consequences of the development in terms of additional runoff and increased flood risk elsewhere due to climate change should be considered. Site specific FRAs should aim for reduction in runoff from existing.

3 The watercourse adjacent to the potential development site has not been modelled. It is recommended that the existing Flood Zone 2 (0.1% AEP) be used to represent Flood Zone 3 with climate change until the watercourse has been assessed in greater detail.

4 This site is protected from water in the FAS storage area by high ground.

5 The design of the road crossing should address the impacts of climate change in terms of increased flood levels and hence flood extents, as well as increased runoff rates.

Table 4a – Potential Development Sites in Kidderminster carried forward from Level 1 SFRA

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
D1	Land to Rear of Crossley	Vacant Brownfield land - currently zoned for employment uses (Offices)	1.14	FZ2 & FZ3a	1	Brownfield	Yes
D3 / SH14 / SH25	KTC.4	Area currently adopted for mixed use redevelopment	8.84	FZ2 & FZ3a	1	Brownfield	Yes
D4 / SH26	Council Depot Site	Current Council Depot - May move	1.22	FZ2	1	Brownfield	Yes
D5 / SH82	Churchfields Business Park	Employment area - potential pressure for change	7.09	None	2	Brownfield	No
D7	Georgian Carpet Factories Site	Potential for Redevelopment	4.55	None	2	Brownfield	No
D8 / SH24	Lime Kiln Bridge	Potential Redevelopment Site	0.45	None	2	Brownfield	No
D9 / SH10	Park Lane Timber Yard	Zoned for residential development	1.00	None	2	Brownfield	No
D10 / SH19	BT Site, Mill Street	Potential Housing Site	0.60	FZ2 & FZ3a	1	Brownfield	Yes
D11	Current Morrisons Application Site	Planning permission granted (06/0590)	3.59	FZ2 & FZ3a	1	Brownfield	Yes
D12 / SH76	Park Lane	Adopted Local Plan Redevelopment Site	1.68	None	2	Brownfield	No
D21	British Sugar Site	Potential Development Site - British Sugar	23.85	None	2	Brownfield	No
D22	Victoria Sports Ground	Potential Development Site	2.22	FZ2 & FZ3a*^	5	Greenfield	No
D23 / SH75 / SH159	Park Lane	Potential Development Site	0.87	FZ2 & FZ3a (Partially)	1	Brownfield	No
D24	Current Sealine Factory (Various Units)	Potential Development Site	6.48	FZ2 & FZ3a (Partially)	1	Brownfield	Yes

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
D25 / SH35	Current Retail Area	Potential Development Site	0.63	FZ2	1	Brownfield	Yes
D26	New Road and Market Street	Potential Development Site	0.49	FZ2 & FZ3a	1	Brownfield	Yes
D27	Brintons Offices - Exchange Street	Potential Development Site	0.21	FZ2 & FZ3a	1	Brownfield	Yes
D28	Current Morrisons Site and other shops	Potential Development Site	1.16	FZ2 (Partially)	1	Brownfield	Yes
D29 / SH60	KTC.3 - Worcester Street Enhancement Area	Potential Development Site - Indicated in the Adopted Local Plan	0.61	None	2	Brownfield	No
D30 / SH9	Church Street Car Park	Potential Development Site	0.09	FZ2 & FZ3a	1	Brownfield	Yes
D31	Puxton	Potential Development Site	7.34	FZ2 & FZ3a	1	Greenfield	Yes
D33	Summerfield - Stradles the District Boundary	Potential Development Site	55.12	None	2	Brownfield	No
D36	Lisle Avenue	Potential Development Site - Currently zoned for employment use within the Local Plan	5.25	None	2	Brownfield	No
D38 / SH40	Puxton Site	Planning permission granted	1.70	FZ2 & FZ3a (Partially)	4	Greenfield	Yes
D40	Hoo-Brook Link Road	Potential road crossing	n/a	FZ2, FZ3a & FZ3b (Partially)	5	-	-

* Adjacent watercourse has not been modelled, so all Flood Zones are derived using JFLOW.

^ Flood Zone 3b has not been modelled for the adjacent watercourse.

Table 4b – Additional Potential Development Sites in Kidderminster identified since completion of Level 1 SFRA

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield of Greenfield	Protected by flood defence
D46	Cheshires Printers	Potential Redevelopment Site	0.30	None	2	Brownfield	No
D47 / SH81	Kidderminster Market Auctions	Potential Redevelopment Site	0.43	None	2	Brownfield	No
D48 / SH71	Comberton Place	Potential Redevelopment Site	0.10	None	2	Brownfield	No
D49 / SH80	Comberton Hill	Potential Redevelopment Site	0.14	None	2	Brownfield	No
D50 / SH152	CMS Car Showrooms	Potential Development Site	0.87	None	2	Brownfield	No
D52 / SH61	Rock Works	Potential Housing Site	0.29	None	2	Brownfield	No
D53	Matalan	Potential Redevelopment Site	0.69	FZ2 & FZ3 (Partially)	1	Brownfield	Yes
D54	Worcester Street	Potential Redevelopment Area – Mixed Use	1.51	None	2	Brownfield	No

Table 4c – SHLAA sites identified in Kidderminster since completion of Level 1 SFRA that fall within FZ2 & FZ3a

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
SH04	78 Mill Street	Unspecified	0.332	FZ2 & FZ3a	1	Brownfield	Yes
SH11	Castle Road/ Park Lane	Unspecified	0.071	FZ2 & FZ3a	1	Brownfield	Yes
SH18	Georgian Carpets	Unspecified	5.392	FZ2 (Partially)^	1	Brownfield	Yes
SH20	Playing Field Adjacent St Mary's School	Unspecified	1.018	FZ2 (Partially)^	1	Greenfield	Yes
SH21	Rear of the Parade Broadwaters	Unspecified	0.347	FZ2 & FZ3a (Partially)	1	Greenfield	No
SH30	New Road Carters Site	Unspecified	0.767	FZ2 & FZ3a	1	Brownfield	Yes
SH31	R&D Aggregates Site	Unspecified	1.049	Marginal	2	Brownfield	No
SH32	Park Lane	Unspecified	0.082	FZ2 & FZ3a (Partially)^	1	Brownfield	No

SH38	Bed City MCF Complex	Unspecified	0.798	FZ2 & FZ3a	1	Brownfield	Yes
SH39	Elgar House Green Street	Unspecified	0.544	FZ2 & FZ3a (Partially)	1	Brownfield	Yes
SH41	Former British Sugar Settling Ponds	Unspecified	15.311	FZ2	1	Greenfield	Yes
SH42	Mill Bank Garage	Unspecified	0.109	Marginal	1	Brownfield	Yes
SH43	Piano Building Weavers Wharf Kidderminster	Unspecified	0.055	FZ2 & FZ3a	1	Brownfield	No
SH44	Zanzibars Castle Road Kidderminster	Unspecified	0.298	FZ2	1	Brownfield	Yes

^ There are misalignments of the Flood Zones on Hoo Brook. These will be remodelled as part of this study.

2.2.2 Stourport-On-Severn

Table 5a – Potential Development Sites in Stourport-On-Severn carried forward from Level 1 SFRA

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
D2 / SH17	Riverside Business Centre	Current adopted employment area	3.09	FZ2, FZ3a & FZ3b	1	Brownfield	Yes
D13 / SH7	STC2	Adopted Local Plan Development Site	6.06	FZ2 FZ3a &FZ3b (Partially)	1	Brownfield	Yes
D14 / SH3	STC3	Adopted Local Plan Redevelopment Site	2.20	FZ2 FZ3a &FZ3b (Partially)	3	Brownfield	No
D15 / SH45	Lichfield Basin	Planning Permission for 144 dwellings	2.03	FZ2	3	Brownfield	No
D16	Shipleys Amusement Area	Potential Development Site	0.95	FZ2, FZ3a & FZ3b	3	Brownfield	No
D17	Thomas Vale - Affordable Housing Site	Under Construction	0.77	FZ2, FZ3a (Partially) ^	3	Brownfield	Yes
D18	Parsons Chain	Potential Development Site	3.71	None	2	Brownfield	Yes
D19	A.Harris and Sons	Planning application approved for light industrial	0.22	None	2	Brownfield	Yes

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
D34 / SH27 / 34 / 117	Baldwin Road	Potential Development Site	1.60	None	2	Brownfield	Yes
D35 / SH8	STC.4	Development site as earmarked by the Local Plan and the STC.4 Supplementary Planning Document	0.38	FZ2	3	Brownfield	No
D39	Stourport Relief Road	Safeguarded within the Local Plan	n/a	FZ2, FZ3a & FZ3b (Partially)	5	-	-

^ Flood Zone 3b has not been modelled for the adjacent watercourse.

Table 5b – Additional Potential Development Sites in Stourport-On-Severn identified since completion of Level 1 SFRA

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield of Greenfield	Protected by flood defence
D41 / SH33	ADR – Power Station Road	Area of Development Restraint	3.14	FZ2	3	Brownfield	No
D42 / SH28	Car Garages – Worcester Road	Potential Redevelopment Area	0.83	FZ2^	1	Brownfield	Yes
D43	Stourport Civic Centre	Potential Redevelopment Site	0.58	None	3	Brownfield	No
D44 / SH15	Lickhill Lodge First School	Potential Redevelopment Site	1.37	FZ2	3	Brownfield	No

^ Flood Zone 3b has not been modelled for the adjacent watercourse.

Table 5c – SHLAA sites identified in Stourport-on-Severn since completion of Level 1 SFRA that fall within FZ 2 & FZ3a

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
SH05	Baldwin Road Local Plan Site	Unspecified	0.358	Marginal	1	Brownfield	Yes
SH16	Parsons Chain	Unspecified	6.259	FZ2 (Partially)	3	Brownfield	Yes
SH37	Land at Moorhall Lane	Unspecified	1.966	FZ2 & FZ3a (Partially)	3	Greenfield	No
SH46	Tontine Buildings	Unspecified	0.169	FZ2	3	Brownfield	No

2.2.3 Bewdley

Table 6a – Potential Development Sites in Bewdley carried forward from Level 1 SFRA

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
D6 / SH01	Load Street – Bewdley Medical Centre	Potential redevelopment of Medical Centre	0.66	FZ2 & FZ3a	3	Brownfield	Yes
D32	Lax Lane Craft Centre/WVRS/British Red Cross	Potential Development Site	0.26	FZ2 & FZ3a	3	Brownfield	Yes

Table 6b – Additional Potential Development Sites in Bewdley identified since completion of Level 1 SFRA

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield of Greenfield	Protected by flood defence
D45 / SH22	Butt Town Meadow Caravan Park	Potential Development Site	2.09	FZ2 & FZ3a	3	Brownfield	No

Table 6c – SHLAA sites identified in Bewdley since completion of Level 1 SFRA that fall within FZ 2 & FZ3a

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
SH02	Texaco Garage Bewdley	Unspecified	0.121	FZ2	3	Brownfield	No
SH36	Stourport Road Bewdley	Unspecified	3.184	FZ2	3	Greenfield	No

2.2.4 Cookley and Rural Wyre Forest

Table 7a – Potential Development Sites in Cookley carried forward from Level 1 SFRA

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
D37 / SH29	Titan Steel Wheels – Cookley	Potential Development Site	5.71	FZ2 & FZ3a (Partially)	3	Brownfield	No

Table 7b – SHLAA sites identified in Rural Wyre Forest since completion of Level 1 SFRA that fall within FZ 2 & FZ3a

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
SH06	Blackstone Barns	Unspecified	0.27	FZ2	3	Greenfield	No
SH12	Rock Tavern, Caunsall Road	Unspecified	0.06	FZ2 (Partially)	3	Brownfield	No
SH13	The Manor House, Wolverley	Unspecified	1.01	FZ2 & FZ3a (Partially)	3	Brownfield	No
SH23	Adjacent to Chaddesley Corbett Surgery	Unspecified	2.28	FZ2 & FZ3a (Partially)	3	Greenfield	No

2.3 Summary

Table 8 summarises the number of potential development sites located in Flood Zones 2, 3a or 3b and thus requiring further analysis within this level 2 SFRA. These sites are highlighted in grey in the above table.

Table 8 – Potential development sites Located within Flood Zones 2 and 3

	Potential Development Sites taken Forward from Level 1 SFRA (D1 – D40)	Potential Development Sites in Addition to Level 1 SFRA (D41 – D54)	SHLAA Sites* (SH1 – SH163)
Kidderminster and surrounding Areas	16	1	14
Stourport	8	3	4
Bewdley	2	1	2
Cookley	1	0	0
Rural Wyre Forest	0	0	4

** (which do not overlap with the Potential Development Sites D1 – D54)*

3 FLOOD RISK IN KIDDERMINSTER AND SURROUNDING AREA

3.1 Study Area

The study area under consideration in this section is shown in **Figure 2**. It consists of the entire town of Kidderminster, but also extends as far south as to include the village of Wilden and north to include the village of Cookley. The Chaddesley Corbett potential development site is also shown on this map as an inset. The majority of the sites requiring attention within this Level 2 SFRA are located in the central area of the town of Kidderminster along the eastern bank of the River Stour. The surrounding area includes potential development sites SH13 and D37/SH29 and SH12 to the north of Kidderminster in the villages of Wolverley and Cookley, D20 in Wilden to the south and site SH23 in Chaddesley Corbett to the east.

3.2 Overview of Flood Risk

Fluvial Flood Risk within the study area is mainly associated with the River Stour. However, the tributary watercourses of Hoo Brook and Blakedown Brook to the east (both enmained in their downstream extents) and Drakelow/Hors Brook to the west (Ordinary Watercourses) also pose a fluvial flood risk to the potential development sites. SH23 in Chaddesley Corbett is at risk from the Hockley Brook, which, rather than being a tributary of the River Stour, is a tributary of the River Severn, classified as an Ordinary Watercourse, joining it downstream of the District boundary.

In addition to the fluvial flood risk from these watercourses, the Level 1 SFRA identifies problems arising when the River Stour interacts with Staffordshire and Worcestershire Canal, which also bisects Kidderminster, running in very close proximity to the River Stour along its course through the District. In 2007 the River Stour overtopped its banks and, upstream of the Wyre Forest District boundary, the floodwaters interacted with the canal, filling all available freeboard and rapidly conveying floodwaters downstream, resulting in flooding in Kidderminster. Although the threat of flooding from the canal can be alleviated through the control of sluices, it is a source that should be considered for all potential development sites located in proximity to the waterway.

The flood risk associated with sewer, groundwater and overland flooding was addressed in the Level 1 SFRA. The Level 1 report summarised that there have been numerous instances of historic flooding throughout Kidderminster, and seven records of sewer flooding on the Severn Trent DG5 register. The Environment Agency confirmed that they are not aware of any specific incidences of groundwater flooding within the District.

The majority of developments considered within this SFRA which are located in and around Kidderminster are proposed to be located on Brownfield land. Although suitable SUDS policies will be required on these sites (discussed in greater detail in the accompanying WCS report), their impact on surrounding potential development sites as a result of increased runoff should be minimal. However, a number of Greenfield sites have also been proposed, mainly in the more rural areas surrounding the town. For these sites increased emphasis should be placed on the management of surface water so that the risk of flooding is not increased downstream. The Environment Agency has a requirement to ensure the post development runoff is equivalent to, or less than, that existing prior to the development taking place.

3.3 Flood Risk from the River Stour through Kidderminster

3.3.1 Flood Defence Infrastructure

The main town of Kidderminster is protected by a flood alleviation scheme (FAS) located upstream of the town centre and designed to provide a 1% AEP standard of protection. It consists of an earth dam containing a concrete culvert which crosses the River Stour and surrounding embankments which form a flood storage area. In times of flood the culvert limits the flow in the River, causing flood water to back-up into the Puxton marshes. The scheme also includes privately maintained channel improvements through Kidderminster and was completed in 2003. In addition to this FAS a number of flood banks and walls, both privately and Environment Agency maintained, are sporadically located throughout Kidderminster. These provide a varying standard of defence, up to 1% AEP, and are discussed in greater detail below. All these defences are shown on **Figure 2**.

Asset Condition

The Environment Agency's National Flood and Coastal Defence Database (NFCDD), contains an estimate of the condition of flood defences, along a 5 point scale, as shown in **Table 9** below.

Table 9 – Description of Asset Conditions

Grade	Rating	Description
1	Very Good	In good condition, fully serviceable, no remedial work required. Maintenance to continue as present. No significant defect.
2	Good	Minor defects, non urgent. Minor routine maintenance work required In reasonable condition, some increase in maintenance needed, probably no more than 5% affected with slight defect.
3	Fair	Some cause for concern, requires careful monitoring Significant maintenance works required Average condition, some minor repairs needed & moderate 5% - 20% affected
4	Poor	Structurally unsound now or in the near future Major remedial works required and replacement (1-5 years) Extensive repair required in short term. Extensive defect 20% - 50% affected.
5	Very Poor	Completely failed or derelict requires complete reconstruction. Major urgent repairs or replacement needed without delay to avoid failure probably beyond repair. Extensive defect >50%

All of the raised flood defences through Kidderminster have been analysed and their description, location, condition and defence standard have been recorded, as detailed in the NFCDD. The complete record is presented in *Appendix 2*.

All of the raised defences within Kidderminster and the surrounding area have condition standards of Grades 1-4. Most of them fall within Grades 1 & 2 and are therefore classified as Good or Very Good standard, with an average grade 2.3. **Table 10** presents the defences and assets assigned a condition Grade 3 and 4. In addition, this table also includes defences and assets noted as having a defence standard of less than 1%. All of the defences highlighted in this table are shown in **Figure 3**.

Table 10 – Kidderminster Defence Conditions or 1% AEP standard

NFCDD Reference	Unique ID	Maintainer	Description	Location	Actual Condition	Defence Standard (yrs)
0310312650401L02	1	Environment Agency	Wall	KIDDERMINSTER	2	2
0310312650401L07	2	private	Wall	KIDDERMINSTER	3	2
0310312650401L08	3	private	Wall	KIDDERMINSTER	3	-
0310312650401L09	4	private	Wall	KIDDERMINSTER	3	2
0310312650401L12	5	private	Wall	KIDDERMINSTER	2	2
0310312650401L14	6	private	Steep Natural Rock Face	KIDDERMINSTER	2	2
0310312650401L15	7	private	High Ground	KIDDERMINSTER	2	2
0310312650401L17	8	private	WALL	KIDDERMINSTER	2	2
0310312650401L18	9	private	Brick Wall	KIDDERMINSTER	2	2
0310312650401L20	10	private	Brick Wall	KIDDERMINSTER	2	2
0310312650401R09	11	private	Wall	KIDDERMINSTER	3	-
0310312650401R20	12	private	Wall	KIDDERMINSTER	3	-
0310312650401R21	13	private	Wall	KIDDERMINSTER	3	-
0310312650401R23	14	private	Wall	KIDDERMINSTER	3	-
0310312650501L02	15	private	Wall	KIDDERMINSTER	2	2
0310312650501L11	16	private	Arched Bridge Abutment	KIDDERMINSTER	3	-
0310312650501L12	17	private	Wall	KIDDERMINSTER	3	2
0310312650501R01	18	private	Wall	KIDDERMINSTER	3	2
0310312650501R10	19	private	Masonry Wall	off New Road, KIDDERMINSTER	4	-
0310312650501R11	20	private	Arched Bridge Abutment	KIDDERMINSTER	3	-
0310312650601L02	21	private	channel side	KIDDERMINSTER	3	-
0310312650601L03	22	private	Cement bag wall	KIDDERMINSTER	3	-
0310312650601L05	23	private	wall	KIDDERMINSTER	3	-
0310312650601L13	24	private	Channel Side with car park on crest	Fire Station, KIDDERMINSTER	3	-
0310312650601R04	25	private	Wall	KIDDERMINSTER	2	2
0310312650601R11	26	private	Fire Station	KIDDERMINSTER	2	2
0310312650701L01	27	private	REGRADED CHANNEL SIDE	KIDDERMINSTER	3	-
0310312650701L02	28	local authority	BRICK WALL	KIDDERMINSTER	3	2
0310312650701L03	29	local authority	Concrete Bridge Abutment	KIDDERMINSTER	3	-
0310312650701L04	30	private	Concrete Capped Steel Sheet Piled Wall	KIDDERMINSTER	3	-
0310312650701L06	31	private	Wall	KIDDERMINSTER	3	-
0310312650701L07	32	private	Wall	KIDDERMINSTER	3	2
0310312650701L08	33	private	Brick Masonry Wall of Building	KIDDERMINSTER	3	-
0310312650701L10	34	private	Wall	KIDDERMINSTER	3	-
0310312650701L13	35	private	Brick Masonry Wall	KIDDERMINSTER	3	-
0310312650701L14	36	local authority	Brick Masonry Bridge Abutment	KIDDERMINSTER	3	-
0310312650701L15	37	private	Arched Bridge	KIDDERMINSTER	3	-
0310312650701L16	38	private	Stone Protection to Channel Side	KIDDERMINSTER	3	-
0310312650701L18	39	local authority	Concrete Bridge Abutment	KIDDERMINSTER	3	-

0310312650701L19	40	Environment Agency	Rebuilt Sheet Piled Wall (Concrete Capping)	REAR OF SAINSBURY'S PETROL STATION Retail Park, KIDDERMINSTER	3	-
0310312650701L20	41	private	Stone Protection to Channel Side	REAR OF SAINSBURY'S PETROL STATION, CROSSLEY RETAIL PARK, KIDDERMINSTER	3	-
0310312650701L23	42	private	Stone Protection to Channel Side	Blakebrook, KIDDERMINSTER	3	-
0310312650701L24	43	private	Wall	KIDDERMINSTER	2	2
0310312650701L25	44	private	Wall	KIDDERMINSTER	2	2
0310312650701R01	45	private	REGRADED CHANNEL SIDE	KIDDERMINSTER	2	2
0310312650701R02	46	private	Wall	KIDDERMINSTER	3	-
0310312650701R03	47	private	Concrete Bridge Abutment	KIDDERMINSTER	3	-
0310312650701R04	48	private	Wall	KIDDERMINSTER	2	2
0310312650701R06	49	private	Masonry Wall forming side of pub	Bull Ring, KIDDERMINSTER	3	-
0310312650701R07	50	private	Wall	KIDDERMINSTER REAR OF DOCTORS SURGERY	3	2
0310312650701R13	51	private	Wall	KIDDERMINSTER	2	2
0310312650701R14	52	private	Stone Masonry Bridge Abutment	KIDDERMINSTER	3	-
0310312650701R16	53	private	Wall	KIDDERMINSTER	3	-
0310312650701R17	54	private	Channel Side	KIDDERMINSTER	3	-
0310312650701R18	55	private	Concrete Bridge Abutment	KIDDERMINSTER	3	-
0310312650701R19	56	private	Channel Side	KIDDERMINSTER, D/S RDBRIDGE CROSSLEY RETAIL PARK	3	-
0310312650803R01	57	Environment Agency	Flood Bank	Beechcote, KIDDERMINSTER FAS	3	100

Future Maintenance and Upgrade

Of the list of defences in **Table 10**, only one has a 'poor' asset condition assigned to it. Defence 19 is situated downstream of the town centre, protecting Castle Road from flooding. The 'poor' asset condition assigned to the defence defines it as structurally unsound now or in the near future. It must be closely monitored, as it will require major remedial works and replacement within 1 – 5 years. In the short term, extensive repair is required in order to prevent total failure occurring. This defence has been included within the breach analysis due to its condition.

There are numerous defences through the centre of Kidderminster that have a condition of Grade 3. Although satisfactory at the moment, they must be closely monitored and potentially upgraded in the near future to avoid leakage or failure. Defences 27 – 56 have been identified in the EA FRM System as having a planned inspection scheduled for December 2009. Defence 57 has a scheduled inspection date for January 2010. This will allow a reassessment of the Condition Grade to be carried out and an assessment of maintenance needs.

3.3.2 Methodology

General

The Level 1 SFRA considered the flood risk to Kidderminster based on the current Environment Agency Flood Zones. The Flood Zones through the centre of Kidderminster is based upon the River Stour model and is therefore considered sufficient for use in this study. However, as the modelled Flood Zones do not take into account the presence of flood defences, it was considered necessary, as part of this Level 2 SFRA, to identify the "real" flood risk to Kidderminster. The EA River Stour model is currently being updated. This model will replace all internal mapping and modelling. The model will then go on to be reviewed every 5 yrs, and Flood Zone maps will be updated from this new Stour modelling

As the model results are unlikely to be available until summer 2010, the revised information from the new model will not be available for this SFRA. As a result of this, we would recommend that the data is sourced and used in any subsequent updates of the SFRA and policy for Kidderminster, while also taking a precautionary approach to policy recommendations for potential development sites likely to be affected.

Mapping of the "Real" Flood Risk

The existing 1d ISIS model of the River Stour through Kidderminster extends from the FAS dam to the Wilden Marshes and was constructed for the Environment Agency in the 1990s. However, although an ISIS model gives an indication of the area flooded during a flood event and therefore can be used to determine Flood Zone outlines; it does not represent the flow of water through a town or provide an indication of velocities. It was therefore considered inappropriate for the requirements of a Level 2 SFRA. It was considered necessary to model the flow paths behind the flood defences in greater detail, and identify rapid inundation zones and flood hazard mapping.

This was achieved using the 2-dimensional modelling software, TUFLOW, which represents the town in the form of a grid. The squares of the grid have different elevations based on the topography of the land as defined by LiDAR.

It was initially intended that the inputs to the TUFLOW model would be taken from the ISIS model, in the form of a stage hydrograph at each section of defence or bank. The volume of water overtopping the defence or bank would be determined by the relative levels of the stage hydrograph and the defence height. However, although the node locations and levels were available for use within this study, the Environment Agency were unable to locate the model itself. Therefore an alternative approach had to be developed and agreed with the Environment Agency.

As an existing 1d model of the River Stour upstream of Kidderminster was available, with its downstream extent located slightly downstream of the FAS dam, it was used to determine flows through the dam control structure and over the spillway (for events which exceed the capacity of the reservoir). The floodplain of the River Stour through Kidderminster was represented in TUFLOW using a 5m grid size and major obstructions to the flow, such as flood walls and roads, represented using "z lines" and openings, such as underpasses and bridge openings, represented using a 1d connecting unit. The heights of the flood defences, not available from the missing model, were

determined from site measurements and LiDAR data. Both the River Stour and Staffordshire and Worcestershire canal were represented using a series of lowered 5m grid cells, with the depth of these cells determined through comparison of the resulting modelled water levels with the levels available from the missing ISIS model. This new model has been run for the 5%, 1% and 0.1% AEP events, with and without climate change scenarios.

Overtopping scenarios have been run for the FAS for the 1% AEP event plus climate change and 0.1% AEP. As the scheme provides a 1% AEP standard of protection it was only necessary to consider events that exceed this AEP. The outputs of the existing upstream ISIS model formed the input into the new TUFLOW model downstream of the dam structure. The flows through the control structure were added as an inflow to the River Stour and the flow over the spillway was added as an inflow to the 2d grid immediately downstream of the spillway. Hazard mapping for the FAS overtopping is presented in **Figures 4a – 4d.**

3.3.3 Breach Analysis

PPS25 requires a Level 2 SFRA to consider the residual risks to developments behind flood defences, both from overtopping and defence failure. PPS25 recommends that breach and overtopping analysis should follow the recommendations presented in the report FD2320[2]. FD2320[2] suggests three levels of complexity in approach (simple, intermediate and complex). It states that the simple or intermediate approach is usually adequate for the purposes of SFRAs. However, given the importance of the FAS in Kidderminster and the number of potential development sites at risk of breaching or overtopping, it was considered that the complex approach should be adopted. The complex approach involves the use of detailed hydraulic modelling to assess a flood hazard based on coincident velocity and depth, as shown in **Tables 2** and **3**.

Five locations were identified for the simulation of breaches in the flood walls and banks through Kidderminster. In addition the FAS dam was breached to simulate the effect of a catastrophic failure.

As highlighted in our Technical Note (Royal Haskoning, 10th June 2009) we have allowed for five breach locations. The breach model was constructed with limited data. The ISIS model for the area was not available for use, and there were no defence levels or survey data to use. The channel geometry was therefore estimated from a combination of site visits and LiDAR. Water levels from an ISIS results file were replicated within the TUFLOW model. The constraints that were faced in the construction of the TUFLOW model made accuracy difficult. The TUFLOW model was therefore constructed to the greatest level of accuracy with the limited data provided.

The criteria used for determining breach locations are listed below:

1. Firstly, breaches have only been considered in defences which are identified as protecting potential development sites and/or where the LiDAR indicates a drop in ground level behind the defence towards other potential development sites;
2. We have then selected defences where the NFCDD identifies the condition of the defence to be greater than 3 in the Environment Agency's NFCDD, as shown in **Table 10** in Section 3.3.1;

3. However, where they are shown to protect potential development sites, we have also selected defences which the NFCDD identifies as having a standard of protection of less than 1% AEP. These have been selected in preference to defences of a condition greater than 3 which are not identified as directly protecting potential development sites.

The effects of the breaches were simulated using a breach unit in the TUFLOW model. The dimensions and timings to closure of the breach were taken from Environment Agency guidance, based on an assessment of historic breaching incidents. The dimensions and time to closure is a factor of the type and material of the defences, as shown in **Table 11**.

Table 11 – Breach Dimensions

Defence Type	Breach Width (m)	Time to Closure (hrs)
Earth Embankment	40	30
Hard	20	18

Figure 5 shows the six locations (including the FAS dam) where breaching has been assessed for the 5%, 1% (with and without climate change) and 0.1% AEP events, and also breaching of the dam. For consistency, the inflow hydrology for the dam breach has been determined using a methodology provided in Environment Agency guidance on Reservoir Inundation Mapping. **Table 12** summarises the details of the breach analysis.

Table 12 – Breach Analysis Details

Breach	Location	Condition	Standard (AEP)	Material	Dimension
1	Town Mills, Kidderminster	1	1% (1 in 100 year)	Masonry	60m in length
2	Rear of doctors surgery, Kidderminster	3	50% (1 in 2 year)	Masonry	94m in length
3	Downstream of Crown Lane, Kidderminster	3	50% (1 in 2 year)	Brick	67m in length
4	Meadow Mills Industrial Estate, Kidderminster	3	50% (1 in 2 year)	Concrete	25m in length
5	Tram Street, Kidderminster	2	-	Concrete	40m in length
FAS Dam	Puxton Lane, Kidderminster	1	1% (1 in 100 year)	Earth	414m in length

The likelihood of defence failure is also a function of the depth of flooding and hence the force exerted on the face of the defence. **Table 13** shows the dimensions of the flood defence at each assumed breach location and the corresponding modelled water levels for the 1% AEP event.

Table 13 - Flood Defence Dimensions at Breach Locations

Breach Location	Defence Level (mAOD)^	Ground Level (mAOD)	Defence Height Above Ground Level (m)*	1% AEP Water Level (mAOD)
1	34.00	33.2	0.8	33.22
2	34.20	33.2	1.0	32.36
3	33.40	33	0.4	31.89
4	32.15	31.25	0.9	30.90
5	29.24	28.61	0.63	30.97
FAS Dam	34.9	33.7	1.2	34.40

^ Defence level identified at the breach location using LiDAR

*based on NFCDD

Flood defences are designed and constructed with an additional allowance for uncertainty on top of the predicted design water level. This allowance, known as freeboard, allows for uncertainties in the prediction of water levels and also the loadings that could be exerted on the defence. Flood defence guidance, as quoted in PPS25, recommends an allowance of 300mm for fluvial flood defences. **Table 13** shows that during the 1% flood event the freeboard (the distance between the flood level and the top of the defence) is greater than 0.3 metres at all breach locations. It can therefore be assumed that, were the defences in perfect condition, there will be sufficient allowance in the design to withstand the pressures of the 1% AEP event and that the breach would not fail. Further revisions in data may necessitate subsequent reappraisal of policy for specific sites for example the updated River Stour model.

3.3.4 Flood Hazard Analysis

The 'complex approach' presented in FD2320 addresses the issue of flood hazard as a function of flood depth and velocity. As the FAS upstream of Kidderminster provides a 1% AEP standard of protection, there was no need to model the hazard mapping for this scenario, as the Dam will provide protection to the town. **Figures 6 - 8** show the flood depths produced by the TUFLOW model for the 1%, 1% with climate change and 0.1% AEP breach scenarios respectively. **Figure 9** represents flood depth and hazard for the dam breach. The flood hazard matrix is presented in **Tables 2** and **3** of this report.

The estimation of flood hazard assessment will aid the application of the Sequential test to steering development towards more appropriate areas within the Flood Zones. Interpretation and analysis of hazard data within the context of emergency planning process will assist the emergency services in ascertaining safe access and evacuation routes in the event of a flood. Emergency services will welcome receipt of depth and velocity data for operational purposes, but an interpretation of that data is required for production of the Emergency Plan. The use of hazard data in flood monitoring, warning and communication is particularly complex due to the diversity of application. Asset management systems will also benefit from hazard data in understanding or calculating the potential impact of channel or structural blockages, defence failure or estimation of the standard of protection or physical performance of the asset management system or individual defence.

Table 14 - Flood Hazard Ratings

Site	Breaches 1 - 5	Dam Breach	Dam Overtopping
D1			
D3 / SH14 / SH25			
D4 / SH26			
D10 / SH19			
D11			
D23 / SH75 / SH159			
D24			
D25 / SH35			
D26			
D27			
D28			
D30 / SH9			
D31			
D38 / SH40			
D40			
D53			
SH04			
SH11			
SH18			
SH20			
SH21			
SH30			
SH32			
SH38			
SH39			
SH42			
SH43			
SH44			

Low Moderate Significant Extreme None

The *worst* flood hazard category for each of the proposed development sites within Kidderminster is presented in **Figures 10 and 10a**, and summarised in **Table 14. It can be concluded that there are a number of development sites within extreme danger if breaching of flood defences occurs. This is also the case if dam overtopping occurs. Only a small number of potential development sites are within no hazard risk if breaching or overtopping within Kidderminster occurs. Figure 10** outlines the hazard resulting from bank breaches along the River Stour, and **Figure 10a** outlines the hazard resulting from the dam breach. Flood risk from other watercourses is considered in *Section 3.4*. The colour code is explained fully in **Table 2** but summarised at the base of each of the tables.

Access/Egress

In addition to assessing the flood hazard for the potential development sites, it is also important to review the constraints flooding will place on the access and egress routes to the sites as it may impede evacuation and rescue efforts during a flood event.

Table 15 summarises the availability of access and egress routes during each of the flooding events mentioned above, taken from **Figures 10 and 10a** for the sites identified in **Table 14**. Red indicates that all access roads leading to and from a potential development site are at risk of flooding during the stated event. Orange indicates that there will be severe restrictions to the access routes, resulting in only one passable road or direction (for sites to which an access road has not yet been constructed). However, it must be noted that this analysis is based upon the major routes identifiable now but these may change with development.

Table 15 – Access/Egress Routes Not Affected by Flooding

Site	Breaches 1 - 5	Dam Breach	Dam Overtopping
D1			
D3 / SH14 / SH25			
D4 / SH26			
D10 / SH19			
D11			
D23 / SH75 / SH159			
D24			
D25 / SH35			
D26			
D27			
D28			
D30 / SH9			
D31			
D38 / SH40			
D40			
D53			
SH04			
SH11			
SH18			
SH20			
SH21			
SH30			
SH31			
SH32			
SH38			
SH39			
SH41			
SH42			
SH43			
SH44			

No access/egress routes available

Only 1 access/egress route or direction available

2+ access/egress routes or directions available

3.3.5 Rapid Inundation

An important consideration in assessing flood risk, and one that is not adequately addressed in PPS25, is the issue of the speed of flooding. The results of the TUFLOW model were used to calculate the rate of flooding.

A depth of 250mm was selected as representing the depth below which safe evacuation on foot could be achieved. Rapid inundation has been identified as flooding which reaches a depth of 250mm in half an hour or less.

TUFLOW analysis shows evidence of no breaching in locations 1 – 5 in the 1% AEP event. The effect of throttling through the dam structure in any flow greater than 1% AEP event means that the dam will overtop.

Normally, rapid inundation is mapped to show a buffer zone of rapid inundation surrounding the channel, but based on the dam structure throttle, the most effective way of displaying rapid inundation in Kidderminster is from the 0.1% AEP dam breach event. **Figure 10a** presents the 30 minute rapid inundation zone resulting from the dam breach in the 0.1% AEP event.

This issue should be addressed within the planning process when considering the vulnerability of the proposed land use. Preference should be given to sites which would not experience rapid flooding or ensuring that adequate mitigation measures are put in place to alleviate the consequences. As outlined in Section 1.2, more vulnerable, highly vulnerable and essential infrastructure are prohibited in areas identified as rapid inundation zones. As identified in Figure 10a, the potential development sites that are considered to be susceptible to rapid inundation are D31, D1, D10/ SH19, SH04, SH42, and D53.

As mentioned in Section 3.3.3, due to the data available and methods used, simplifications to the model have been made. This should be appreciated for future development purposes.

3.3.6 Pluvial Flooding

In accordance with PPS25, the proposed development sites in Kidderminster require assessment against pluvial flooding. Intense rainfall that is unable to soak into the ground or enter drainage systems can run quickly off land and result in local flooding. This issue is often worsened by local topography which can have damaging effects upon the direction and depth of flow. PPS25 states that overland flow paths should be taken into account in spatial planning for urban developments.

By generating a topographic grid in TUFLOW based on LiDAR data, flood depths were calculated through Kidderminster for the critical storm duration of 0.75 hours. The results of this simulate an extreme event within the catchment. **Figure 11** illustrates the resulting flood depths and hazard through Kidderminster. Due to the lack of guidance for pluvial flooding analysis, the hazard categories were based upon the same categories used to define fluvial flood hazard mapping.

The flood depths in Kidderminster are illustrated in **Figure 11.** The north, more urban areas of Kidderminster appear to suffer with greater depths of pluvial flooding, while the south of Kidderminster has pluvial flood depths on the lower end of the scale. The pluvial hazard mapping through Kidderminster shows that the majority of the town falls within the 'Danger for Some' category with sporadic patches of 'Danger for all'. This classification refers to the potential danger posed to emergency services. The majority of potential development sites within Kidderminster are effected in some way from pluvial flooding, so it is recommended that prior to any development being carried out, the opportunities to implement SUDS is explored to reduce surface water flooding.

3.4 Flood Risk from Minor Watercourses and the River Stour Outside Kidderminster

3.4.1 General

As outlined in **Sections 3.1** and **3.2**, a number of potential development sites are located within Flood Zones 2 and 3 along the smaller watercourses in Kidderminster and the River Stour outside the town. Sites SH13, D37/SH29 and SH12 are located along the Stour to the north of Kidderminster in the villages of Wolverley and Cookley (site SH13 is also located within the Flood Zones of the Drakelow/Hors Brook), site D20 is located on the east bank of the Stour to the south of Kidderminster and site SH23 is located beside the Hockley Brook in Chaddesley Corbett. Within Kidderminster itself site SH21 is at risk of flooding from the Blakedown Brook and site D22 is located on the bank of the Hoo Brook.

Since the flood risk from the River Stour through Kidderminster is mitigated by the FAS and flood banks and walls, it could be argued that the minor watercourses and the River Stour upstream and downstream from the town pose the most significant risk, either of direct flooding from the watercourse itself or of increased flood risk elsewhere due to increased surface runoff from the newly developed site. This section addresses these issues in relation to the potential development sites only, as opposed to an exhaustive analysis of flood risk at all locations.

Where possible, analysis has been based on existing hydraulic studies in conjunction with topographic data derived from LiDAR.

3.4.2 The River Stour outside Kidderminster

No flood defences are located along the River Stour in proximity to any of the watercourses mentioned above. As an ISIS model exists for the River Stour through Wolverley and Cookley, and the results of the Kidderminster ISIS model are available for Wilden, the analysis of the potential development sites in these areas has been based on this information and the LiDAR.

<u>Cookley</u>

Cookley is situated to the north of the District with the River Stour flowing through the centre of the village. **Figure 12** shows two potential development sites located within Flood Zones 2 and 3 of the village of Cookley.

Sites D37/ SH29 and SH12 lie within a small area of both Flood Zones 2 and 3 of the River Stour, as shown in **Figure 12**. The analysis at Cookley was based on an existing ISIS model produced for the Environment Agency. **Figure 13** shows an extract of the LiDAR data, with changes in elevation denoted at 200mm intervals. Site D37/ SH29 lies partially on low lying land on the south bank of the River Stour, while SH12 is located on higher ground to the North.

Figure 12 – Potential development site SH12 and D37/SH29 and River Stour Flood Zones

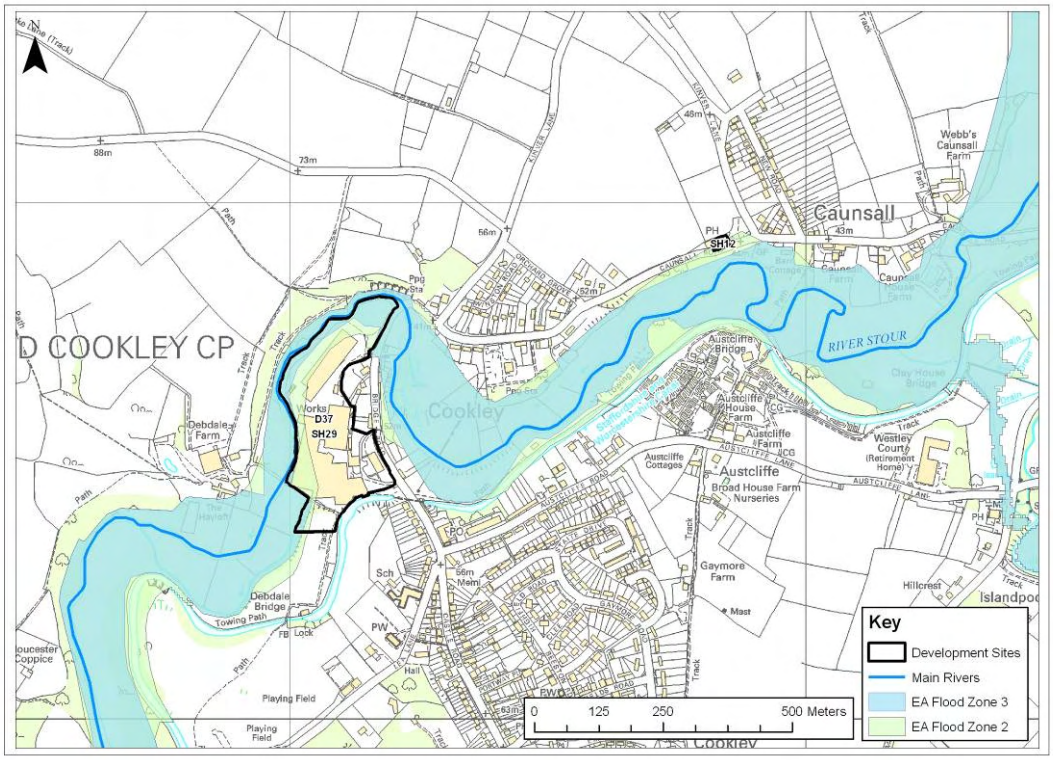
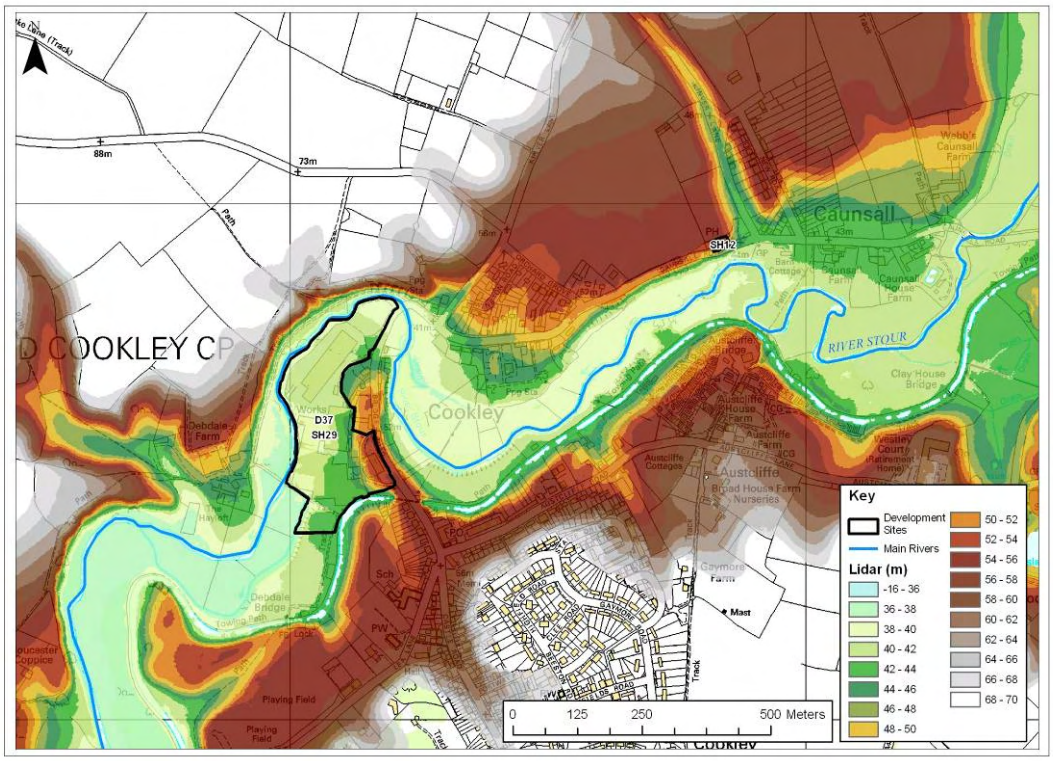


Figure 13 – Topography of sites SH12 and D37/SH29



The maximum flood levels for the River Stour model through Cookley was not available at the time of this study, so flood levels at the potential development sites could not be derived or mapped. It is recommended that site specific Flood Risk Assessments (FRA) are carried out for the Cookley potential development sites prior to further viability testing. Further guidance on FRAs can be seen in *Appendix 4*.

Wilden

Site D20 lies within a small area of both Flood Zones 2 and 3 of the River Stour, as shown in **Figure 14**. The analysis at Wilden was based on an existing ISIS model produced for the Environment Agency. The model extends from Wolverley to Hartlebury Park. The model provides the maximum water levels for the 10%, 4%, 2% and 1% AEP events.

Figure 15 shows an extract of the LiDAR data, with changes in elevation denoted at 200mm intervals. Site D33 covers a large area on high ground to the east of the River Stour. Surface runoff from the site could be exacerbated by the steep topography of the site, as shown in **Figure 15**, where the construction of infrastructure could have the potential to act as flood routes towards the lower lying land adjacent to the River Stour. Site D20 is located on lower lying land on the bank of the River Stour.

The maximum flood levels were extracted from the River Stour ISIS model at the closest cross sections to these potential development sites for the 10%, 4%, 2% and 1% AEP events. From these results, the 1% +cc, 0.1%, and 0.1% +cc EAP events were derived.

The resulting maximum water levels are shown in **Table 15** and were plotted over the LiDAR data in order to generate updated Flood Zone outlines as shown in **Figure 16**.

Table 17 - Maximum Flood Levels at the Wilden Potential development sites

AEP Events (%)	Flood Level (mAOD) D20	Flood Level (mAOD) D33
1%	25.26	26.116
1% + Climate Change	30.31	31.34
0.1%	29.26	27.95
0.1% + Climate Change	35.11	33.53

Figure 14 – Potential development site D20 and D33 and River Stour Flood Zones

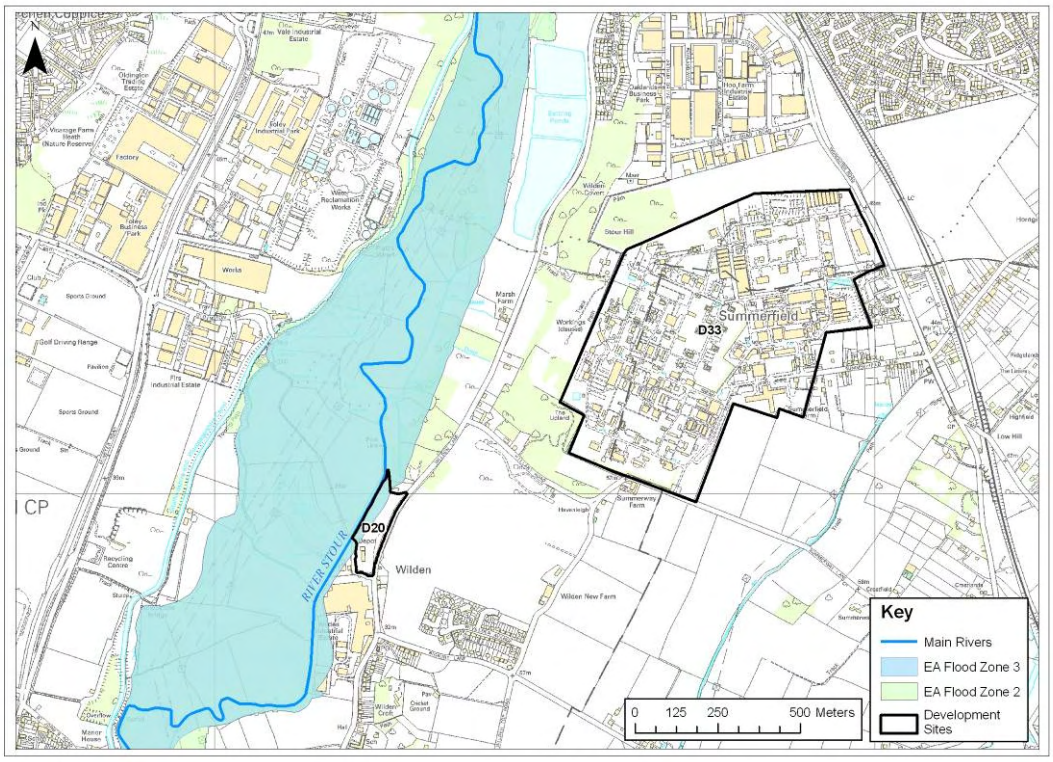


Figure 15 – Topography at D20 and D33

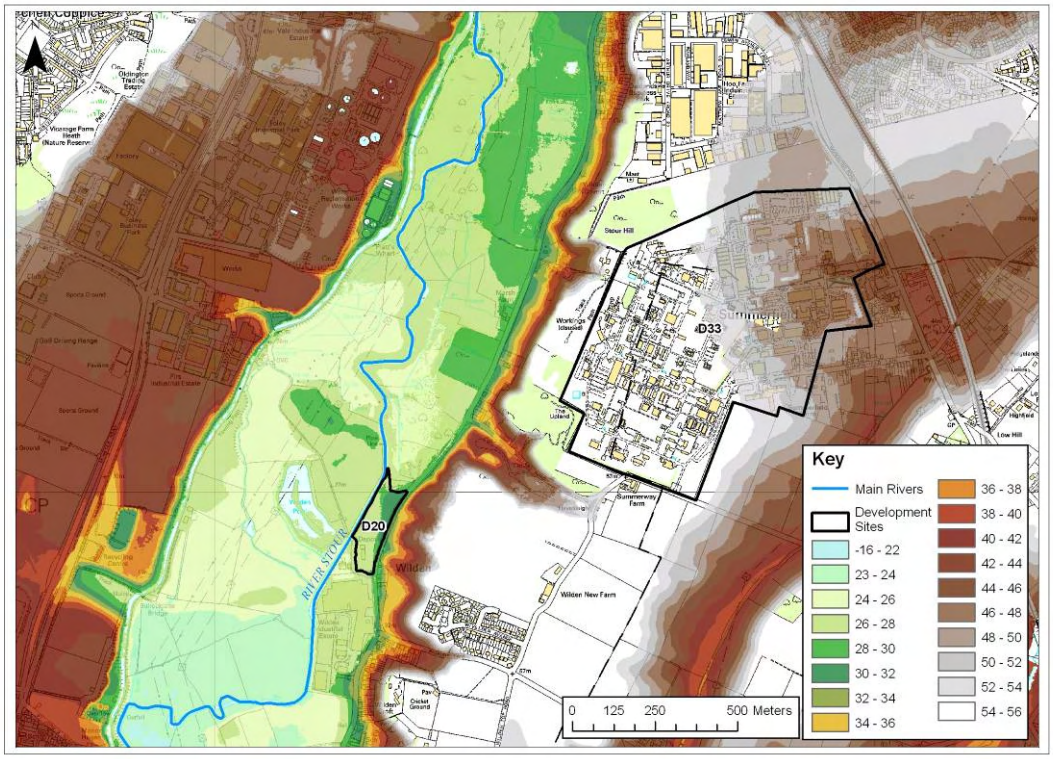
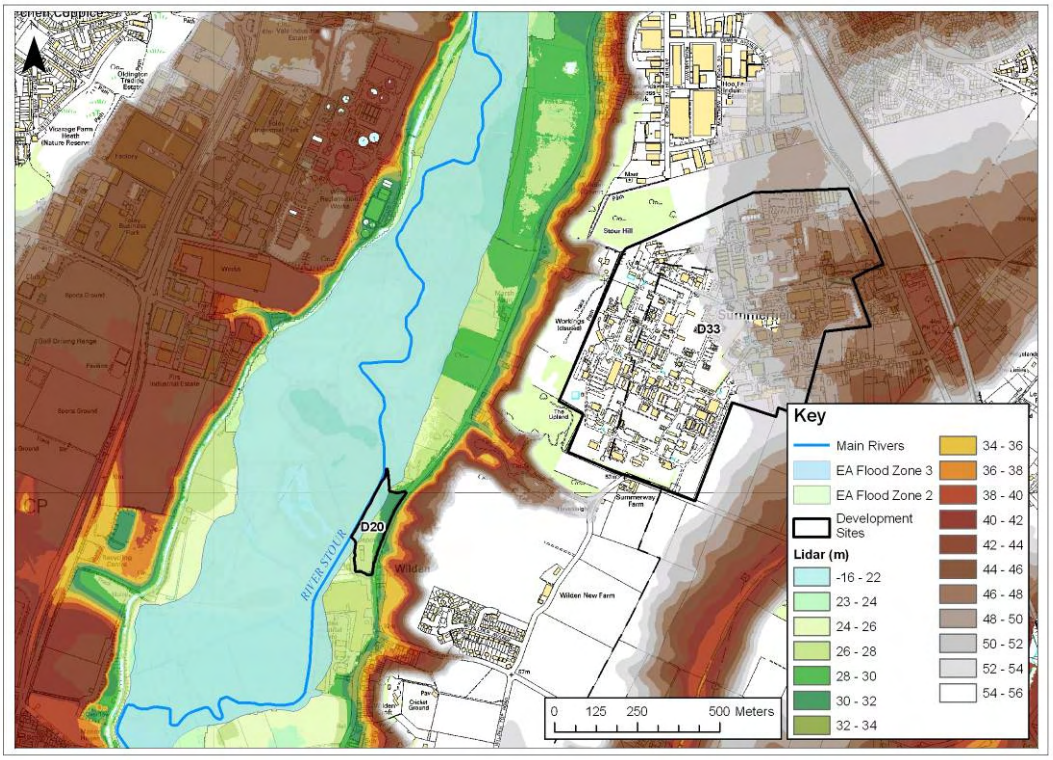


Figure 16 – Wilden Flood Extents



Site D20 has typical ground levels of 26 to 28m AOD. This suggests that in the event of overtopping during a 1% AEP event with climate change, part of the potential

development site would suffer from flooding, as shown in **Figure 16**. It would therefore be necessary to consider the opportunity of raising the ground to mitigate flood risk.

3.4.3 Drakelow/Hors Brook

The Drakelow Brook drains an area in the north of the District, including the settlements of Kingsford, Shatterford and Drakelow. It joins the River Stour at Wolverley, upstream of Kidderminster. In addition to being at risk of flooding from the River Stour, site SH13 is also at risk of flooding from this Brook, as shown in **Figure 17**.

Site SH13 lies within a small area of both Flood Zones 2 and 3 of the River Stour, as shown in **Figure 17**. The analysis at Wolverley was based on an existing ISIS model produced for the Environment Agency. The model extends from Wolverley to downstream of the Kidderminster FAS. The model provides the maximum water levels for the 4%, 1%, 1% +cc, 0.1% and 0.1% +cc AEP events. The resulting water levels were plotted over the LiDAR data in order to generate updated Flood Zone outlines as shown in **Figure 18**.

Figure 17 – Potential development site SH13 and River Stour Flood Zones

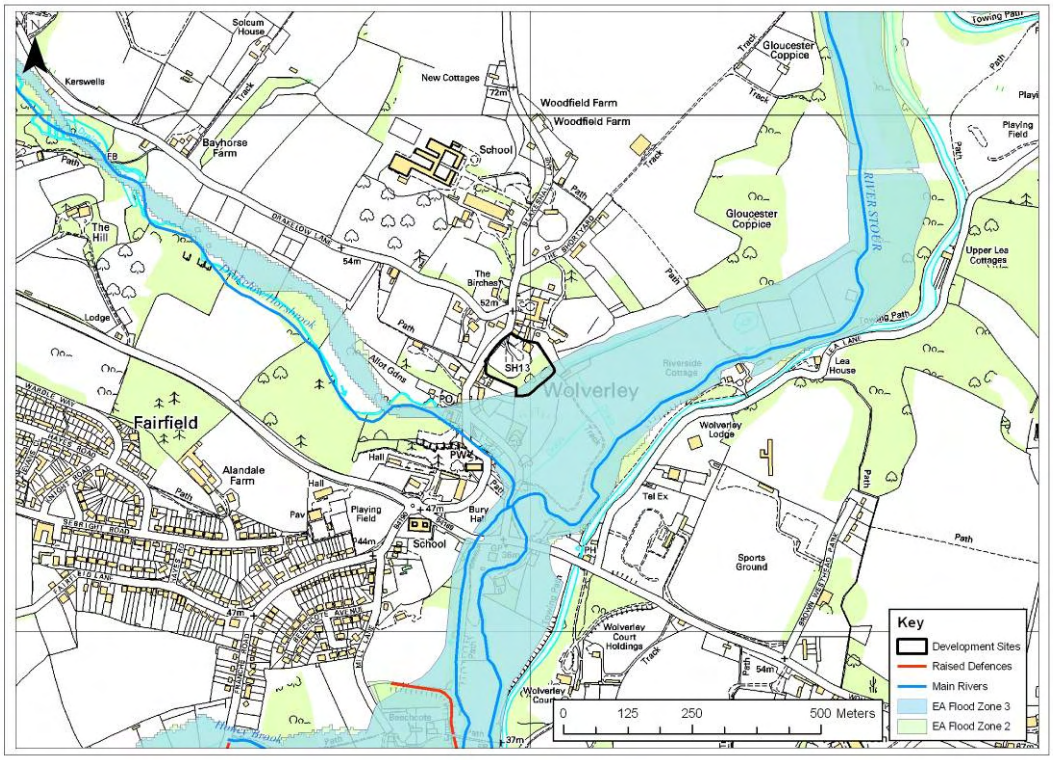
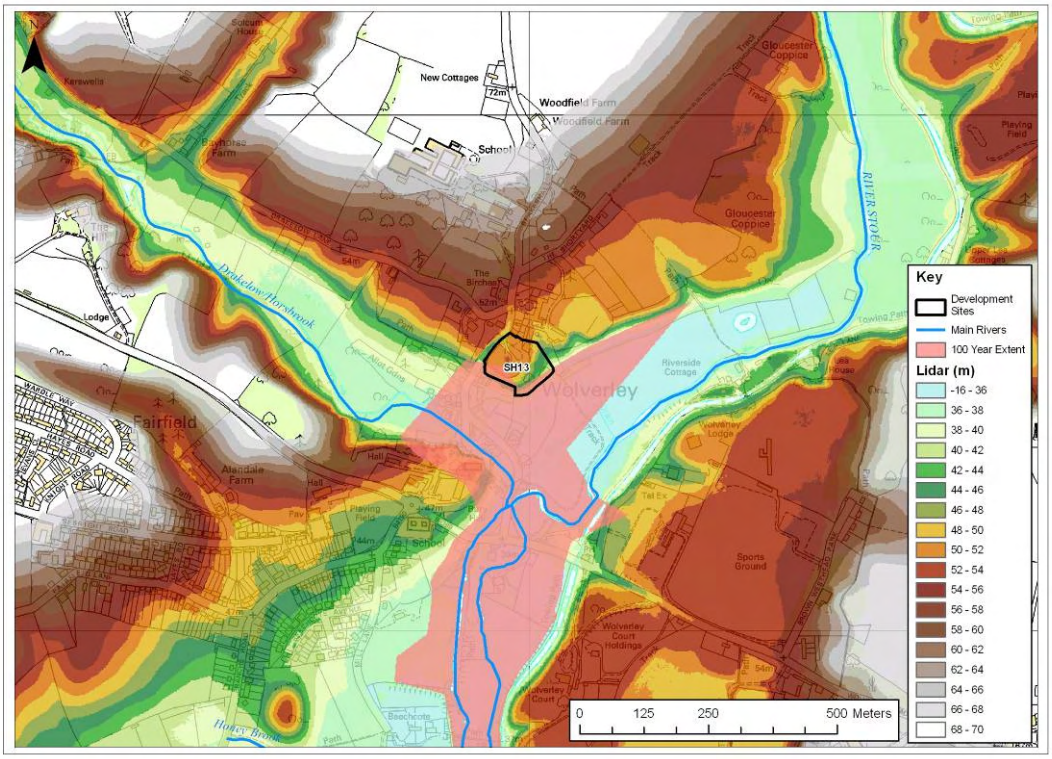


Figure 18 – Wolverley Flood Extents



It is evident from the LiDAR in **Figure 18** that the land to the south west of the potential development site SH13 is significantly lower than the land to the north and east. It is evident that site SH13 is more influenced by the Stour than by Drakelow Brook. In order to avoid increased flood risk elsewhere adequate provision should be made to accommodate any increase in surface water runoff from the site. Guidance notes on the management of Surface Water can be seen in *Appendix 4*.

3.4.4 Blakedown Brook

Blakedown Brook joins the River Stour at Broadwaters, just upstream of the Kidderminster FAS. **Figure 19** shows the proposed SHLAA development site, SH21 in Broadwaters, which is marginally located within Flood Zones 2 and 3. The site is Greenfield, meaning that any development at this location could increase the runoff into the adjacent Brook.

The analysis along Blakedown Brook was based on an existing ISIS model produced for the Environment Agency. The model extends from Wolverley to downstream of the Kidderminster FAS extending east to cover the largely urban stretch of the Blakedown Brook. The model provides the maximum water levels for the 4%, 1%, 1% +cc, 0.1% and 0.1% +cc AEP events. The resulting water levels were plotted over the LiDAR data in order to generate updated Flood Zone outlines as shown in **Figure 20**.

Figure 19 – Development Site SH21 and River Stour Flood Zones

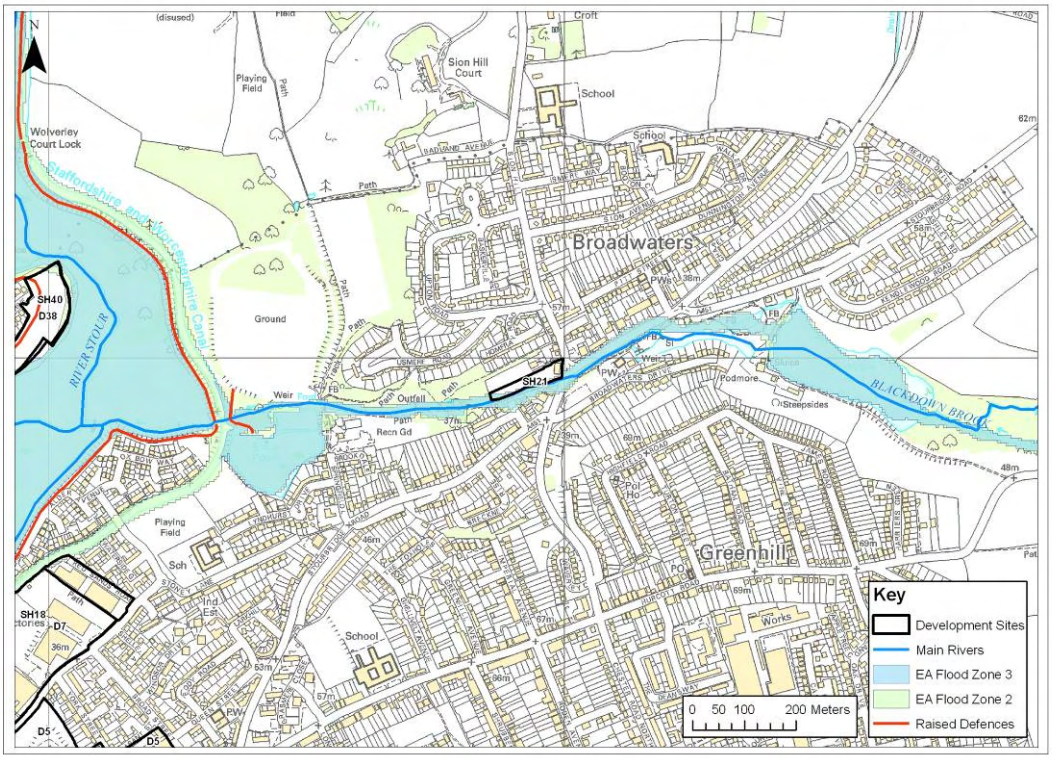
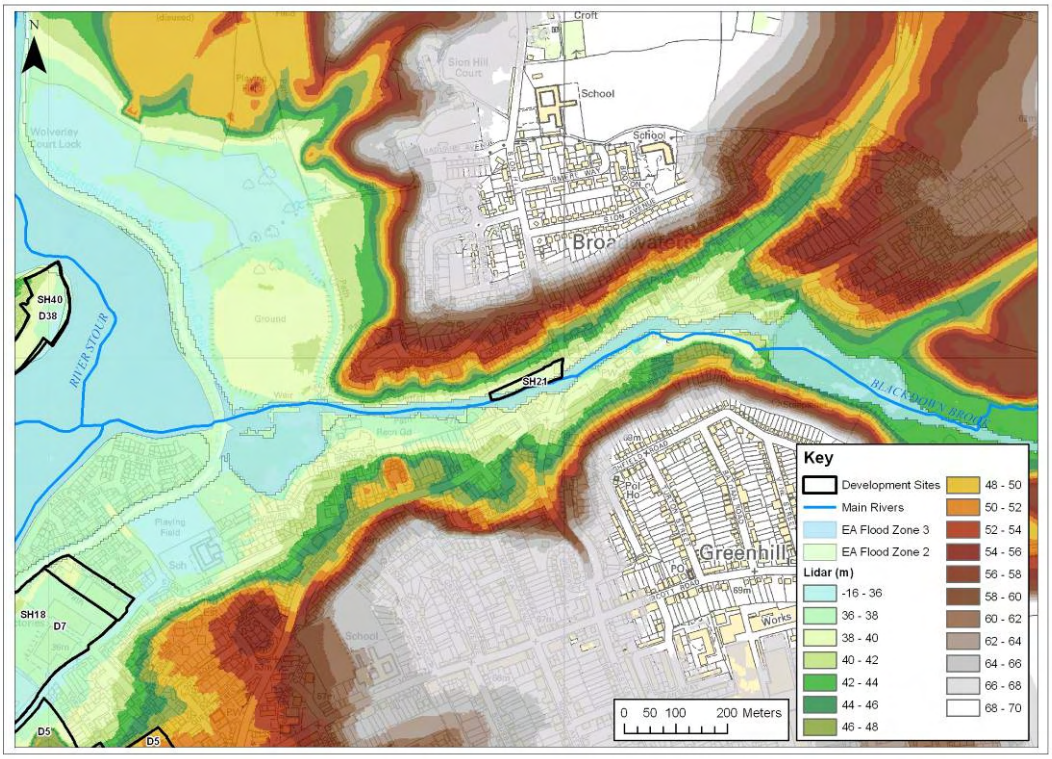


Figure 20 – Blakedown Brook Flood Extents



The LiDAR in **Figure 20** shows the ground elevations of the proposed development site to be approximately 38 to 40m AOD. This is significantly lower than the adjacent ground behind the potential development site, placing the site in a vulnerable area. **Figure 20** also shows the potential development site borders the 1% AEP event.

3.4.5 Hoo Brook

Hoo Brook enters the River Stour from the east of the District and flows through the settlements of Hillpool, Stone and adjacent to the Spennells housing estate. During the Level 1 SFRA it became apparent that there were substantial misalignments in the Hoo Brook Flood Zones, originally modelled using JFLOW. The original JFLOW flood outlines are shown in **Figure 21**. As a number of potential development sites are located in proximity to this Brook, the Council commissioned additional analysis to be undertaken to identify more accurately the flood risk along the watercourse. This was undertaken by constructing a 1d ISIS model, discussed in more detail in *Appendix 3.* The Hoo Brook model was constructed inline with EA requirements.

The analysis of Hoo Brook was based on the ISIS model constructed by Royal Haskoning for this Level 2 SFRA. The model extends from Heathy Mill Farm to downstream of the A449. The model provides the maximum water levels for the 4%, 1%, 1% +cc, 0.1% and 0.1% +cc AEP events. The resulting water levels were plotted over the LiDAR data in order to generate updated Flood Zone outlines as shown in **Figure 22**.

Figure 21 – Potential Development Site D22 and Flood Zones

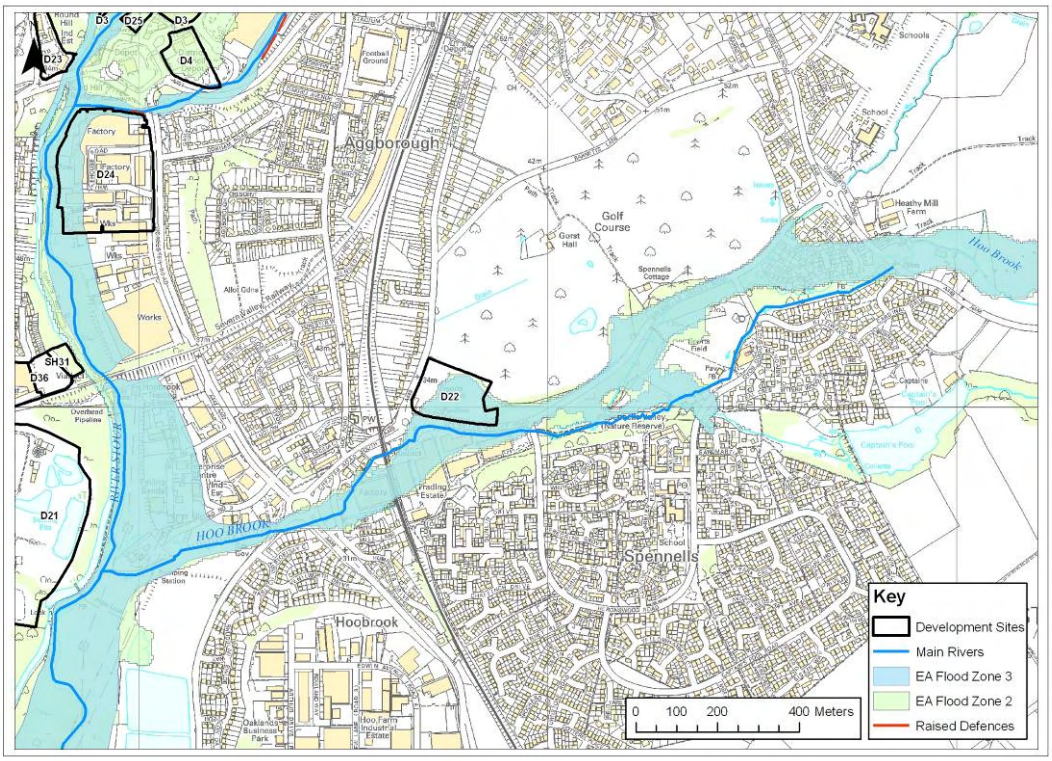


Figure 22 – Hoo Brook Flood Extents

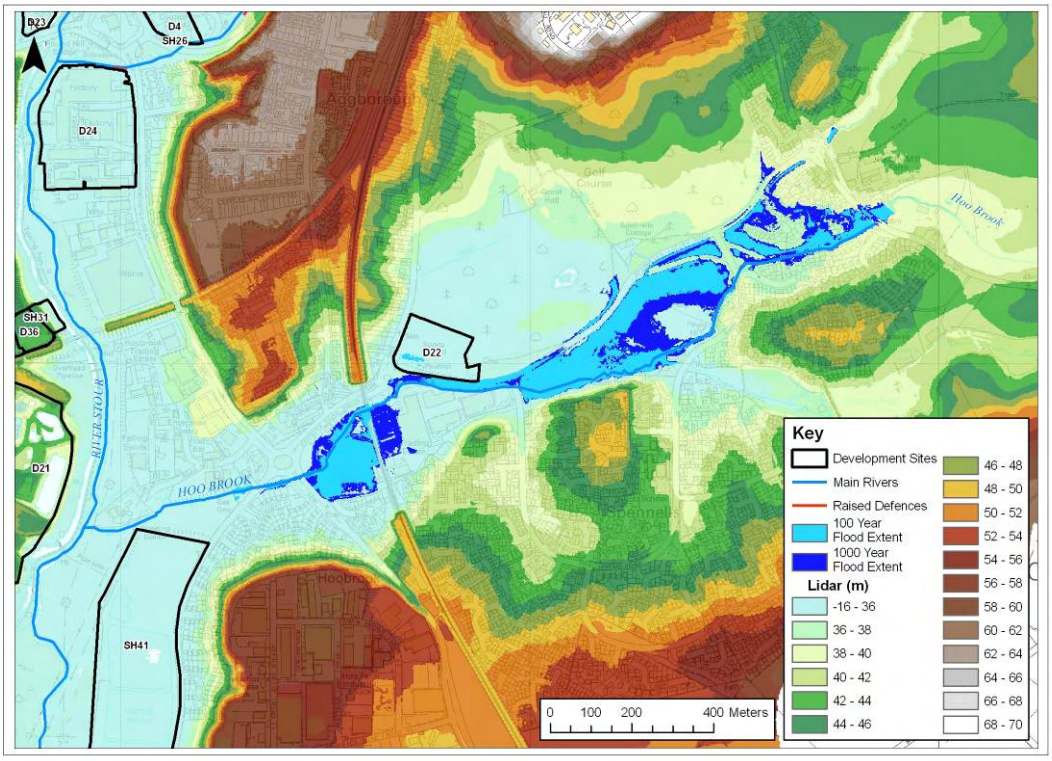


Figure 22 shows that since the revision of the flood extents on Hoo Brook, the potential development site is no longer located in the 1% or 0.1% AEP events.

4 FLOOD RISK IN STOURPORT-ON-SEVERN

4.1 Study Area

The study area under consideration in this section is shown in **Figure 23**. It covers the town of Stourport-on-Severn. There are numerous potential development sites in Stourport-on-Severn, with the main concentration situated on the left bank of the River Severn at the confluence with the River Stour. The potential development sites are also in close proximity to the Staffordshire and Worcestershire Canal Basin.

Along the River Severn, with the exception of just one Greenfield Site, all are 'Unclassified Brownfield Development'. Many potential development sites are situated in industrial estates in close proximity to the unmodelled stretch of the River Stour. These potential development sites will need consideration regarding surface water drainage, as their location is prone to flooding.

4.2 Overview of Flood Risk

Flood risk to the potential development sites within Stourport-on-Severn is mainly associated with the River Severn. However flood risk in the potential development sites in question are also associated with the River Stour as mentioned in Section 4.1. In addition, there are two smaller, unmodelled watercourses that are present within Stourport-on-Severn which may add to the risk posed by the River Severn. Both of the watercourses join the River Severn on the right bank upstream of a large residential area in Stourport. The flood risk posed to potential development sites is reduced, as there are no sites within the Flood Zones of the two brooks.

The flood risk associated with canal flooding was discussed in the Level 1 SFRA. It was discussed that when the river levels in the Stour exceed the bank heights of the canal, water enters the canal system and quickly uses the storage afforded by the available freeboard. The canal then acts as a conduit to flood water, passing floodwater downstream to the canal basin in Stourport-on-Severn. In the past when this has occurred, the threat to flooding has been alleviated by opening the sluices to the River Severn.

4.3 Flood Risk from River Severn

4.3.1 Flood Defence Infrastructure

There is no raised flood defence infrastructure located on the watercourses around Stourport-on-Severn.

4.3.2 Methodology

The Environment Agency Flood Zones for the River Severn were derived using a computational model. The ISIS model and the accompanying modelling report were provided by the Environment Agency for the use in the Level 2 SFRA.

The risk-based Sequential Test should be applied at all stages of planning. The aim is to steer new development to areas at the lowest probability of flooding (Zone 1). The flood

zones are the starting point for the sequential approach. **Figure 23** shows Flood Zones 2, 3 and 3b for the River Severn based on the results of the Environment Agency model. The Sequential approach should be used between flood zones and also within flood zones to achieve a sustainable location at least risk of flooding. Paragraphs 14 – 15 of PPS25 sets out the requirement to apply the sequential approach. This approach is a simple decision-making tool designed to ensure that areas at little or no risk of flooding are developed in preference to areas at higher risk. Local Planning authorities should make the most appropriate use of land to minimise flood risk and reduce flood risk where possible. Paragraph D10 within PPS25 outlines that the Exception Test should be applied by decision-makers only after the Sequential Test has been applied.

With the exception of a few potential development sites (SH27, D34, SH34, SH5 and D43) all developments within Stourport-on-Severn are located within either Flood Zone 2 or 3. In accordance with PPS25, Table D1 requires all development proposals in Flood Zones 2 and 3 to be accompanied by an FRA. Guidance on reviewing FRAs can be seen in *Appendix 4*. In order for developments within Flood Zone 2 to go ahead, developers and local authorities should try to avoid flood risk through the layout and form of the development and apply SUDS where possible. In accordance with PPS25, highly vulnerable developments are only permitted in Flood Zone 2 if the Exception Test is passed. This includes basement dwellings along with emergency services.

Table D3 within PPS25 indicates the different requirements for Flood zone 3a and 3b. Developments within Flood Zone 3a (D2, D13, D14, D16, D39) should only be water compatible or less vulnerable, which includes shops, leisure, agriculture and office space. Where possible, the developments should be relocated to land with lower probability of flooding. The developers should explore the opportunities to restore the functional floodplain and flood flow pathways for flood storage. Essential infrastructure or More Vulnerable developments require the Exception Test to be carried out in Flood Zone 3a.

Developments D13, D14, D17 and SH37 are fractionally located within Flood Zone 3b. The majority of the site falls out of this flood zone and therefore more uses may be suitable for this site than just water compatible and less vulnerable uses.

Developments D2, D16, and D39 are located within Flood Zone 3b. This zone comprises land where water has to flow or be stored in times of flood. Only essential infrastructure or water compatible developments should be built in this zone; the former requiring an Exception Test to be carried out. These developments must not impede water flows or increase flood risk elsewhere.

4.3.3 Pluvial Flooding

As stated in the Level 1 SFRA, the flooding that occurred as a result of the June and July 2007 events was attributed to drainage problems and flash flooding from the smaller tributaries. This was exacerbated by excessive rainfall on the largely urban catchment.

In accordance with PPS25, the proposed development sites in Stourport-on-Severn require assessment against pluvial flooding. The grounds for pluvial flooding analysis are referred to in section 3.3.6.

By generating a topographic grid in TUFLOW based on LiDAR data, flood depths were calculated through Stourport-on-Severn for the critical storm duration. **Figure 24** illustrates the resulting flood depths and hazard through Stourport-on-Severn. Due to the lack of guidance for pluvial flooding analysis, the hazard categories were based upon the same categories used to define fluvial flood hazard mapping.

The pluvial hazard mapping through Stourport-on-Severn shows that the majority of the town falls within the 'Danger for Some' category. This is a simplified guidance that indicates that vulnerable groups of people including children, the elderly and infirm may be at some danger of the pluvial flooding. The depth of pluvial flooding throughout Stourport-on-Severn does not highlight any particular areas of concern. Therefore, all roads within Stourport have the potential to act as flow routes for pluvial flooding.

The pluvial modelling within this study was carried out on a high level. In order to take this problem forward, it is recommended that prior to any development within Stourport-on-Severn the drainage networks are assessed in more detail. The opportunities to implement SUDS in all new developments within Stourport-on-Severn should be explored where possible to reduce surface water flooding. As a result of the findings of this study, it is recommended that the Local Planning Authority prepare a Surface Water Management Plan for the area.

5 FLOOD RISK IN BEWDLEY

5.1 Study Area

The area under consideration in this section is shown in **Figure 25**. Bewdley, the third main settlement, has historically suffered from large flooding events. This is due to the proximity and relationship of the town to the River Severn. Bewdley has recently benefited from multi-million pound demountable flood defences along Severnside North and South, which indicates the pressures from flooding experienced within the town. **Figure 25** shows Flood Zones 2, 3 and 3b for the River Severn through Bewdley based on the results from the Environment Agency model. All of the potential development sites are located within Flood Zone 2, of which two are also located within Flood Zone 3a. Both of these sites are located on the right bank of the River Severn within the confines of the demountable defence, so are within the area prone to flooding based on past experience.

5.2 Overview of Flood Risk

Flood risk within Bewdley is mainly associated with the River Severn.

In addition, a number of smaller unmodelled watercourses are present within Bewdley and may pose a risk of flooding to the potential development sites along their banks. Riddings Brook is a Main River that flows in a south westerly direction from the eastern side of the town through a series of standing ponds before joining the River Severn on the downstream end of Bewdley. Snuff Mill Brook also poses potential flood risk to Bewdley. Flow enters the River Severn under Red Hill Road, however it may cause overland flooding behind the Bewdley defences. The other ordinary watercourses are located away from potential development sites so pose limited flood risk.

5.3 Flood Risk from River Severn

5.3.1 Flood Defence Infrastructure

The southern side of Bewdley is protected by an extensive demountable flood defence scheme, extending from the north of Dog Lane to the cricket ground boundary. The demountable defence scheme provides a flood protection standard of 1% AEP and is maintained by the Environment Agency. **Figure 25** shows the NFCDD defences through Bewdley.

Asset Condition

The condition of flood defences along the River Severn in Bewdley are presented in **Table 19** below, as recorded in the NFCDD. The condition levels relate to the Environment Agency scale presented in **Table 9**.

Table 19 – Flood Defences along the River Severn, Bewdley

NFCDD Reference	Unique ID	Maintainer	Description	Location	Condition	Defence Standard
0310312500702R05	60	Environment Agency	Flood wall	d/s side of road bridge, Bewdley	1	100
0310312500702R06	61	Environment Agency	Demountable barriers in walk way	Bewdley	1	100
0310312500702R07	62	Environment Agency	Wall for demountables	d/s end of new scheme, Bewdley	1	100
0310312500702R08	63	Environment Agency	Brick/ Blockwork wall	Cricket ground boundary	1	100
0310312500803R01	64	Environment Agency	Flood Wall and sheet piling	Car Park, Bewdley	1	-
0310312500803R02	65	Environment Agency	Demountable Defence Section	Severn Side North, Bewdley	1	100
0310312500803R05	66	Private	New garden wall	Dog Lane, Bewdley	1	2

Future Maintenance and Upgrade

Flood defences 60 – 66 are in Very Good condition, and as a result should not require repair work in the near future. The standard of all the defences in Bewdley are currently at 1% AEP standard, which will not withstand the effects of climate change. There are however residual risks associated with the speed at which the demountable defences are erected. This must be taken into account when considering the development of areas currently benefiting from the protection of these defences, namely sites D6 and D32. All of the defences in Bewdley have scheduled inspection dates as listed in the EA FRM System.

5.3.2 Methodology

The Environment Agency Flood Zones for the River Severn were derived using a computational model. The ISIS model and the accompanying modelling report were provided by the Environment Agency for use in the SFRA.

5.3.3 Breach Analysis and Rapid Inundation Zones

Two locations were identified for the simulation of breaches in the demountable defences through Bewdley. The same criterion was adopted as presented in section 3.3.3 in respect to the breach width and closure time. The dimensions and time to closure are referred to in **Table 11**.

Figure 26 shows the locations where breaching has been assessed for the 1% AEP event and the resulting flood outlines. **Table 20** summarises the details of the breach analysis.

Table 20 – Breach Analysis Details

Breach	Location	Condition	Standard (AEP)	Material
A	SO 7859 7552	**1**	**1%**	**Demountable defence**
B	SO 7894 7517	**1**	**1%**	**Demountable defence**

The likelihood of defence failure is also a function of the depth of flooding and hence the force exerted on the face of the defence. **Table 21** shows the dimensions of the flood defence at each assumed breach location and the corresponding modelled water levels for the 1% AEP event.

Table 21 – Flood Defence Dimensions at Breach Locations

Breach Location	Defence Level (mAOD)	Ground Level (mAOD)	Defence Height Above Ground Level (m)	1% AEP Water Level (mAOD)
A	**23.6**	**20.5**	**3.1**	**22.6**
B	**22.6**	**20.5**	**2.1**	**22.3**

Flood defences are designed and constructed with an additional allowance for uncertainty on top of the predicted design water level. This allowance, known as freeboard, allows for uncertainties in the prediction of water levels and also the loadings that could be exerted on the defence. Flood defence guidance, as quoted in PPS25, recommends an allowance of 300mm for fluvial flood defences. **Table 21** shows that during the 1% flood event the freeboard (the distance between the flood level and the top of the defence) is greater than 0.3 metres at all breach locations. It can therefore be assumed that, were the defences in perfect condition, there will be sufficient allowance in the design to withstand the pressures of the 1% AEP event and that the breach would not fail.

5.3.4 Flood Hazard Analysis

The 'complex approach' presented in FD2320 addresses the issue of flood hazard as a function of flood depth and velocity. **Figures 27– 28** show the flood depths produced by the TUFLOW model for the 1%, 1% with climate change and 0.1% breach scenarios respectively. The flood hazard matrix is presented in **Tables 2** and **3** of this report.

The *worst* flood hazard category for each of the proposed development sites within Bewdley is presented in **Figure 29**, and summarised in **Table 22**. It should be noted that this hazard is based on all breaches causing flooding from the River Severn only. The colour code is explained fully in **Table 2** but summarised at the base of each of the following tables.

Table 22 - Flood Hazard Ratings

Site	Breaches A & B
SH1/ D6	
D32	

Low Moderate Significant Extreme

Access/Egress

In addition to assessing the flood hazard for the potential development sites, it is also important to review the constraints flooding will place on the access and egress routes to the sites as it may impede evacuation and rescue efforts during a flood event.

Table 23 summarises the availability of access and egress routes during each of the flooding events mentioned above, taken from **Figure 29** for the sites identified in **Table 22**. Red indicates that all access roads leading to and from a potential development site are at risk of flooding during the stated event. Orange indicates that there will be severe restrictions to the access routes, resulting in only one passable road or direction (for sites to which an access road has not yet been constructed). However, it must be noted that this analysis is based upon the major routes identifiable now but these may change with development.

Table 23 – Access/Egress Routes Not Affected by Flooding

Site	Breaches
SH1/ D6	
D32	

No access/egress routes available | Only 1 access/egress route or direction available | 2+ access/egress routes or directions available

5.3.5 Rapid inundation analysis

An important consideration in assessing flood risk, and one that is not adequately addressed in PPS25, is the issue of the speed of flooding. The results of the TUFLOW model were used to calculate the rate of flooding at each of the proposed development sites within Bewdley included within this Level 2 SFRA. Two specific issues were considered:

- The time taken for water to reach the proposed development site from the onset of flooding (i.e. the first occurrence of overtopping); and
- The time taken for water to reach a depth of 250mm from the onset of flooding at the site

A depth of 250mm was selected as representing the depth below which safe evacuation on foot could be achieved. Rapid inundation has been identified as flooding which reaches a depth of 250mm in half an hour or less. **Table 24** presents the results of this analysis at each of the proposed development sites.

Table 24 – Rapid Inundation Analysis

Site	Breach A				Breach B			
	1% +cc		0.1%		1% +cc		0.1%	
	Time from Onset (min)	Time to reach 250mm (min)	Time from Onset (min)	Time to reach 250mm (min)	Time from Onset (min)	Time to reach 250mm (min)	Time from Onset (min)	Time to reach 250mm (min)
SH1/ D6	3	3	3	3	21	2.4	27	33
D32	2.4	27	3	33	3	3	3	3

Table 24 shows that the sites would experience rapid inundation, with flood levels reaching a significant depth in a short space of time. This issue should be addressed within the planning process when considering the vulnerability of the proposed land use. Preference should be given to sites which would not experience rapid flooding or ensuring that adequate mitigation measures are put in place to alleviate the consequences. As outlined in Section 1.2, more vulnerable, highly vulnerable and essential infrastructure are prohibited in areas identified as rapid inundation zones. In consideration of this, the proposed housing sites highlighted in **Table 24** should be relocated outside the rapid inundation areas.

6 GUIDANCE

Throughout this SFRA guidance is given in relation to the development of each of the proposed development sites. Additional generic guidance is presented in *Appendix 4* of this report for the following issues:

- The Exception Test;
- Dealing with Surface Water;
- Review of FRAs; and
- Emergency Planning.

7 CONCLUSIONS AND RECOMMENDATIONS

This Level 2 SFRA has assessed the flood risk on each of the proposed development sites within the Wyre Forest District. The SFRA has indicated the reliance on the continued maintenance and upgrade of the existing defences throughout the District. The SFRA has also shown the residual risk from overtopping, breach and pluvial flooding scenarios. It is essential that this residual risk is appreciated and sufficiently mitigated against in the future development of the District.

Tables 25 – 28 summarise the appropriate policies for potential development sites within the District. Each potential development site has been reviewed with reference to its location and situation in relation to the Flood Zones. PPS 25 has been used to provide the summary. **Appendix 5** should be referred to in reference to land uses throughout **Sections 7.1 – 7.3**.

7.1 Development Sites in Zone 1 – Low Probability

Zone 1 Low Probability

Definition
This zone comprises land assessed as having less than a 1 in 1000 annual probability of river flooding in any year (<0.1%).
Appropriate uses
All uses of land are appropriate in this zone
FRA requirements
For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river or sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a FRA. This need only be brief unless the factors above or other local considerations require particular attention.
Policy aims
In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage techniques.

(PPS25, 2006: pp22)

Table 25a – Kidderminster Development Sites in Zone 1

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
D5 / SH82	Churchfields Business Park	Employment area - potential pressure for change	7.09	None	2	Brownfield	No
D7	Georgian Carpet Factories Site	Potential for Redevelopment	4.55	None	2	Brownfield	No
D8 / SH24	Lime Kiln Bridge	Potential Redevelopment Site	0.45	None	2	Brownfield	No
D9 / SH10	Park Lane Timber Yard	Zoned for residential development	1.00	None	2	Brownfield	No
D12 /	Park Lane	Adopted Local Plan	1.68	None	2	Brownfield	No

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
SH76		Redevelopment Site					
D21	British Sugar Site	Potential Development Site - British Sugar	23.85	None	2	Brownfield	No
D29 / SH60	KTC.3 - Worcester Street Enhancement Area	Potential Development Site - Indicated in the Adopted Local Plan	0.61	None	2	Brownfield	No
D33	Summerfield - Stradles the District Boundary	Potential Development Site	55.12	None	2	Brownfield	No
D36	Lisle Avenue	Potential Development Site - Currently zoned for employment use within the Local Plan	5.25	None	2	Brownfield	No
D46	Cheshires Printers	Potential Redevelopment Site	0.30	None	2	Brownfield	No
D47 / SH81	Kidderminster Market Auctions	Potential Redevelopment Site	0.43	None	2	Brownfield	No
D48 / SH71	Comberton Place	Potential Redevelopment Site	0.10	None	2	Brownfield	No
D49 / SH80	Comberton Hill	Potential Redevelopment Site	0.14	None	2	Brownfield	No
D50 / SH152	CMS Car Showrooms	Potential Development Site	0.87	None	2	Brownfield	No
D52 / SH61	Rock Works	Potential Housing Site	0.29	None	2	Brownfield	No
D54	Worcester Street	Potential Redevelopment Area – Mixed Use	1.51	None	2	Brownfield	No

Table 25b - Stourport-on-Severn Development Sites in Zone 1

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
D18	Parsons Chain	Potential Development Site	3.71	None	2	Brownfield	Yes
D19	A.Harris and Sons	Planning application approved for light industrial	0.22	None	2	Brownfield	Yes
D34 / SH27 / 34 / 117	Baldwin Road	Potential Development Site	1.60	None	2	Brownfield	Yes

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
D43	Stourport Civic Centre	Potential Redevelopment Site	0.58	None	6	Brownfield	No

7.2 Development Sites in Zone 2 – Medium Probability

Zone 2 Medium Probability

Definition
This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%).
Appropriate uses
The water-compatible, less vulnerable uses of land and essential infrastructure in **Appendix 5** are appropriate in this zone. Subject to the Sequential Test being applied, the highly vulnerable uses are only appropriate in this zone if the Exception Test is passed.
FRA requirements
All development proposals in this zone should be accompanied by a FRA.
Policy aims
In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage techniques.
Summary
Development should be safe and seek opportunities to reduce flooding where possible.

(PPS25, 2006: pp23)

Table 26a – Kidderminster Development Sites in Zone 2

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
D4 / SH26	Council Depot Site	Current Council Depot - May move	1.22	FZ2	1	Brownfield	Yes
D25 / SH35	Current Retail Area	Potential Development Site	0.63	FZ2	1	Brownfield	Yes
D28	Current Morrisons Site and other shops	Potential Development Site	1.16	FZ2 (Partially)	1	Brownfield	Yes
SH18	Georgian Carpets	Unspecified	5.392	FZ2 (Partially) ^	1	Brownfield	Yes
SH20	Playing Field Adjacent St Mary's School	Unspecified	1.018	FZ2 (Partially) ^	1	Greenfield	Yes
SH31	R&D Aggregates Site	Unspecified	1.049	Marginal	2	Brownfield	No
SH41	Former British	Unspecified	15.311	FZ2	1	Greenfield	Yes

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
	Sugar Settling Ponds						
SH42	Mill Bank Garage	Unspecified	0.109	Marginal	1	Brownfield	Yes
SH44	Zanzibars Castle Road Kidderminster	Unspecified	0.298	FZ2	1	Brownfield	Yes

Table 26b – Stourport_On-Severn Development Sites in Zone 2

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
D15 / SH45	Lichfield Basin	Planning Permission for 144 dwellings	2.03	FZ2	6	Brownfield	No
D35 / SH8	STC.4	Development site as earmarked by the Local Plan and the STC.4 Supplementary Planning Document	0.38	FZ2	6	Brownfield	No
D41 / SH33	ADR – Power Station Road	Area of Development Restraint	3.14	FZ2	6	Brownfield	No
D42 / SH28	Car Garages – Worcester Road	Potential Redevelopment Area	0.83	FZ2^	1	Brownfield	Yes
D44 / SH15	Lickhill Lodge First School	Potential Redevelopment Site	1.37	FZ2	6	Brownfield	No
SH05	Baldwin Road Local Plan Site	Unspecified	0.358	Marginal	1	Brownfield	Yes
SH16	Parsons Chain	Unspecified	6.259	FZ2 (Partially)	6	Brownfield	Yes
SH46	Tontine Buildings	Unspecified	0.169	FZ2	6	Brownfield	No

Table 26c – Bewdley Development Sites in Zone 2

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
SH02	Texaco Garage Bewdley	Unspecified	0.121	FZ2	6	Brownfield	No
SH36	Stourport Road Bewdley	Unspecified	3.184	FZ2	6	Greenfield	No

Table 26d – Cookley and Rural Wyre Forest Development Sites in Zone 2

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
SH06	Blackstone Barns	Unspecified	0.27	FZ2	6	Greenfield	No
SH12	Rock Tavern, Caunsall Road	Unspecified	0.06	FZ2 (Partially)	6	Brownfield	No

7.3 Development Sites in Zone 3a – High Probability

Zone 3a High Probability

Definition
This zone comprises land assessed as having a 1 in 100 year or greater annual probability of river flooding (>1%).
Appropriate uses
The water-compatible and less vulnerable uses of land in **Appendix 5** are appropriate in this zone.
The highly vulnerable uses in **Appendix 5** should not be permitted in this zone.
The more vulnerable and essential infrastructure uses should only be permitted in this zone if the Exception Test is passed. Essential infrastructure permitted in this zone should be designed and constructed to remain operational and safe for users in times of flood.
FRA requirements
All development proposals in this zone should be accompanied by a FRA.
Policy aims
In this zone, developers and local authorities should seek opportunities to:
- reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage techniques;
- relocate existing development to land on zones with a lower probability of flooding; and
- create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for flood storage.
Summary
Safe Development with no net loss of flood storage including betterment of flood risk.

(PPS25, 2006: pp23)

Table 27a – Kidderminster Development Sites in Zone 3a

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
D1	Land to Rear of Crossley	Vacant Brownfield land - currently zoned for employment uses (Offices)	1.14	FZ2 & FZ3a	1	Brownfield	Yes
D3 /	KTC.4	Area currently	8.84	FZ2 &	1	Brownfield	Yes

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
SH14 / SH25		adopted for mixed use redevelopment		FZ3a			
D10 / SH19	BT Site, Mill Street	Potential Housing Site	0.60	FZ2 & FZ3a	1	Brownfield	Yes
D11	Current Morrisons Application Site	Planning permission granted (06/0590)	3.59	FZ2 & FZ3a	1	Brownfield	Yes
D22	Victoria Sports Ground	Potential Development Site	2.22	FZ2 & FZ3a*^	5	Greenfield	No
D23 / SH75 / SH159	Park Lane	Potential Development Site	0.87	FZ2 & FZ3a (Partially)	1	Brownfield	No
D24	Current Sealine Factory (Various Units)	Potential Development Site	6.48	FZ2 & FZ3a (Partially)	1	Brownfield	Yes
D26	New Road and Market Street	Potential Development Site	0.49	FZ2 & FZ3a	1	Brownfield	Yes
D27	Brintons Offices - Exchange Street	Potential Development Site	0.21	FZ2 & FZ3a	1	Brownfield	Yes
D30 / SH9	Church Street Car Park	Potential Development Site	0.09	FZ2 & FZ3a	1	Brownfield	Yes
D31	Puxton	Potential Development Site	7.34	FZ2 & FZ3a	1	Greenfield	Yes
D38 / SH40	Puxton Site	Planning permission granted	1.70	FZ2 & FZ3a (Partially)	4	Greenfield	No
D53	Matalan	Potential Redevelopment Site	0.69	FZ2 & FZ3 (Partially)	1	Brownfield	Yes
SH04	78 Mill Street	Unspecified	0.332	FZ2 & FZ3a	1	Brownfield	Yes
SH11	Castle Road/ Park Lane	Unspecified	0.071	FZ2 & FZ3a	1	Brownfield	Yes
SH21	Rear of the Parade Broadwaters	Unspecified	0.347	FZ2 & FZ3a (Partially)	1	Greenfield	No
SH30	New Road Carters Site	Unspecified	0.767	FZ2 & FZ3a	1	Brownfield	Yes
SH32	Park Lane	Unspecified	0.082	FZ2 & FZ3a (Partially) ^	1	Brownfield	No
SH38	Bed City MCF Complex	Unspecified	0.798	FZ2 & FZ3a	1	Brownfield	Yes

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
SH39	Elgar House Green Street	Unspecified	0.544	FZ2 & FZ3a (Partially)	1	Brownfield	Yes
SH43	Piano Building Weavers Wharf Kidderminster	Unspecified	0.055	FZ2 & FZ3a	1	Brownfield	No

Table 27b – Stourport_On-Severn Development Sites in Zone 3a

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
D17	Thomas Vale - Affordable Housing Site	Under Construction	0.77	FZ2, FZ3a (Partially) ^	3	Brownfield	Yes
SH37	Land at Moorhall Lane	Unspecified	1.966	FZ2 & FZ3a (Partially)	6	Greenfield	No

Table 27c – Bewdley Development Sites in Zone 3a

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
D6 / SH01	Load Street – Bewdley Medical Centre	Potential redevelopment of Medical Centre	0.66	FZ2 & FZ3a	6	Brownfield	Yes
D32	Lax Lane Craft Centre/WVRS/British Red Cross	Potential Development Site	0.26	FZ2 & FZ3a	6	Brownfield	Yes
D45 / SH22	Butt Town Meadow Caravan Park	Potential Development Site	2.09	FZ2 & FZ3a	6	Brownfield	No

Table 27d – Cookley and Rural Wyre Forest Development Sites in Zone 3a

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
D37 / SH29	Titan Steel Wheels – Cookley	Potential Development Site	5.71	FZ2 & FZ3a (Partially)	6	Brownfield	No
SH13	The Manor House, Wolverley	Unspecified	1.01	FZ2 & FZ3a (Partially)	6	Brownfield	No

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
SH23	Adjacent to Chaddesley Corbett Surgery	Unspecified	2.28	FZ2 & FZ3a (Partially)	3	Greenfield	No

7.4 Development Sites in Zone 3b – The Functional Floodplain

Zone 3b The Functional Floodplain

Definition
This zone comprises land where water has to flow or be stored in times of flood.
Appropriate uses
Only the water-compatible uses and the essential infrastructure listed in **Appendix 5** that has to be there should be permitted in this zone. It should be designed and constructed to:
- remain operational and safe for users in times of flood;
- result in no loss of floodplain storage;
- not impede water flows; and
- not increase flood risk elsewhere.

Essential infrastructure in this zone should pass the Exception Test.
FRA requirements
All development proposals in this zone should be accompanied by a FRA.
Policy aims
In this zone, developers and local authorities should seek opportunities to:
- reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage techniques;
- relocate existing development to land on zones with a lower probability of flooding.

Summary
Safe Development with no net loss of flood storage including betterment of flood risk.

(PPS25, 2006: pp23)

Table 28a – Kidderminster Development Sites in Zone 3b

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
D40	Hoo-Brook Link Road	Potential road crossing	n/a	FZ2, FZ3a & FZ3b (Partially)	5	-	-

Table 28b – Stourport-on-Severn Development Sites in Zone 3b

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
D2 / SH17	Riverside Business Centre	Current adopted employment area	3.09	FZ2, FZ3a &	1	Brownfield	Yes

Unique ID[1]	Location	Current Status	Total Area (ha)	Flood Zones	Impact of Climate Change	Brownfield or Greenfield	Protected by flood defence
				FZ3b			
D13 / SH7	STC2	Adopted Local Plan Development Site	6.06	FZ2 FZ3a &FZ3b (Partially)	1	Brownfield	Yes
D14 / SH3	STC3	Adopted Local Plan Redevelopment Site	2.20	FZ2 FZ3a &FZ3b (Partially)	6	Brownfield	No
D16	Shipleys Amusement Area	Potential Development Site	0.95	FZ2, FZ3a & FZ3b	6	Brownfield	No
D39	Stourport Relief Road	Safeguarded within the Local Plan	n/a	FZ2, FZ3a & FZ3b (Partially)	5	-	-

Recommendations for future analysis in the District would include the linkage of a 1D ISIS model into the existing TUFLOW model. This would create a more accurate representation of the channel throughout Kidderminster. Further data would be needed in order to carry out this effectively, including attaining the River Stour ISIS model, or carrying out a topographic survey of the channel.

The constraints that were faced in the construction of the TUFLOW model through Kidderminster made construction difficult. The TUFLOW model was therefore constructed to the greatest level of accuracy with the limited data provided.

In areas of intense development or locally complex drainage issues, it may be necessary to formulate a Surface Water Management Plan that has multi-agency engagement and support. Development in and around Kidderminster is a prime example. Therefore, future analysis within the District should include a Surface Water Management Plan. Surface Water Management Plans will build on the knowledge of the SFRA and will aim to provide cost-beneficial solutions for the areas at greatest risk of surface water flooding.

The conclusions from this evidence based report, along with the WCS has shown that there are a number of potential restrictions and constraints to develop within the District. These issues and opportunities need to be addressed within the Core Strategy and future planning within the District.

Local Development Documents (LDDs) provide a key planning tool for ensuring that flood risk is factored into the allocation of land types in accordance with regional policy but also taking account of local issues and concerns. The Core Strategy LDD should include clear, strategic and robust policies for the management of flood risk, taking climate change into account.