

**Sevenoaks District Council**  
Strategic Flood Risk Assessment for  
Local Development Framework

Final Draft  
April 2008

**Halcrow Group Limited**



***Halcrow***



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Martlett House St John's Street Chichester West Sussex PO19 1UH  
Tel +44 (0)1243 649900 Fax +44 (0)1243 538105  
[www.halcrow.com](http://www.halcrow.com)

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# **Sevenoaks District Council**

## Strategic Flood Risk Assessment for Local Development Framework

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# Glossary of Terms

**Annual Monitoring Report (AMR)** - Assesses the implementation of the Local Development Scheme and the extent to which policies in Local Development Documents are being successfully implemented.

**Area action plans** – Development Plan Documents that provide a planning framework for areas of change and areas of conservation.

**Core Strategy** - The Development Plan Document which sets the long-term spatial planning vision and objectives for the area. It contains a set of strategic policies that are required to deliver the vision including the broad approach to development.

**Development plan** - As set out in Section 38(6) of the Planning and Compulsory Purchase Act (2004), an authority's development plan consists of the relevant Regional Spatial Strategy (or the Spatial Development Strategy in London) and the Development Plan Documents contained within its Local Development Framework.

**Development Plan Documents (DPDs)** - Spatial planning documents within the Council's Local Development Framework which set out policies for development and the use of land. Together with the Regional Spatial Strategy they form the development plan for the area. They are subject to independent examination. They are required to include a core strategy and a site allocations document, and may include area action plans if required; other DPDs may also be included, e.g. development control policies.

**DEFRA** - Department for Environment, Food & Rural Affairs.

**Emergency Planning** – Planning for and response to emergencies such as flooding, including consideration of the resilience of emergency infrastructure that will need to operate during flooding.

**Environment Agency** - The leading public body for protecting and improving the environment in England and Wales. Flood management and defence are a statutory responsibility of the Environment Agency; it is consulted by local planning authorities on applications for development in flood risk areas, and also provides advice and support to those proposing developments and undertaking Flood Risk Assessments. The Environment Agency reports to DEFRA.

**Environment Agency Flood Zones** - Nationally consistent delineation of 'high' and 'medium' flood risk, published on a quarterly basis by the Environment Agency.

**Flood Estimation Handbook** - The latest hydrological approach for the estimate of flood flows in UK.

**Flood Risk Vulnerability** - PPS 25 provides a vulnerability classification to assess which uses of land may be appropriate in each flood risk zone.

**Formal Flood Defence** - A structure built and maintained specifically for flood defence purposes.

**Habitable Room** - A room used as living accommodation within a dwelling but excludes bathrooms, toilets, halls, landings or rooms that are only capable of being used for storage. All other rooms, such as kitchens, living rooms, bedrooms, utility rooms and studies are counted.

**Informal Flood Defence** - A structure that provides a flood defence function, but has not been built or maintained for this specific purpose (e.g. a boundary wall).

**LiDAR** – 'Light Detection and Ranging' is an airborne terrain mapping technique which uses a laser to measure the distance between the aircraft and the ground. It therefore provides accurate topographical/contour mapping.

**Local development documents** – the collective term for Development Plan Documents and Supplementary Planning Documents.

**Local Development Framework (LDF)** - The name for the portfolio of Local Development Documents. It consists of the Local Development Scheme, a Statement of Community Involvement, Development Plan Documents, Supplementary Planning Documents, and the Annual Monitoring Report.

**Local Development Scheme (LDS)** - Sets out the programme for preparing Local Development Documents. All authorities must submit a Scheme to the Secretary of State for approval within six months of commencement of the 2004 Act (thus all authorities should now have submitted an LDS). LDSs are subject to review.

**'Making Space for Water' (DEFRA 2004)** - The Government's new evolving strategy to manage the risks from flooding and coastal erosion by employing an integrated portfolio of approaches, so as: a) to reduce the threat to people and their property; b) to deliver the greatest environmental, social and economic benefit, consistent with the Government's sustainable development principles, c) to secure efficient and reliable funding mechanisms that deliver the levels of investment required.

**Planning Policy Statements** - The Government has updated its planning advice contained within Planning Policy Guidance Notes (PPGs) with the publication of new style Planning Policy Statements (PPSs), which set out its policy for a range of topics.

**Previously Developed (Brownfield) Land** - Land which is or was occupied by a building (excluding those used for agriculture and forestry). It also includes land within the curtilage of the building, for example a house and its garden would be considered to be previously developed land. Land used for mineral working and not subject to restoration proposals can also be regarded as brownfield land.

**Regional Spatial Strategy** - Sets out the region's policies in relation to the development and use of land and forms part of the development plan for local planning authorities.

**Residual Risk** - The risk which remains after all risk avoidance, reduction and mitigation measures have been implemented.

**Statement of Community Involvement (SCI)** - Sets out the standards which authorities will achieve with regard to involving local communities in the preparation of local development documents and development control decisions. It is subject to independent examination.

**Strategic Environmental Assessment (SEA)** - A generic term used to describe environmental assessment as applied to policies, plans and programmes. The European 'SEA Directive' (2001/42/EC) requires a formal 'environmental assessment of certain plans and programmes, including those in the field of planning and land use'.

**Supplementary Planning Documents (SPDs)** - Provide supplementary information in respect of the policies in Development Plan Documents. They do not form part of the Development Plan and are not subject to independent statutory examination, but are normally subject to public consultation.

**Sustainability Appraisal (SA)** - Tool for appraising policies to ensure they reflect sustainable development objectives (i.e. social, environmental and economic factors) and required in the 2004 Act to be undertaken for all local development documents. It incorporates Strategic Environmental Assessment.

**Sustainable Development** - "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (The World Commission on Environment and Development, 1987).

**The Exception Test** - If, following application of the Sequential Test, it is not possible (consistent with wider sustainability objectives) to demonstrate that there are no reasonably available sites in areas with less risk of flooding that would be appropriate to the type of development or land use proposed, the Exception Test may apply. PPS 25 sets out strict requirements for the application of the Test.

**The Sequential Test** - Informed by a Strategic Flood Risk Assessment, a planning authority applies the Sequential Test to demonstrate that there are no reasonably available sites in areas with less risk of flooding that would be appropriate to the type of development or land use proposed.

## **Executive Summary**

In August 2007, Sevenoaks District Council commissioned Halcrow to produce a Strategic Flood Risk Assessment (SFRA) in accordance with Planning Policy Statement 25 (PPS 25) and Development and Flood Risk, a Practice Guide Companion to PPS 25 (February 2007).

This SFRA and the scoping stage of the Sustainability Appraisal, together with other background documents, will inform the plan-making process of the Local Development Framework (LDF). They will in particular inform the Core Strategy, Balanced Communities and Development Control Policies Development Plan Documents (DPDs).

This report provides an overview of the methodology, assumptions, uncertainties, tasks undertaken and the links to the wider sustainability appraisal process. It provides policy recommendations and guidance for the application of the Sequential Test, the preparation of flood risk assessments and the use of sustainable drainage systems, within the Council's administrative boundary.

The Medway Catchment Flood Management Plan (CFMP) was completed in 2004 (prior to the adoption of PPS 25) and the North Kent Rivers CFMP is currently at scoping consultation stage. This SFRA, and consequently the LDF, should adopt the most current policies from the local CFMPs.

Additional work may be required to determine more precise locations appropriate for development pending the undertaking of the Sequential Test. It is likely that flood hazard mapping (which identifies the level of risk to life and property) will be required as a Level 2 SFRA at locations where the Exception Test will need to be undertaken.



*Photo: Flooding immediately upstream from Horton Kirby Paper Mill at South Darent in October 2000.*

## Background Information

### A.1 Introduction

In August 2007, Sevenoaks District Council commissioned Halcrow to produce a Strategic Flood Risk Assessment (SFRA) in accordance with Planning Policy Statement 25 (PPS 25). Advice on flood risk within the administrative boundary of the planning authority is required to support the preparation of their Local Development Framework (LDF), in accordance with government guidance and advice from the Environment Agency.

For this study, a Level 1 SFRA approach has been agreed with Sevenoaks District Council and the Environment Agency. A Level 1 SFRA is defined in the Practice Guide Companion to PPS 25 as a desk-based study using existing information to allow application of the Sequential Test on the basis of Table D1 of PPS 25.

It is important to recognise that the SFRA is a 'living' document in that as new information becomes available (such as improved river models) updates will be made to the Flood Maps (see **Appendix C**) and SFRA report, to ensure that the best information is used to guide the site selection process for future developments.

This report complies with the proposal dated 10 July 2007. The Environment Agency has fully reviewed this document and all issues have been addressed (see formal responses from the Environment Agency in **Appendix E**).

### A.2 The Study Area

Sevenoaks District lies within West Kent bordered by Dartford, Gravesham, Tonbridge and Malling, Tunbridge Wells, Wealden, Mid Sussex, Tandridge and Bromley (Greater London) local authorities (see **Figure 1: Study Area**).

The District covers an area of 36,305 hectares with a resident population of some 109,305 people. The District is predominantly rural interspersed with small towns and villages. The main centre for commercial activity is the town of Sevenoaks, with other main centres including Swanley, Westerham and Edenbridge.

The District has a diverse countryside including chalk downs, large arable fields, woodland, river valleys, historic parks and clay lowland pastures. The many rural settlements tend to have strong distinctive characters based on their landscape



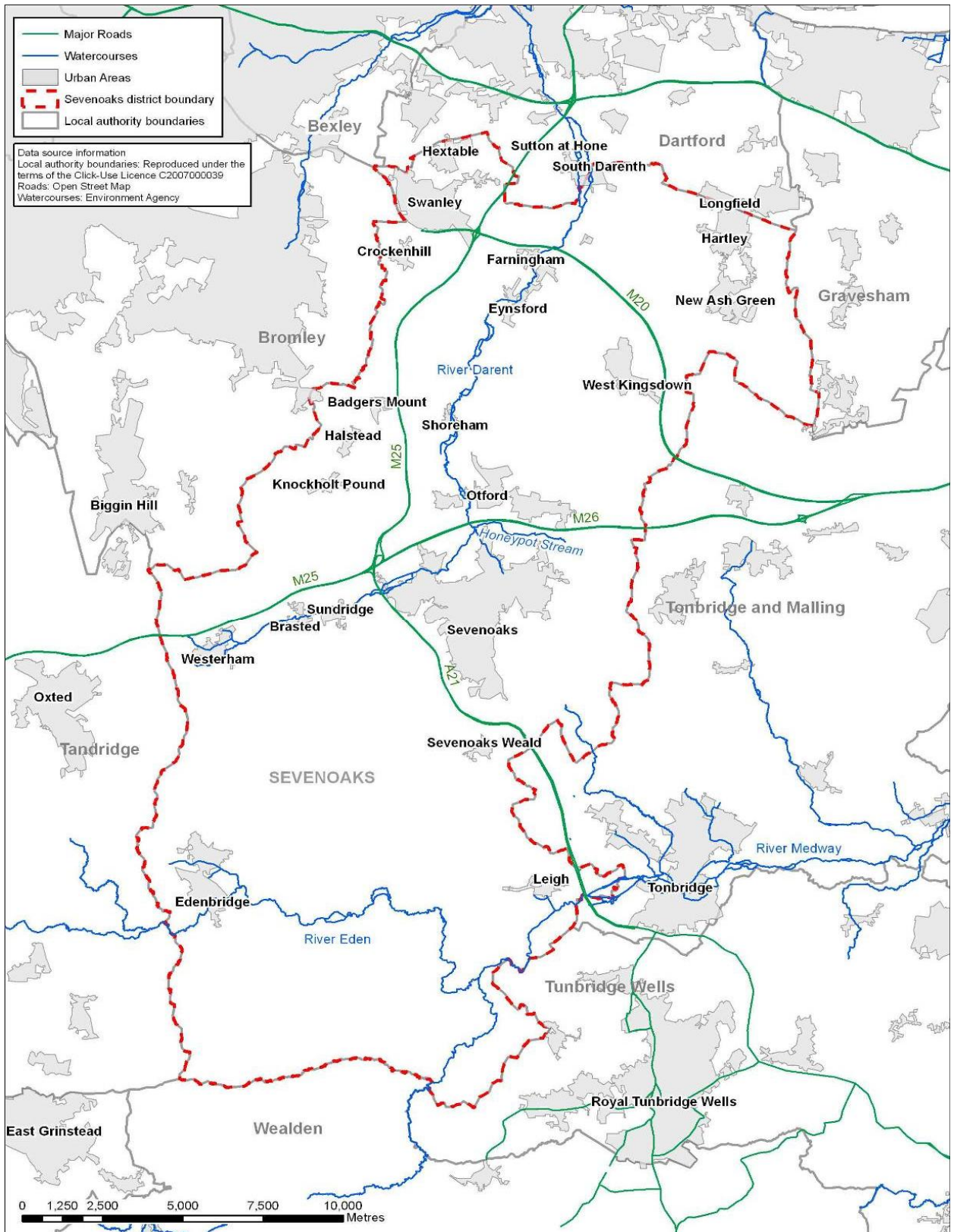


Figure 1: Study Area

setting, form and vernacular architecture and materials. Indeed the geology of the District has influenced where settlements have evolved.

The northern part of the District is dominated by chalk and forms part of the North Downs which run east and west to the north of Sevenoaks. The North Downs is designated as an Area of Outstanding Natural Beauty (AONB). The landscape comprises chalk escarpments, distinctive dry valleys, historic hedgerows, ancient woodland and associated wildlife. The chalk ridge separates the upper and lower reaches of the River Darent.

Through the centre of the District the Greensand Ridge characterises the area immediately to the south of Sevenoaks. This elevated landscape comprises of rolling farming fields interspersed with woodland and parkland, including the extensive Knole Park. Woodland and heath typically covers the outcrop of the Hythe Beds around Sevenoaks, reflecting the poor soils.

To the south of the District, the landscape is dominated by the Vale of Kent, a broad flat featureless landscape formed principally of Weald Clay. The River Medway and its tributary the River Eden drain this clay vale from west to east. The principal land use is farmland composed of pasture fields separated by strips of woodland and scattered small settlements, of which Edenbridge is the largest.

In total, 93% of the area of Sevenoaks District is designated Green Belt, with 60% covered by the High Weald and Kent Downs Areas of Outstanding Natural Beauty (AONB).

### **A.3 Hydrology and Geology**

#### **A.3.1 Introduction**

There are two main river systems that drain the Sevenoaks area into the River Thames, the River Darent and the River Medway (see **Figure 1: Study Area**).

The underlying geology dictates how the natural drainage catchment responds to rainfall, which in turn dictates the natural course of rivers. Urbanisation over time can alter the runoff characteristics of the catchment making the natural drainage system incapable of adequately coping with rainfall runoff, and increasing the risk of flooding.

#### **A.3.2 Main Rivers**

There are two principal water courses within the District which are categorised as Main Rivers:

- The River Darent flows in an easterly direction from Westerham to Sevenoaks and then northerly to South Darent where it flows out of the District through to Dartford and the River Thames.
- The River Eden enters the District at Edenbridge and flows in an easterly direction joining the River Medway at Penshurst. The River Medway leaves Sevenoaks District before flowing to Tonbridge and north-easterly through Maidstone to the Thames Estuary.

The River Darent valley has kept its rural identity. The upper catchment is an attractive valley between the North Downs Chalk scarp slope and the gentler dip slope of the Lower Greensand. The river is fed from a series of springs from the Chalk and Lower Greensand along the valley between Sevenoaks and Westerham. Near Otford the Darent meets the Honeypot Stream and Watercress Stream before heading north through the narrow valley carved through the North Downs. There are a number of springs at the foot of the North Downs scarp in the Otford and Kemsing area that feed the river.

Throughout the District the course of the Darent has been frequently modified by the mills that used to operate along this stretch, with the river course having been diverted along the valley side, and in places enlarged upstream of the mills to meet their need for water. In some reaches this has resulted in the current river channel not being at the lowest point of the valley and, together with some abrupt changes of direction, this exacerbates flooding issues in high flows.

More recently, gravel extraction has further altered the hydraulics of the river flows and groundwater. The Darent and Cray Catchment Abstraction Management Strategy cited the possibility of using these gravel pits to augment the river. A flood relief channel at Chipstead takes advantage of the storage provided by Chipstead Lake.

During the droughts of the late 1980s, some parts of the river dried up as water abstraction caused the water table to reduce below the bed of the river, which is often comprised of coarse gravel through which water can flow.

The upper catchment of the River Medway is spread across the Vale of Kent, with both the River Medway and its tributary the River Eden flowing in wide valleys with pronounced meanders. Development is relatively restricted in the flood plain with the exception of Penshurst and Edenbridge. A number of small tributaries join the system draining the surrounding Weald Clay sub-catchments. A large abstraction point for Bough Beech reservoir is located on the River Eden.



The Leigh Flood Storage Barrier (*largest on-line storage in Europe – see <http://www.environment-agency.gov.uk/commondata/acrobat/126554>*) just outside the District protects Tonbridge from flooding from the River Medway by impounding a large area of agricultural land adjacent to Leigh, much of which falls within the District. Following the autumn 2000 floods the option of impounding to a higher level is being considered.

The names of all the principal waterways within the study area are shown by **Figure 1: Study Area** and annotated on **Tiles A to H**.

#### A.3.3 *Geology*

The geology varies across the District of Sevenoaks, with the solid geology outcrops running in bands in an east to west direction. To the north the geology is characterised by Chalk forming the North Downs. Further south stretches a band of Gault Clay (mudstone) followed by the significant outcrop Greensand Ridge which is formed of Lower Greensand comprising of Folkestone Formation (sandstone), Sandgate Formation (sandstone & mudstone) and Hythe Formation (sandstone and limestone). Further south, the wide Vale of Kent is characterised by the flat Weald Clay, and to the south of the River Eden is a less predominant mix of Tunbridge Wells Sands, Wadhurst Clay and Ashdown Sands. The geological succession dips towards the north.

The River Darent and the Honeypot Stream are constrained between the Greensand Ridge and the North Downs. For most of their lengths, the rivers flow through the drift deposits overlying the Lower Greensand formation, except for the section where it cuts through the Chalk of the North Downs at Otford.

The upper River Medway and River Eden flow over Weald Clay. The surface water catchment of the Eden extends to just beyond the base of the Chalk, but the groundwater catchment of the Chalk and Lower Greensands flows towards the north.

#### A.3.4 *Hydrology*

The base flows of the River Darent, Watercress Stream and the Honeypot Stream are heavily reliant on groundwater flows originating from a series of springs, either from the Greensand aquifer or from the Chalk aquifer of the North Downs. Groundwater from the Hythe Beds aquifer in the Darent valley to the north and west of Sevenoaks provides an important source for public water supply.

In the Chalk areas to the north of the District, permanent watercourses are generally absent in many of the sub-catchment valleys. The Chalk is a major aquifer capable of absorbing large amounts of rainfall and releasing it slowly over a long period. However, after prolonged rainfall the water table in the Chalk and Greensand aquifer can rise to the ground surface potentially causing ephemeral springs to appear in certain locations. These effects can lead to local “groundwater flooding” lasting for several months in the late parts of very wet winters. Public supply and agricultural water abstraction from the Chalk and Greensand aquifers tends to increase their buffering effect, thereby suppressing the frequency at which ephemeral springs occur.

Despite the underlying aquifers, dry valleys on the dip slope of the Greensand ridge can respond quickly with overland flow causing flooding problems at the bottom of these valleys. This can occur during heavy rainfall events when antecedent moisture conditions are high. Similarly, snow melt and rainfall on a frozen Upper Chalk catchment can also lead to rapid surface water run off to the river system and flooding, although this has not occurred in recent years.



*Photo: Property flooding in Brasted December 2002*

Urban run-off and new development have altered the localised response to rainfall and localised flooding does occur following heavy rainfall events. It is not known to what extent discharges from motorway drainage systems influence flows in the river, however the effect may be significant. It is understood that motorway widening is

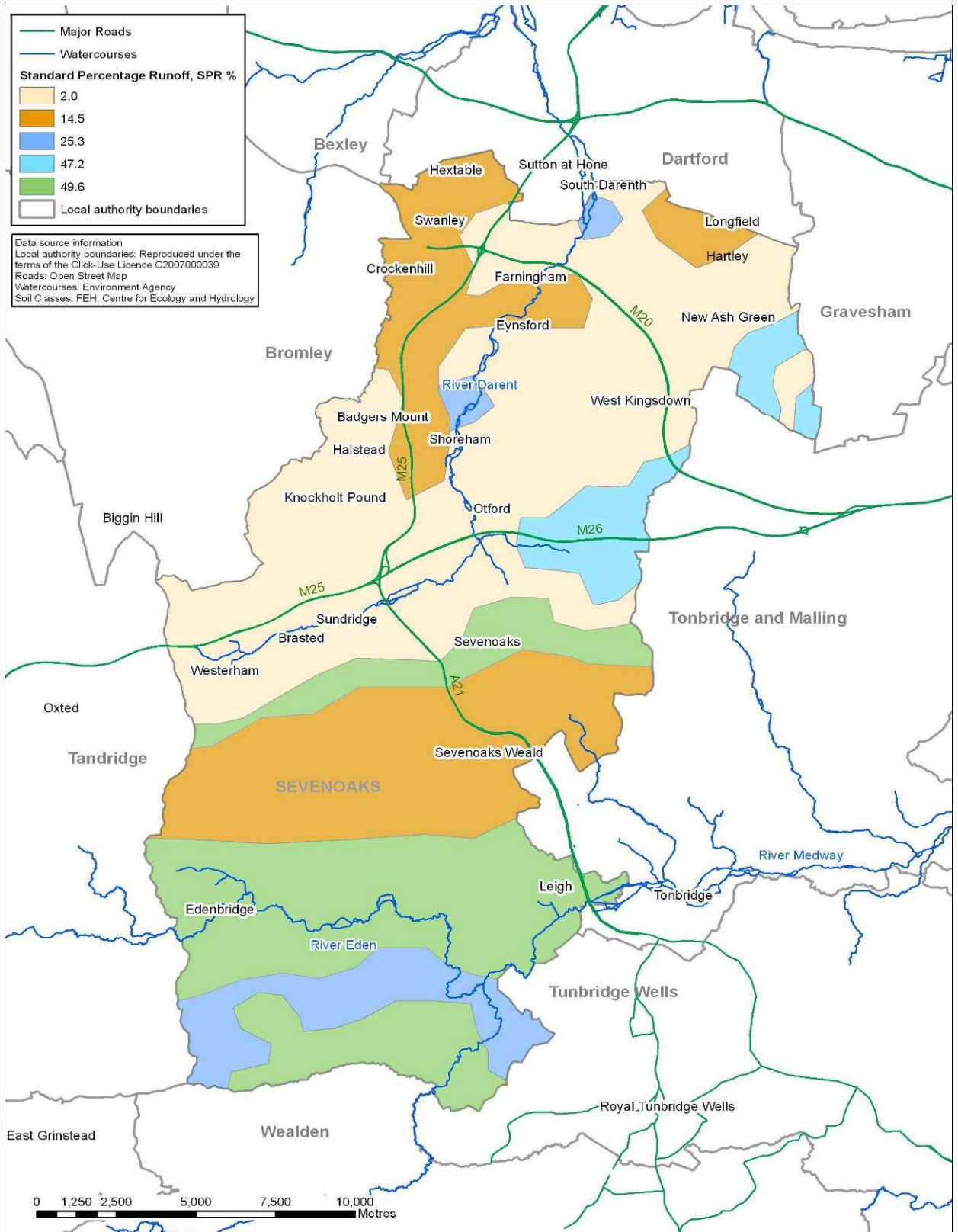
being considered and through direct consultation with the Highways Agency and through the Planning System this will be an opportunity to assess the effect of future discharges.

The other principal main river serving the District is the River Medway and its tributary the River Eden. These rivers flow through the Vale of Kent, fed from springs from the water-bearing limestones and sandstones of the Greensand Ridge. The flow characteristics of this river system are influenced by development runoff and the low permeability of the Weald Clay. As a result the River Medway and River Eden respond rapidly to rainfall and high river levels can be sustained for some time as the catchment drains after a storm.

A small section of the Sevenoaks District forms part of the upper catchment for the adjacent Cray Catchment.

#### **A.3.5 Soils**

Soil type classification provides a generic description of drainage characteristics, which affects the means of surface water disposal from a site. Soil type may only be fully determined after suitable ground investigations, although an indication of soil permeability and infiltration potential across the District is shown by **Figure 2: Distribution of Soil Permeability**.



**Figure 2: Distribution of Soil Permeability**

#### **A.4 Constraints on Development**

Around 93% of the District is designated as Green Belt and the High Weald and Kent Downs Areas of Outstanding Natural Beauty (AONB) cover over 60%. Much of the North Downs and Greensand Ridge has also been designated as a Special Landscape Area.

There are 61 Sites of Special Scientific Interest (SSSIs) in the District designated for their ecological or geological interest (e.g. Dryhill), typical habitats include: species-rich grassland (e.g. Preston Hill), ancient woodland (e.g. Hanging Bank and Farningham Woods), and wooded commons (e.g. Westerham, Seal Chart, Fawke and Bitchet Commons). The area around Sevenoaks has several large worked out gravel pits, one of which is the Sevenoaks Gravel Pits SSSI. The District also has 17 Sites of Nature Conservation Interest (SINCSs)

The urban areas of the District are home to 40 Conservation Areas and numerous listed buildings, ancient monuments and historic parks and gardens.

Therefore, Sevenoaks District has relatively stringent controls and constraints to new development and the scope for future development including new housing, is considered limited.

There are no designated Special Areas of Conservation (SACs), Special Protection Areas (SPAs), Environmentally Sensitive Areas (ESA's), National Nature Reserves, or Ramsar sites in the District.

The locations of the designated sites are illustrated in **Figure 3: Designated Sites Map**.





## Planning Context

### **A.5 Introduction**

This SFRA conforms to the National Planning Policy Statement 25 (PPS 25): Development and Flood Risk.

A SFRA is a living document which is used as a tool by a planning authority to assess flood risk for spatial planning, producing development briefs, setting constraints, informing sustainability appraisals, identifying locations of emergency planning measures and requirements for flood risk assessments.

The success of the SFRA is dependent upon the Planning Authority's ability to implement the recommendations put forward for future sustainable flood risk management in conjunction with the Environment Agency. It is their responsibility to establish policies to ensure future sustainability with respect to flood risk.

Emerging planning policies normally cover about 20 years in advance. Planning for flood management is a longer-term practice and SFRA's consider implications for spatial planning about 100 years ahead.

### **A.6 National Planning Policy – PPS 25**

In December 2006 the Government published PPS 25: Development and Flood Risk (a restatement of PPG 25). It reflected the general direction set out in 'Making Space for Water' (Defra, 2004), the evolving new strategy to shape flood and coastal erosion risk over the next 10-20 years (see Glossary of Terms).

PPS 25 advises that regional planning bodies preparing Regional Spatial Strategies (RSSs) should include a broad consideration of flood risk from all sources, and set out a strategy for managing it in accordance with policies and plans prepared under the Water Framework Directive. For further detailed discussions on the planning context of this SFRA refer to **Appendix A** and for discussions on PPS 25 refer to **Appendix B**.

The scope of this report is a Level 1 (see **Appendix B**) SFRA as defined in PPS 25, to inform the plan-making process of the Core Strategy and other DPDs as required. This information will be used by the planning authority to undertake sequential testing in identifying general locations for development and to formulate strategic

policies, and may assist in informing the Council's emergency plan. The study covers the area within the administrative boundary of Sevenoaks District Council.

**A.7 Regional Planning Policy**

The South East Plan, which has recently undergone examination, sets out the housing requirement for Sevenoaks District. The Examination in Public: Report of the Panel Report recommends that 3,300 dwellings be built between 2006 and 2026. It is a requirement that this SFRA is in general conformity with regional planning policy. For further detail on the South East Plan refer to **Appendix A**.

**A.8 Local Planning Policy**

**A.8.1 Sevenoaks District Local Plan**

The Local Plan adopted in March 2000 recognises the importance of achieving sustainable development and the role played by natural resources such as water. For further detail on the Sevenoaks District Local Plan refer to **Appendix A**.

**A.8.2 LDF and Sustainability Appraisal**

The role of this SFRA is to inform the decision making process to determine the best and most sustainable options for the spatial development strategy. This SFRA will feed into the District Council's LDF documents, in particular the Core Strategy and Balanced Communities DPDs, and build on the findings of the Sustainability Appraisal. For further detail refer to **Appendix A**.



## Study Methodology

### A.9 **Specific Project Outputs**

The specific outputs are based on the required outputs for a Level 1 SFRA, as follows:

- i. Map existing Flood Zones 1, 2 and 3 across the plan area (see **Section 4.4.2** and **Tiles A to H**).
- ii. Map Flood Zones 1, 2 and 3 for the future climate change scenarios of 2070 and 2115 as set out in PPS 25 Annex B, taking account of recommended national precautionary sensitivity ranges for peak rainfall intensities and peak river flows (see **Section 4.4.3**).
- iii. Identify areas at risk from flooding from sources other than rivers (see **Sections 4.3, Chapter 5, Tables 2, 3 and 4** and **Tiles A to H**).
- iv. Identify and take into account flood risk management measures including flood defences and emergency warning systems (see **Chapter 6**).
- v. Guidance on the Application of the Sequential Test (see **Chapter 7**).
- vi. Guidance for the preparation of Flood Risk Assessments (see **Chapter 8**).
- vii. Guidance on possible mitigation measures, including the likely applicability of different sustainable drainage systems (SUDS) techniques for managing surface water runoff at key Level 1 SFRA development sites (see **Chapter 9**).
- viii. Identify locations where development would significantly increase the risk of flooding elsewhere (see **Section 5.3 and 9.4**).

### A.10 **Approach to Data Gathering**

Throughout the data collection process it has been crucial to make best use of the significant amount of information which already exists with respect to flood risk. The main source of data for this study has been the Environment Agency, previous Halcrow projects, a number of relevant websites, the Local Planning Authority, Kent County Council, Southern Water and Thames Water (see Audit Trail Database in **Appendix D**). The only Internal Drainage Board (IDB) in Sevenoaks District is the Upper Medway IDB.

This data gathering exercise has included a review of:

- Environment Agency Flood Zone Maps and detailed flood risk mapping outputs;

- localised flooding information from Sevenoaks District Council, the Environment Agency, Southern Water and Thames Water; and
- information on the major flood defences and flow control structures (from the National Fluvial and Coastal Defence Database).

The main approach has been to build on the large number of strategic studies and relevant available data. The Medway and North Kent Rivers Catchment Flood Management Plans (CFMPs) have provided a good foundation for catchment understanding and flood risk assessment.

Valuable flood risk information for localised flooding areas (as opposed to the 'non-localised' flood zones) was obtained from the drainage specialists working for Sevenoaks District Council and Kent County Council. The collected information complemented information provided by the Environment Agency, Southern Water and Thames Water.

## **A.11 Forms of Flooding and Data Limitations**

### **A.11.1 Introduction**

For the purpose of this assessment, forms of flooding (also defined as sources of flooding) are divided into four categories:

- a) river floods;
- b) flooding from impounded water bodies such as canals and reservoirs;
- c) groundwater flooding; and
- d) flooding from other sources.

The reason for adopting this classification is to provide an understanding of data limitations and assumptions as there are different standards for the collection of each of these types of data.

The various sources of flooding within the study area are described and shown in **Tables 2, 3 and 4** and **Tiles A to H**.

#### A.11.2 *Tidal and Fluvial Flooding*

The Environment Agency Flood Zone Maps show the areas at risk of flooding from rivers and the sea, ignoring the presence of defences. The Environment Agency Flood Zone Map is continuously being improved as new studies are undertaken, detailed hydraulic models are constructed and more flooding data and information becomes available. Fluvial flooding (flood zones) is described in **Appendix C**.

As the Sevenoaks District area is inland, it does not experience tidal flooding.

#### A.11.3 *Records of Flooding from Impounded Water Bodies*

Records of flooding from reservoirs and canals are erratic as there is no requirement for the Environment Agency to provide information on historic flooding from canals and raised reservoirs on plans. In particular, PPS 25 does not require flood risk from canals and raised reservoirs to be shown on the Environment Agency Flood Zones. Overtopping from canals is common due to flows from land drainage and their frequent lack of controlled overflow facilities. Occasionally, major bank breaches also occur, leading to rapid and deep flooding of adjacent land.

Reservoirs with an impounded volume in excess of 25,000 cubic metres (measured above natural ground level) are governed by the Reservoirs Act and are listed on a register held by the Environment Agency. Due to high standards of inspection and maintenance required by legislation, flood risk from registered reservoirs is normally moderately low.

#### A.11.4 *Records of Groundwater Flooding*

The Environment Agency keeps records of individual groundwater flooding events, but only a few records exist for Sevenoaks District.

In some cases groundwater flooding is incorporated within the flood zones, at locations where its effect is not localised. This occurs at a few locations within the District, including the Sevenoaks area (see further details in **Section 5.2.4**).

#### A.11.5 *Records of Flooding from Other Sources*

Until 2006, the methodologies for recording flooding from sources other than tidal and fluvial were not standardised, so records held of such flooding are neither complete nor to a uniform standard. As part of Defra's Making Space for Water study, a report was published by the Environment Agency titled "Flooding from other sources". The report recommended a classification for such flooding and methods

for recording other sources of flooding. The classification approach has been adopted for this study.

Sources of information on flooding from other sources can be obtained from local government, highway authorities, the Environment Agency, sewerage undertakers, businesses, individuals and archives such as libraries.

The recording of flood instances by the authorities has often led to improvements intended to prevent recurrence, and hence historical flooding is not necessarily evidence of propensity for future flooding.

Currently few records of flooding from other sources contain sufficient detail to enable them to be classified in accordance with the Environment Agency classification of "flooding from other sources" and, indeed, many flood incidents had more than one cause.

The sources of flooding from the Environment Agency (Source report, JBA 2006) have been merged and are reproduced in **Table 1: Other Sources of Flooding**.

Type	Flooding Phenomenon	Sources	Pathways	Receptors	Hazard
1	Direct runoff	Intense rainfall	All surfaces including road network	People, vehicles, properties, commercial, environment	Deep fast water, with high rate of inundation Deep water / debris / cellar flooding Fast water – erosion
2	Sewerage and drainage system flooding from pipe capacity exceedance	Heavy rainfall over a long duration or intense rainfall	Surcharging from manholes and openings in the drainage system. Surcharging	People, vehicles, properties, commercial, environment.	Cellar and ground floor flooding with water quality issues
3	Sewerage and drainage system flooding from 'other causes' (blockage and collapse)	Long duration or intense rainfall	Manholes and overflows in drainage and sewerage network	People, vehicles, properties, commercial, environment	Deep ponded water. Cellar and ground floor flooding with water quality issues
4	Restricted outlets from drainage systems due to high flood levels in the receiving watercourse	Heavy rainfall over long duration	All surfaces and drainage network	People, vehicles, properties, commercial	Deep ponded water, and water diverted along unexpected routes.
5	Surcharge from small (ordinary) and 'lost' watercourses	Heavy or intense rainfall	All surfaces and drainage network	People, vehicles, properties, commercial	Deep ponded water
6	Floodplain flooding from ordinary watercourses not covered by the flood map (catchment area > 3km <sup>2</sup> )	Heavy rainfall	Ordinary watercourse embankments and floodplains	People, vehicles, properties, commercial	Deep ponded water and fast flowing floodplain flows.
7	Intense rainfall leading to overland flow including mud/debris flow and flow along old drainage lines, roads and railways.	Intense rainfall or long duration heavy rainfall	Land, field drainage, river and watercourse network	People, vehicles, properties, commercial, environment	Fast water erosion of soil for high grade agricultural land. Rapid rates of inundation affect road users. Runoff from land on urban fringe to flood properties
8	Heavy, long duration rainfall leading to ponding on for example roads or fields	Long duration heavy rainfall	Rural surfaces and field drainage	People, vehicles, properties, commercial, environment	Deep water, runoff from fields onto rural roads can cause serious hazard to drivers
9	Changes to drainage or land management. Reduction in agricultural pumping / land use management / drainage leading to increased risk of flooding	Loss of pumping / irrigation	Field drains, drift geology, watercourses and land surface	People, properties, environment	Reduction in capacity of land to drain water away – leading to ponding and or more surface runoff and erosion. Await findings of FD2120 (DEFRA document).

**Table 1: Other Sources of Flooding**

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## A.12 Production of Flood Maps

### A.12.1 Introduction

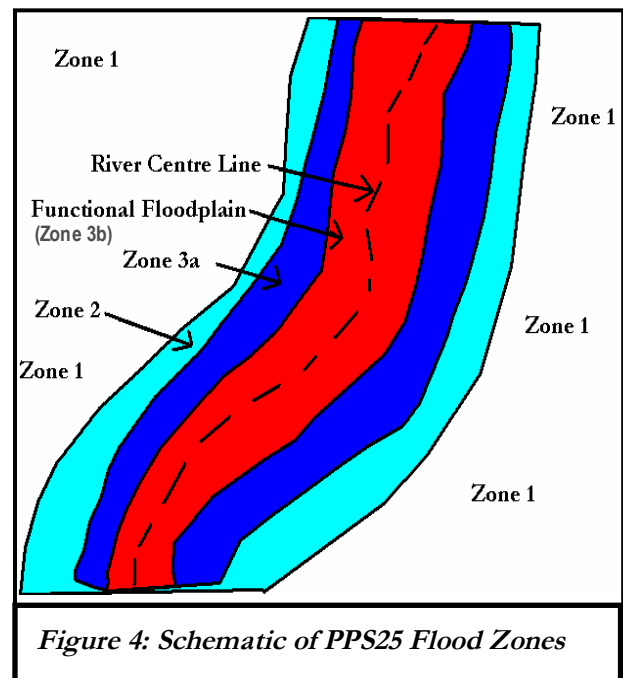
The Environment Agency's Flood Map and more detailed maps within this document, indicate the level of flood risk ignoring the presence of any flood defences. This is a reasonable pre-cautionary option for the application of the Sequential Test, as it gives priority to development areas that do not require the presence and maintenance of defences.

### A.12.2 Current Flood Maps (without climate change allowance)

Flood Zones subdivide the land, according to its spatial variation of flood probability, into 4 classifications; the low, medium and high probability flood zones and the functional floodplain - Zones 1, 2, 3a and 3b respectively (see **Figure 4: Schematic of the PPS 25 Flood Zones**). The Flood Zones are described in PPS 25 and are shown on the Environment Agency Flood Map.

Refer to **Appendix C** for further details about the Environment Agency flood zones.

The SFRA Flood Maps (see **Tiles A to H**) have reproduced the Environment Agency low, medium and high probability flood zones as no other more up-to-date information is available. The maps show fluvial flood zones and localised flooding areas which relate to historical flooding at individual locations. Their main form of flooding can be other sources of flooding (see **Section 4.3.5**) or mainly fluvial/groundwater combined with insufficient surface drainage, etc. The flood risk at localised flooding areas that fall in Zones 1 and 2 may in some cases be significant, with deep and frequent flooding. These areas could be considered as if they were high risk areas (equivalent to Zone 3a) when applying the Sequential Test (see **Chapter 7**).



The August 2007 Environment Agency Flood Zones have been used for the production of the SFRA Flood Maps (see **Tiles A to H**). The scale of the Flood Maps is 1:50,000 to give a strategic overview and clarity of general features.

Further updates are likely to occur, for example following the new Hydrological assessments and hydraulic modelling at Edenbridge for the Level 2 SFRA. Once the Environment Agency approves these studies, both the SFRA Flood Maps and the Environment Agency Flood Zones can be updated. SFRAs are living documents and, in order to ensure consistency, at least the digital flood maps should be updated in conjunction with Environment Agency Flood Zone updates.

The functional floodplain covers flooding that occurs frequently, so it may in some cases be possible to estimate its extent based upon historical data. However, there is insufficient data to determine this for the whole Sevenoaks District and as this method is complex and time-consuming it is not generally appropriate for a Level 1 SFRA.

In the absence of sufficient historical data or modelling work, a precautionary principle was adopted where it was assumed that Zone 3b covers all of Zone 3. In this case Zone 3a is represented in the flood maps merely as an outline since it is subsumed completely by the functional floodplain (Zone 3a + Zone 3b = Zone 3). In relation to development planning (see **Chapter 7**) Zone 3b only permits water compatible and essential infrastructure land uses so in the event that the Sequential Test leads to a more vulnerable development being considered for a Zone 3 area, an Exception Test should be applied with a more detailed, Level 2 assessment to distinguish between Zones 3a and 3b.

Flooding incident records are currently not maintained by Sevenoaks District Council, but some limited historical data was used during the workshop and reproduced on the maps. However, following occurrence of localised flooding, the authorities may have taken steps to mitigate flooding, and thus any historical events are not necessarily indicative of future flooding.

The Environment Agency also maintains flood incident records but these mainly relate to groundwater incidents and those that occur in the vicinity of main rivers. These have not been included in the map tiles to minimise duplication. The



Environment Agency should, however, be consulted in relation to the flood incident records during the application of the Sequential Test as explained in **Section 7**.

#### A.12.3 Effects of Climate Change

In October 2006, DEFRA published a document identifying the climate change impacts to be considered when undertaking Flood Risk Assessments. This suggests rainfall intensity and peak river flow may increase by 30% and 20% respectively and is summarised in the table below. These effects will tend to increase both the size of flood zones associated with rivers, and the amount of flooding experienced from "other sources".

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	+5%	+10%	+20%	+30%
Peak river flow	+10%	+20%		

As recommended by the Environment Agency, the design life of commercial and residential development is assumed to be approximately 60 years and 100 years respectively.

#### A.13 Climate Change Flood Maps

Based on an estimated increase of 20% in peak river flow (which is expected to occur during the life of the new commercial and residential developments, see **Section 4.4.3**) the following precautionary rules/assumptions have been adopted for this Level 1 SFRA:

- C1) The extent of Flood Zone 3b (functional floodplain) will increase to equal that of the current Flood Zone 3a
- C2) The extent of Flood Zone 3a will increase to equal that of the current Flood Zone 2.

Many previous flood mapping studies by Halcrow confirmed that increases in flows by 20% to Flood Zone 3, result in flood extents which are in general smaller than Flood Zone 2.

C3) The 'Climate Change' Flood Zone 2 is slightly larger than current Flood Zone 2 (as there is little certainty about the effect that climate change will have on very extreme fluvial events). It is reasonable to assume that these two Zones 2 (with and without climate change) are the same on the large scale SFRA flood maps.

The current flood maps (***Tiles A to H: Flood Maps***) can therefore be used to take account of climate change predictions along the fluvial reaches by applying rules C1, C2 and C3.

## Flood Risk in the Study Area

### **A.14 Introduction**

All forms of historical flooding have been considered, both in isolation and when occurring at the same time. For references to locations within the study area see the set of maps, **Tiles A to H**.

### **A.15 Historical Flooding**

#### **A.15.1 Introduction**

This section is to be read in conjunction with **Tiles A to H** and **Tables 2, 3 and 4**. The tiles identify the fluvial flood zones as provided by the Environment Agency and any localised flooding problem locations supplied by Sevenoaks District Council. The flooding locations are shown on the tiles, and annotated with a reference to **Table 2**. These tables include sewerage related flooding incident data for the years 1997-2006 supplied by Southern Water and for the years 1997 to 2007 supplied by Thames Water.

#### **A.15.2 Notable Flood Events**

A brief history of significant flood events is set out below:

1968, Sept – The extreme flood event in 1968 is considered to be of a return period greater than 1 in 100 years. It is suspected that the ground was dry and hard following the summer and that this exacerbated the run-off from the catchment. There was extensive flooding of agricultural land and damage to properties between Westerham and Farningham. Several old bridges were washed away and Dartford was flooded. The 1968 event produced the greatest damage in recent times and was the trigger for channel and floodplain conveyance improvements in the Darent.

2000, Oct – Three subsequent rainfall events in one month caused severe flooding in many parts of Kent. Flooding occurred in the Eden around Edenbridge and Penshurst and upper sections of the Darent, particularly in Eynsford where there was flooding of some properties and roads. The high rainfall during 2000 made it the wettest year for over 200 years.

2002/03, Jan to Dec – The 24<sup>th</sup> December signalled the start of a serious flood event in Kent, which lasted until the 3<sup>rd</sup> January 2003. Over this period three weather fronts moved in from the west each bringing between 20 and 25mm of rain across

the area. The most severe weather lingered over the North Downs giving rainfall accumulations of over 100mm. The River Darent catchment was most severely affected in the area, with the worst flooding recorded since 1968. Approximately 50 properties were flooded in Westerham, Brasted, Sundridge, Chipstead, Farningham and South Darenth. In most of these locations flooding was probably caused by a combination of high river flow with specific local factors such as surface run-off or blocked culverts.

*A.15.3 Flooding shown on Environment Agency's Formal Flood Map*

Flood Zones shown on the Environment Agency's formal flood map are reproduced on **Tiles A to H**. Flood Zone 3 represents the 1:100 year event (high probability). Flood Zone 2 represents the 1:1,000 year event (medium probability).

*A.15.4 Groundwater Flooding*

Localised flooding areas recorded in **Table 2** for which groundwater was a contributory factor are South Darenth, Bradbourne Lakes and Sevenoaks.

*A.15.5 Flooding from Other Sources*

Southern Water describe all of the limited sewerage flooding incidents listed in **Table 3** as having "hydraulic" problems and as a "foul/combined" type. As the locations of all the incidents are clear from the tiles and **Table 3**, and no additional information has been made available, the incidents are not described further.

The information provided by Thames Water for sewerage flooding incidents in the District is listed in **Table 4**. Unlike the Southern Water data, the listed flooding events are grouped by postcode area and hence detail regarding the exact location of these incidents is not clear.

Source Of Flooding	Title	Location	Details	Occurrence (Years)	Source	Date Received
Surface Water	A	Fawkham	Water runs down road like river.	Not known	Workshop with Council	19/09/2007
	A	Springcroft Road, Hartley	Occasional flooding in cul-de-sac development as highway drainage to soakaways is inadequate to cope with run-off from catchment.	Not known	Workshop with Council	19/09/2007
	B	Button Street, Swanley Village	Run-off has caused flooding particularly in Dartford BC's area adjacent.	Not known	Workshop with Council	19/09/2007
	B	Upper Austin Lodge Golf Club	Chalk based dry valley.	Not known	Workshop with Council	19/09/2007
	C	Knole Park, Sevenoaks	Water discharges via "hole in the wall" (gateway in park boundary wall) and contributes to flooding in Seal Hollow Road that eventually arrives at Mill Pond at top of Mill Lane - some via the Southern Water sewer system.	Not known	Workshop with Council	19/09/2007
	C	Brittains Lane, Sevenoaks	Watercourse culverted but designated public sewer and combines with highway drainage. Floods area adjacent to railway embankment, also flood risk to area to north of railway embankment around Bradbourne Lakes.	Not known	Workshop with Council	19/09/2007
	C	Lingfield Road, Edenbridge	Surface water flood history.	Not known	Workshop with Council	19/09/2007
	C	The Dene, Grassy Lane, Kippington	Surface water flooding from dry valley.	Not known	Workshop with Council	19/09/2007
	C	Dene catchment, Sevenoaks	Overloaded Southern Water sewer due to land use change related to development. Surplus water occasionally reaches Hill House in South Park and then discharges to railway cutting.	Not known	Workshop with Council	19/09/2007
	D	Brasted Place, Brasted	Dry valley to South contributes to some basement flooding and to flooding in Brasted.	Not known	Workshop with Council	19/09/2007
D	Between New Road and Church Road, Sundridge	Floods Main Road and Woodside and Chapmans Roads.	Not known	Workshop with Council	19/09/2007	
Groundwater	A	South Darenth, Mill Stone Close	Groundwater flooding where the Darent has been diverted for Horton Kirby Mill. Most flood damage to properties outside of Sevenoaks in Dartford. Flooding may have resulted from flow connection to underlying chalk aquifer through mill borehole shafts to the surface. Dartford Borough Council have installed pumps to control the groundwater.	Not known	Workshop with Council	19/09/2007
	B	Eynsford	Groundwater incident noted.	Feb, 2003	Workshop with Council	19/09/2007
	C	East of Riverhead, Bradbourne Lakes	Lakes are spring fed and groundwater is high in this area. No history of property flooding but area potentially vulnerable.	Not known	Workshop with Council	19/09/2007
	C	Sevenoaks	Some locations where the aquifer cap is missing resulting in groundwater infiltration when full. Typically results in waterlogged gardens not in serious flooding of properties.	Not known	Workshop with Council	19/09/2007
Highways	A	Gorsewood Road, Hartley	Inadequate highway drainage plus surface water run-off.	Not known	Workshop with Council	19/09/2007

	C	Kemsing	Water drains from Kemsing toward M26.	Not known	Workshop with Council	19/09/2007
	C	M25 at Westerham/Brasted	Drainage lagoons have three stage discharge controls that drain to the River Darent and are believed to contribute to fluvial flooding. Increased risk in Chipstead from M25 drainage lagoons when full.	Not known	Workshop with Council	19/09/2007
	C	Amherst Hill and A25, Riverhead	Flooding by the Harvester Public House. Highway drainage has been improved but small stream adjacent not adequate. Flooding can extend north towards River Darent.	Not known	Workshop with Council	19/09/2007
	C	Lingfield Road, Edenbridge	History of flooding to terraced housing.	Not known	Workshop with Council	19/09/2007
Fluvial	A	River Darent, South Darent	Millstead Close and the area between St John's Loop and the main channel of the River Darent. 14 properties flooded. Contributing factors were exceedence of the culverted section of the River Darent flowing through Horton Kirby Mill and flooding from groundwater at Millstone Close.	January 2003	Environment Agency Flood Report	26/10/2007
	B	River Darent, Eynsford	Riverside Road closed for 2 weeks. Flood risk plus sewage contamination due to vented local sewers in places.	January 2003	Environment Agency Flood Report	26/10/2007
	B	River Darent, Farningham	4 properties flooded due to opening of the sluice at Eynsford. The Street at Horton Kirby was flooded by out-of-bank flow being trapped by the mill head.	January 2003	Environment Agency Flood Report	26/10/2007
	C	River Darent, Dunton Green, Otford,	Flood risk plus sewage contamination due to vented local sewers in places.	Not known	Workshop with Council	19/09/2007
	C	Leigh	Flood barrier provides protection but some areas still appear flood prone.	Not known	Workshop with Council	19/09/2007
	C	River Darent, Chipstead	Low lying area vulnerable to flooding from small stream under M25. Base flow from springs can be significant at times. History of flooding in this area. River Darent nearby has also caused serious flooding, EA weir now carries bypass channel under Chipstead Lane into Chipstead Lake.  Flooding of 2 properties. The bifurcation upstream of the motorway may not have taken enough flow from the Mill Stream to the relief channel.	Not known	Workshop with Council	19/09/2007
				January 2003	Environment Agency Flood Report	26/10/2007
	C	Kippington, Sevenoaks	Hill House flooded 8 times in 3 years (1992-1994).	Not known	Workshop with Council	19/09/2007
	C	River Eden, Chiddingstone	Known flooding in 1968.	Not known	Workshop with Council	19/09/2007
	C	River Eden, Edenbridge	Bank full upstream and downstream of Town Bridge. Bank protection formerly thought to be 1:30. Several hundred properties at risk including new development.	Autumn 2000  1:17 year event.	Workshop with Council	19/09/2007
	C	Skinner's Stream, Edenbridge	History of flooding due to blocked culvert at Enterprise way. Flood risk at Spitals Cross estate and former school site on Four Elms Road.	Not known	Workshop with Council	19/09/2007
	C	Shoreham	Undefended floodplain. Some flood history, no details available.	Not known	Workshop with Council	19/09/2007
C	Brittains Lane Stream	Area of former law courts is vulnerable to flooding due to railway	Not known	Workshop	19/09/2007	

			embankment		with Council	
	D	River Darent, Sundridge	14 properties flooded by surface water running down the hill towards River Darent. A25 affected by surface water runoff.	January 2003	Environment Agency Flood Report	26/10/2007
	D	River Darent, Westerham	Flooding from variety of sources including Courte Lake and surface runoff from A25. 5 properties flooded. 1968 flood mark on wall at Quebec House from fluvial event.	January 2003	Environment Agency Flood Report	26/10/2007
	D	Croydon Road, Westerham	Stream culverted in parts passing under former railway station.	Not known	Workshop with Council	19/09/2007
	D	River Darent, Brasted	Main source overtopping from river into the office complex upstream of Rectory Lane road bridge. Exceedence of highway drainage system. 23 properties and businesses flooded to depth of 400mm or more. Rectory Lane closed during event. Flood alleviation scheme is being implemented.	January 2003	Environment Agency Flood Report Workshop with Council	26/10/2007 19/09/2007
	G	Penshurst	Flooding to property, no EA records. Sewage works on island may be vulnerable to fluvial flooding.	Not known	Workshop with Council	19/09/2007
Foul Water Sewers	A	West Kingsdown	Deep sewer running under Brands Hatch has been known to cause problems due to flat gradient.	Not known	Workshop with Council	19/09/2007
	A	Church Road, Hartley	Sewer has very flat gradient and silts up. Serious flood risk if not regularly maintained.	Not known	Workshop with Council	19/09/2007
	B	Crockenhill	Issues with foul sewer flooding in this area.	Not known	Workshop with Council	
	C	Kemsing	Vented covers, other covers are very low and can lift. Discharge to Honeypot Stream. History of pollution incidents, some by blockages.	Not known	Workshop with Council	19/09/2007
	C	Bradbourne Park Road, Sevenoaks	Flows converge at T-junction and towards railway causing backing up and RTU/internal foul flooding.	Not known	Workshop with Council	19/09/2007
	C	Bat & Ball Station, Sevenoaks	Foul sewer capacity issues.	Not known	Workshop with Council	19/09/2007

**Table 2: Sources of Flooding**

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Date of most recent incident	Post town	Locality	Street	Sewer Problem Description	Sewer Type Description	Curtilage Flooding	Highway or Open Space
09/11/1997	Edenbridge		Main Road	Hydraulic	Foul/Combined	Yes	
12/10/2000	Edenbridge		High Street	Hydraulic	Foul/Combined		Yes
16/11/2000	Edenbridge	Cowden	High Street	Hydraulic	Foul/Combined		Yes
23/11/2003	Tonbridge	Leigh	Powder Mill Lane	Hydraulic	Foul/Combined	Yes	
14/12/2006	Edenbridge		Four Elms Road	Hydraulic	Foul/Combined	Yes	

**Table 3: Historical Flooding - Southern Water** (Source: Southern Water Oct 2007)

Postcode	Total Number of Properties Flooded 1998 to 2008		
	By surface water from overloaded	By foul water from overloaded sewers	By combined overloaded sewers
BR8	-	-	-
TN8	-	-	-
TN13 2	-	-	1
TN13 3	-	2	-
TN14 6	-	1	-
TN14 5	-	1	-
TN15	-	-	-
TN16 3	-	-	1

**Table 4: Historical Flooding – Thames Water** (Source: Thames Water Nov 2007)

**A.16 Areas Where Development May Increase Flood Risk Elsewhere**

The study of flood risk in this chapter leads to the following conclusion: careful investigation of local flood risk (with a detailed investigation of flood incident records, management and maintenance issues) is required at many locations in the SFRA area before development is allocated.

It is not sufficient to assume that locating development away from Flood Zones 2 and 3 and localised flooding areas and the use of sustainable drainage systems (SUDS) techniques will automatically render flood risk to third parties adequately low irrespective of location (see **Section 9.4**). A situation may arise in which there is no spare capacity at an outfall (for example a surface water drainage system a few kilometres from the proposed allocation). The approach could be to produce a specific policy in which development will not take place until the surface water drainage system is upgraded (unless an alternative outfall is identified and subject to approval by the planning authority and the Environment Agency).

A general policy for localised flooding issues could be as follows: 'No development will be allowed unless it is demonstrated that: a) dry access and egress is provided (see **Section 8.4**), b) the receiving watercourse has sufficient capacity and c) flood risk will not be increased in nearby localised flooding areas and/or flood incident locations.

## High Level Plans, Flood Management Measures and Flood Warning Systems

### **A.17 Introduction**

SFRA reports are 'living documents' which should be updated when Environment Agency flood zones and other relevant documents (for example CFMPs, Strategies, Flood Warning Systems) are updated. It ensures a consistent and integral approach to flood risk management.

### **A.18 Catchment Flood Management Plans**

The Medway Catchment Flood Management Plan (CFMP) was completed in 2004 prior to the adoption of PPS 25. The North Kent Rivers CFMP is currently at scoping consultation stage and has yet to be finalised but the key messages for base policies and actions have been outlined in a report dated June 2006.

The Medway CFMP covers the River Medway and its tributary the River Eden. The document identified a total of 11-15 floods in Edenbridge and Penshurst between 1846 and 2001. It identifies Edenbridge as a key flood risk area in the catchment and identifies storage upstream of Edenbridge (also considered by Kent River Authority in 1971) for significantly reducing river levels in the town. The report recommends that further studies are commenced to address flood risk issues in the upper reaches of the Eden.

The North Kent Rivers CFMP covers the River Darent and its tributaries. The report identified some of the more significant historical flood events which have been reproduced in **Section 5.2.2**. It identifies that a total of 735 properties in the villages in the upper Darent will be susceptible to flooding from the 1 in 100 year event, notably (for the Sevenoaks District) in Brasted and Holton Kirby. Annual Average Damages (AAD) total £11.7m for the villages on the Darent.

The North Kent CFMP identified 5 economic objectives to reduce the economic flood risk:

Nr	Objective	Description	Indicator	Target
<b>Economic objectives</b>				
<i>Overall objective: to reduce economic flood risk</i>				
1	To reduce risk of flooding to property, infrastructure and services	Reduction of risk means the reduction of probability and / or consequences of flooding. Our flood risk management policies need to minimise economic risk as much as possible. Typical measures can include the reduction of run-off (land use, land management practices), managing river systems, provision of flood defences or the prevention of inappropriate development in the floodplain. Note that measures need to be economically justifiable. The objective covers the whole plan period so it needs to take into account developments (incl. uncertainty) in land use, urbanisation and climate change. Links:WFD3	<ol style="list-style-type: none"> <li>1. Estimated annual average damages from flooding of commercial and residential properties</li> <li>2. Number of properties at risk of flooding in 1/100 year flood</li> <li>3. Probability of disruption through flooding of major infrastructure (Motorways and main railways)</li> </ol>	<ol style="list-style-type: none"> <li>1. Maximum reduction in annual average damages, balanced with costs</li> <li>2. Maximum reduction in properties within 1/100 year floodzone, balanced with costs</li> <li>3. Minimum disruption of major infrastructure</li> </ol>
2	To reduce the risk of flooding that is damaging to agricultural land where it is cost-effective to do so, and to enhance the benefits of flooding of agricultural land.	Agricultural flooding typically has less severe consequences than flooding of properties, services or infrastructure. Short term flooding of agricultural land with clean fresh water can have neutral or, in certain situations, (environmentally) beneficial impacts. Consequently this objective includes both the reduction of damaging flooding and the possible enhancement of beneficial agricultural flooding. The objective covers the whole plan period, so long term developments are included. Links:WFD3	<ol style="list-style-type: none"> <li>1. Estimated annual damages from agricultural flooding</li> <li>2. Number of instances of cost-neutral or beneficial flooding</li> </ol>	<ol style="list-style-type: none"> <li>1. Maximum reduction in annual average damages, balanced with costs</li> <li>2. As many instances as possible, balanced with costs</li> </ol>
3	To manage flood risk in such a way that all sustainable, compliant new developments are not prevented or disrupted	Development plans need to take into account flood risk. However, flood risk management planning must be able to accommodate new development where that development is both sustainable and compliant with planning policies. Our flood risk management policies need to ensure that flood risk is and remains at a level at which these developments remain sustainable.	Probability of flooding of each development, relative to the upper limit of the appropriate PPG25 / PPS25 zone	Probability of flooding to be below upper limit of the appropriate PPG25 / PPS25 zone for all sustainable, compliant developments

Nr	Objective	Description	Indicator	Target
<b>Social objectives</b>				
<i>Overall objective: to reduce social flood risk and to provide an acceptable level of public safety</i>				
4	To reduce the risk of direct impacts of flooding on human health.	Death or injuries due to flooding can be caused by a combination of factors such as rapid inundation, deep and high velocity flooding (e.g. through flood defence breach), blocked evacuation routes, lack of awareness among the public about flood risk, inadequate warning. Our flood risk management policies need to minimise these factors. Note that we cannot measure 'probability of deaths and injuries' directly, so the above factors are used as indicators. Links: WFD3	<ol style="list-style-type: none"> <li>1. Condition of flood defence assets</li> <li>2. Probability of disruption of strategic evacuation routes</li> <li>3. Level of public awareness and preparedness in areas at risk</li> <li>4. Coverage of warning in areas at risk</li> </ol>	<ol style="list-style-type: none"> <li>1. Condition 3 or better</li> <li>2. Strategic evacuation routes usable during flooding up to 1/1000 year flood</li> <li>3. All public in 1/1000 year flood zone aware of risk</li> <li>4. Full 1/1000 year flood zone covered by flood warning service</li> </ol>
5	To reduce risk of flooding to community assets where it is cost-effective to do so	Flooding of community assets can cause disruption which in turn can have negative social consequences. This is especially the case for the assets in the 'Highly vulnerable' and 'More vulnerable' categories in Table D.2 of PPS25 (hospitals, emergency dispersal points, doctors' surgeries). Links: WFD3	Probability of disruption to community assets due to flooding	Maximum reduction in probability of disruption, balanced with costs

It is important to note that recent CFMP policies consider a 100 year horizon and SFRA should consider how to implement these, in the short, medium and long term.

### **A.19 Flood Management Systems**

This section reviews the flood defences, flood warning areas and emergency planning procedures currently in place within the SFRA study area.

#### **A.19.1 Existing Flood Defences**

Flood defences are structures which affect flow in times of flooding. They generally fall into one of two categories: 'formal' or 'defacto'. A 'formal' defence is a structure which has been specifically built to control floodwater. It is maintained by its owner (this is not necessarily the Environment Agency) so that it remains in the necessary condition to function.

Currently there are no areas that could be potentially allocated for Flood Risk Management Schemes by the Environment Agency or others. If such areas were identified, they would be considered as spatial constraints to development proposals.

A 'defacto' defence includes road and rail embankments and other linear infrastructure (buildings and boundary walls) which may act as water retaining structures or create enclosures to form flood storage areas in addition to their primary function. Other structures are identified on the Environment Agency database, but these have not necessarily been built to control floodwater and are not maintained for this purpose.

In accordance with the scope of a Level 1 SFRA, a high level review of formal flood defences has been carried out using data from the National Flood and Coastal Defence Database (NFCDD). The NFCDD is a good starting point for identifying significant flood defences and potential areas benefiting from defence, but the quantity and quality of information provided differs considerably between structures.

The NFCDD is intended to give a reasonable indication of the condition of an asset and should not be considered to contain consistently detailed and accurate data (this would be undertaken as part of a Level 2 SFRA where the need arises).

A total of 634 flood defences were identified from the NFCDD database as 'formal' or 'defacto' flood defences. The Standard of Protection (SoP) provided by these defences to reduce the frequency and extent of flooding has been assessed.

Each of the principal settlements in Sevenoaks District has been identified in **Table 5: Flood Defences and SUD potential for principal settlement areas**. The table includes a description of the principal flood defence structures and the generally accepted standard of defence as assessed by the Environment Agency. Should development be planned in these settlements, further investigations should be undertaken to assess in detail the flood defences present and assess the current standard of defence. This should be undertaken through consultation with the Environment Agency with due regard to up to date condition assessments and modelling.

The defences around Edenbridge are considered the most vulnerable in Sevenoaks District and have therefore been investigated in more detail. The defences are raised earth embankments situated alongside the River Eden and are designed to protect houses to southern Edenbridge. This defence is currently included in the Environment Agency model for the River Eden. However, the Environment Agency flood zone extents have been used to demark the Flood Zone extents behind this defence (since flood zones are required to represent the without defences condition).

Discussions with the Environment Agency suggest that this defence system only offers a standard of protection against approximately a 1 in a 50 year flood event (excluding climate change). This defence does not therefore provide the required standard of protection against a 1 in 100 year plus allowance for climate change. Further hydrological investigations and hydraulic modelling are currently being undertaken to improve the flood mapping at this location. The results of this modelling will be incorporated into subsequent SFRA flood maps.

#### A.19.2 *Flood Risk Management Schemes*

Current flood risk management schemes include improved flow conveyance at South Darenth by a private developer and the Environment Agency is due to complete a flood protection scheme at Brasted during mid 2008.



Settlement	SFRA Map Tile	Fluvial Flooding Source	Description of Principal Flood Defences	General Standard of Defence (fluvial flooding)	Lowest Standard of Defence (fluvial flooding)	Average Infiltration Rate	Groundwater Protection Zone	Applicability of SUDS
Sevenoaks (incl. Seal)	C	River Darent & Honeypot Stream	Concrete lined channel (east & west A225). End TQ 5325858366.	minor	5 years	High (bottom of town) and Low (higher parts of town)	Zone 1 (inner) and Zone 2 (outer)	Retention
Swanley (incl. Crockenhill)	B	None	N/A	N/A	N/A	High	Zone 3	Retention or Infiltration
Edenbridge	F	River Eden and Skinner Stream	Flood embankments (west of High Street – right bank; south of Church St; east of High Street; south of Cobbets Way; End TQ 44996046106.	Greater than 30 years (tbc with level 2 modelling)	1 in 50 (tbc with level 2 modelling)	Low	None	Retention
Westerham	D	River Darent	Concrete wall (rear of Mill St). End TQ. 4490554017. Right bank.	minor	5 years	High	None	Infiltration
Riverhead (incl. Chipstead and Dunton Green)	D	River Darent	Flood relief channel (raised banks). Marley Lake. End TQ 4995656344.	Not known	5 years	High	Zone 1 & 2	Retention
New Ash Green	A	None	N/A	N/A	N/A	High to Medium	Zone 1, 2 & 3	Retention or Infiltration
West Kingsdown	A	None	N/A	N/A	N/A	High	Zone 3	Retention or Infiltration



Settlement	SFRA Map Tile	Fluvial Flooding Source	Description of Principal Flood Defences	General Standard of Defence (fluvial flooding)	Lowest Standard of Defence (fluvial flooding)	Average Infiltration Rate	Groundwater Protection Zone	Applicability of SUDS
Otford (incl. Kemsing)	C	River Darent & Honeypot Stream	N/A	N/A	N/A	High	Zone 3	Retention or Infiltration
Hartley	A	None	N/A	N/A	N/A	High	Zone 1 & 2	Retention
Eynsford	B	River Darent	N/A	N/A	N/A	High	Zone 1	Retention
Hextable	B	None	N/A	N/A	N/A	High	Zone 3	Retention or Infiltration
Farningham	B	River Darent	N/A	N/A	N/A	High	Zone 2 & 3	Retention
Leigh	E	None	N/A	N/A	N/A	Low	None	Retention
Brasted	D	River Darent	Recently completed improved flood defences: flood walls and gates. 1 in 100 yr standard.	100 years	5 years	High	Edge zone 2	Retention or possibly infiltration
Shoreham	C	River Darent	N/A	N/A	N/A	High	Zone 2	Retention
South Darent	A	River Darent	Earth embankment (adjacent to Franks Hall). End TQ 5557667798. Right bank.	Minor	2 years	Medium	Zone 1 & 2	Retention
Halstead	D	None	N/A	N/A	N/A	High	Zone 3	Retention or Infiltration

**Table 5: Flood Defences and SUD potential for principal settlement areas (increasing ranking for development opportunity in the district)**

*Note: Assessment of flood defence standard of defence based on anecdotal evidence with no verification from detailed modelling*

### *A.19.3 Flood Warning Systems*

The current flood warning service in the study area is operated by the Environment Agency. The Environment Agency monitors rainfall and river levels 24 hours a day at a number of Flood Warning telemetry stations throughout the study area and uses this information to forecast the probability of flooding. For further details about this service see the Environment Agency website at <http://www.environment-agency.gov.uk/subjects/flood/826674/829803/946278/?lang=e>

Flood warnings are issued using a set of four codes, each indicating the level of risk with respect to flooding. The warnings issued are Flood Watch, Flood Warning, Severe Flood Warning and All Clear. A Flood Warning is issued if property is expected to flood and a Severe Flood Warning if there is extreme danger to life. The 'All Clear' is issued to indicate receding flood waters.

Within the study area there are a total of 4 Flood Warning Areas that cover the reaches:

- River Darent between Westerham and Chipstead;
- River Darent between Chipstead and Dartford;
- The Upper Medway; and
- Rivers Eden and Eden Brook.

The Environment Agency encourages those within Flood Zone 3 to register for the Floodline Warnings Direct Service (FWD). This free service aims to provide people with valuable time to prepare for flooding. The Environment Agency also produces a number of useful publications to help people to be prepared for flooding. For further information refer to [www.environment-agency.gov.uk/floodline](http://www.environment-agency.gov.uk/floodline) or call Floodline on 0845 988 11 88.

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## Guidance on the Application of the Sequential Test

### **A.20 Introduction**

The application of the Sequential Test can be summarised as follows (refer to **Appendix B**):

- to look for sites in areas at least risk from flooding (Zone 1), only making allocations in Zones 2 or 3 if there were no alternatives;
- within Zones 2 and 3, give preference to Zone 2, with Zone 3 only being used as a last resort; and
- for sites in Zones 2 and 3, to apply the Exception test as required, as set out in PPS 25.

The following Sections/Steps provide additional guidance to that from PPS 25 and its Practice Guide, and have been produced in consultation with the Environment Agency. They provide details on how to take account of other sources of flooding (and not just the Flood Zones) during the application of the Sequential Test, and as part of a Sustainability Appraisal.

### **A.21 First Step – Strategic Overview of Flood Risk for all Potential Areas**

The recommended initial step is to determine broad extents of potential land allocations in large scale maps showing the most up-to-date flood zones, in accordance with PPS 25 (areas to be drawn in the SFRA Flood Maps - **Tiles A to H**). Summary tables of flood risk issues are then prepared for each location, indicating if the potential areas overlap Zones 2, 3, localised flooding areas or if there are records of previous flood incidents shown in the maps. It is then recommended that the summary tables and proposed locations are sent to the Environment Agency to obtain further details about Environment Agency flood incident records within those areas. Particular care should be taken by identifying allocations that could increase flood risk elsewhere (flood incident points, localised flooding areas, flood zones) and lack of dry access.

### **A.22 Second Step – Analysis of Flood Risk Issues**

The next step is to analyse all potential sites within Zone 1, by identifying those that have any flood risk issues (for example those affected by other sources of flooding or those that do not have dry access routes during flood events). This step is carried out as part of the Sequential Test for Zone 1 (ideally the land uses most vulnerable to flood risk should be located in Zone 1).

For the sites with flood risk issues, an assessment of likely significance of flood risk is then carried out in terms of likely probability of flooding and potential consequences/flood damages (advice from a drainage specialist may be required, such as the SFRA consultant, the Environment Agency, a highways drainage engineer and/or the planning authority drainage specialist). The purpose is to identify sites with significant flood risk - high probability of flooding and significant flood damages with deep flooding and high velocities which could result in loss of property and potentially loss of life.

If a site with significant non-fluvial flood risk is identified within Zone 1 (or within a 100m radius), this would be considered as if it was in the High Probability Zone 3a for the purpose of the detailed Flood Risk Assessment, therefore requiring a need to satisfy the Sequential Test (see **Section 7.4**). It should be noted that if a more vulnerable land use is required for the site, it will have to pass the Exception Test (see Flood Risk Vulnerability and Flood Zone Compatibility tables in the tiles).

**A.23 Third Step – Apply the Measures of Avoidance/Protection**

It is recommended that the following actions take place prior to the application of the Sequential Test in Zones 2 and 3:

- a) Apply the measure of avoidance/prevention (see **Appendix B**) by moving the boundaries of the potential sites away from Zones 2, 3a and 3b, for those cases where the loss of site area is acceptable. This is generally the case at locations where the loss in area is of the order of 10%.
- b) Within Zones 2 and 3, provisionally adopt land uses that are fully compatible with the vulnerability classification of PPS 25, to try to avoid the need to apply the Exception Test where possible.

**A.24 Fourth Step – Apply the Sequential Test in Zone 2**

The fourth step is to take account of localised flooding areas as indicated for Zone 1 (see **Section 7.3**) and as part of the Sequential Test in Zone 2.

**A.25 Fifth Step – Apply the Sequential Test in Zone 3**

The fifth step is to apply the Sequential Test in Zone 3, and where required the Exception Test in accordance with PPS 25. This applies to all potential sites that fall within Zone 3 as well as those that encroach or are located within a 100m radius from a high risk 'localised flooding area' in Zones 1 and 2.

## Guidance for the preparation of Flood Risk Assessments

### A.26 *Introduction*

A SFRA is a strategic document that provides an overview of flood risk throughout a study area. Flood Risk Assessments (FRAs) will be required for most proposed developments and the level of detail will depend on the existing level of flood risk in the site (see general FRA requirements for each flood zone in Table D.1, PPS 25 and further guidance in the Practice Guide Companion to PPS 25).

For those sites within localised flooding areas or with flood incident records where flood risk issues are not significant (for example shallow flooding and non-frequent blockages, etc), development may still be acceptable provided that appropriate measures are implemented for mitigating the risk. Options range from using on site water balancing and other SUDS solutions, and may include contributions from the developer for the upgrade of the surface water system, if feasible.

It is imperative that site-based FRAs should be discussed early in the planning process and submitted as an integral part of the planning application. It is now a government directive that planning applications seeking approval for development within flood affected areas can be regarded as invalid if not supported by a FRA. This section reflects best practice on what should be addressed within a FRA.

### A.27 *Proposed Developments within Zones 3a and 2*

All FRAs supporting proposed development within High Probability Zone 3a and 2 (as the existing Flood Zone 2 could become a high risk zone in the future due to the effects of climate change) should include an assessment of the following:

- The vulnerability of the development to flooding from other sources (for example surface water drainage, groundwater, etc) as well as from river flooding. This will involve discussion with the planning authority and the Environment Agency to confirm whether a localised risk of flooding exists at the proposed site.
- The vulnerability of the development to flooding over the lifetime of the development (including the potential impacts of climate change), for example maximum water levels, flow paths and flood extents within the property and surrounding area. The Environment Agency may have carried out detailed flood risk mapping within localised areas that could be used to underpin this

assessment. Where available, this will be provided at a cost to the developer. Where detailed modelling is not available, hydraulic modelling by suitably qualified specialists may be required to determine the risk of flooding to the site.

- The potential of the development to increase flood risk elsewhere through the addition of hard surfaces, the effect of the new development on surface water runoff, and the effect of the new development on depth and speed of flooding to adjacent and surrounding property. This will require a detailed assessment, to be carried out by suitably qualified specialists. The use of sustainable drainage systems (SUDS) techniques can help mitigate the risks posed by the new development.
- A demonstration that residual risks of flooding (after existing and proposed flood management and mitigation measures are taken into account) are acceptable. Measures may include flood defences, flood resistant and resilient design, escape/evacuation, effective flood warning and emergency planning.
- Details of existing site levels, proposed site levels and proposed ground floor levels are an essential requirement for any FRA. All levels should be stated relevant to Ordnance Datum.

It is highlighted that all forms of flooding need to be considered as localised flooding may also occur, typically associated with local catchment runoff following intense rainfall. A localised risk of flooding must be considered as an integral part of the detailed Flood Risk Assessment.

It is essential that developers thoroughly review the existing and future structural integrity of formal and informal defences, if present, upon which the development will rely (over the lifetime of the development), and ensure that emergency planning measures are in place to minimise risk to life in the event of overtopping or defence failure.

#### **A.28 Proposed Development within Zone 1**

For all sites within low probability Zone 1, unless the planning authority and the Environment Agency suggest otherwise, a high level FRA should be prepared based upon readily available existing flooding information (sourced from the Environment Agency, the local planning authority and information contained in this SFRA). PPS 25 recommends that an FRA is carried out in Zone 1 for development areas of 1 hectare or more.



The following issues should be considered: a) the vulnerability to flooding from other sources (as well as from river flooding) and b) the potential to increase flood risk elsewhere through the addition of hard surfaces. It is recommended that sustainable urban drainage techniques are employed to ensure no worsening to existing flooding problems elsewhere within the area.

The SFRA provides specific recommendations with respect to the provision of sustainable flood risk mitigation opportunities that will address both the risk to life and the residual risk of flooding to development within particular 'zones' of the area. These recommendations should form the basis for the site-based FRA (see **Section 8.4** and **Chapter 9**).

#### **A.29 Raised Floor Levels, Basements and Dry Access (Freeboard)**

The raising of floor levels above the 1% probability peak flood level will ensure that the damage to property is minimised. Given the anticipated increase in flood levels due to climate change, the adopted floor level should be raised above the 1% probability flood level assuming a 20% increase in flow over the next 20 to 100 years (see PPS 25 climate change Tables in **Section 4.4.3**).

It is highlighted that many of those areas currently situated within Medium Probability Zone 2 could become part of the High Probability Zone 3. This is important as it means that some properties that are today at relatively low risk are likely to be, in 20 to 100 years, within High Probability Zone 3a (see precautionary assumption in **Section 4.4.3**). It is imperative therefore that planning and development control decisions take due consideration of the potential risk of flooding in future years.

Wherever possible, floor levels should be situated a minimum of 300 mm above the 1% annual probability peak flood level plus climate change flood level, determined as an outcome of the site-based FRA, or 600 mm above the 1% annual probability peak flood level if no climate change data is available. The height that the floor level is raised above flood level is referred to as the 'freeboard', and is determined as a measure of the residual risks.

Habitable uses of basements within Flood Zone 3 areas will not be permitted and other uses of basements in these areas is discouraged.

Dry access and egress is recommended above the 1% probability flood level plus climate change. It will facilitate, for example, easy access to emergency services, etc.

## Guidance for the Application of Sustainable Drainage Systems (SUDS)

### A.30 Introduction

PPS 1: Delivering Sustainable Development, PPS1 Supplement and PPS 25 require that Local Planning Authorities (LPAs) should promote Sustainable Drainage Systems (SUDS). LPAs should ensure policies encourage sustainable drainage practices in their Local Development Documents. SUDS is a term used to describe the various approaches that can be used to manage surface water drainage in a way that mimics the natural environment.

The management of rainfall (surface water) is considered an essential element for reducing future flood risk to both the site and its surroundings. Indeed reducing the rate of discharge from urban sites to greenfield (undeveloped) runoff rates is one of the most effective ways of reducing and managing flood risk.

### A.31 Types of SUDS

SUDS may improve the sustainable management of water for a site by:

- reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream;
- reducing volumes of water flowing directly to watercourses or sewers from developed sites;
- improving water quality, compared with conventional surface water sewers, by removing pollutants from diffuse pollutant sources;
- reducing potable water demand through rainwater harvesting;
- improving amenity through the provision of public open space and wildlife habitat; and
- replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

Any reduction in the amount of run-off water that originates from a given site is likely to be relatively small. However, if applied across a catchment, the cumulative effect from a number of sites could be significant and therefore any proposed development should seek to minimise or attenuate the run-off from site through the use of SUDS

For guidance on SUDS, the following documents and websites are recommended:

- PPS 25.
- Practice Guide Companion to PPS 25.
- Interim Code of Practice for Sustainable Drainage Systems, National SUDS Working Group, 2004.
- Best practice guidance for Sustainable Drainage Systems from the Thames Region, providing a clear hierarchy for SUDS requirements at the planning application stage (available from the Environment Agency development control teams).
- Preliminary management of rainfall runoff - September 2005.  
DEFRA/Environment Agency Interim document - R&D Technical Report W5-074/A/TR/1 Revision C.
- [www.ciria.org.uk/suds/](http://www.ciria.org.uk/suds/)

### **A.32 SUDS at the Planning Stage**

A Flood Risk Assessment (FRA) is required that demonstrates an achievable layout and details the methodology for the construction of SUDS within the boundary of the development site. The FRA must comply with PPS 25 requirements and for the Sevenoaks District should also accord with Defra/Environment Agency publication "Preliminary Rainfall Runoff for Developments Revision D".

### **A.33 Application of Sustainable Drainage Systems for Proposed Allocation Sites**

There are numerous different ways that SUDS can be incorporated into a development. The appropriate application of a SUDS scheme to a specific development is heavily dependent upon the topography and geology of the site and the surrounding areas. Careful consideration of the site characteristics is necessary to ensure the future sustainability of the adopted drainage system. For each site it will be necessary to determine whether priority is given to discharging surface water to watercourses or to use of infiltration drainage techniques. In certain locations within Sevenoaks District infiltration techniques are not viable (due to a high water table and local impermeable soils). The key loss of benefit from not utilising infiltration is that these SUDS systems attenuate peak flows but do not significantly reduce flood volumes. Discharging attenuated site runoff directly to watercourses is preferable to the use of sewers.

Large increases in impermeable areas contribute to significant increases in surface runoff volumes and peak flows and could increase flood risk elsewhere unless adequate SUDS techniques are implemented. It is relatively simple to avoid the increase in peak flows by providing attenuation or detention storage that temporarily store the required amounts of runoff within the site boundary. SUDS elements are not able to prevent increases in surface runoff volumes where infiltration is not practicable.

SUDS techniques will be required for all proposed land allocations unless suitable facilities can be provided at a suitable adjacent downstream location. The techniques employed will depend on the individual circumstances. Developers should consult with the Environment Agency at an early stage about their SUDS proposals, to ensure that they are adopting the most effective methods for their site.

There are a number of SUDS elements that could be used within development sites in the Sevenoaks District. The Environment Agency would expect that the initial assumption of any drainage designer would be to include infiltration methods where possible. Thus infiltration should be used unless ground investigation, and in particular infiltration tests, determine that it is not practicable. It should also be noted that the Building Regulation Part H state that preferred option for the disposal of property runoff should be via a soakaway.

Specific SUDS for the Sevenoaks area could comprise of:

**Swales** can be constructed alongside roads and within green areas to transfer runoff to storage facilities. They can also be used themselves for limited storage. The preferred type would be an infiltration swale that will keep them dry between rainfall events and prevent them becoming marshy. It will also allow as much infiltration as the surrounding ground can accommodate.

**Pond / dry basin** to provide the majority of the volume required to attenuate the surface water runoff. This storage facility will be online or offline for the sewers. It is proposed that the ponds are to be offline to meet adoption criteria

**Permeable or porous paving** may be used within development areas, subject to consideration of the adoption issues with the highway department, to attenuate runoff at source as it will collect the rainfall below the surface and discharge it after a significant delay.

**Linear filter drains or infiltration devices** may be used within development areas, subject to ground water conditions, to assist drainage, to store and conduct water and to promote the infiltration of surface water to ground. They can be trenches, basins or soakaways.

It is recommended that priority is given to the use of infiltration drainage techniques as opposed to discharging surface water to watercourses. Where infiltration techniques are not viable (due to a high water table, local impermeable soils, source protection zones etc), discharging attenuated site runoff to watercourses is preferable to the use of sewers. An indication of soil hydrological properties in Sevenoaks is illustrated in **Figure 2: Distribution of Soil Permeability**, which is based on the estimate of the Standard Percentage Runoff from the Flood Estimation Handbook. Apart from the soil area highlighted in light blue and green (which have SPR values of 47.2 and 49.6% respectively) the other soils areas are in principle sufficiently permeable to allow the infiltration of surface runoff. The applicability of infiltration SUDS or retention SUDS (attenuation with later discharge to watercourses) has been identified for all of the principal potential development areas in the District. Refer to **Table 5: Flood Defences and SUDS potential for principal settlement areas**.

#### **A.34 Constraints on Discharges to Ground**

The nature of an aquifer body and the groundwater within it provide significant constraints when considering the potential of SUDS that rely on infiltration to the ground to provide the means of (storm water) drainage, storage and flow attenuation. Constraints on discharges include:

- Groundwater will be a receptor of man-made drainage – whether this be deliberately (e.g. through soakaways, infiltration drainage) or incidentally (e.g. through mains water pipe or sewer leakage).
- In an urban/ semi urban environment groundwater is under considerable pressure with respect to quality, for example from contaminants on brownfield sites; from uncontrolled drainage; leachates from uncontrolled landfill; leakage from sewers, agro chemicals in field drainage; drainage from roads and other hard surfaces; and seepage from poor quality surface water bodies (channels, ditches, streams, rivers).

- Even though locally groundwater may not have value as a major drinking water resource, it may have value in supporting local water and have a role in determining the water quality of these water bodies and any dependant ecosystems.
- UK groundwater policy has just been revised and the EA have recently released their first report on the state of groundwater in England and Wales. These documents stress the need to protect groundwater.

An assessment of the proximity of each of the main settlements in the District to Environment Agency defined groundwater Source Protection Zones (SPZs) has been undertaken. The results are listed in **Table 5: Flood Defences and SUDS potential for principal settlement areas**. Infiltration based SUDS should be avoided if there is potential to contaminate Zone 1 or Zone 2 areas. Zone 1 is defined as the Inner Protection Zone and places strict controls on potential discharges by defining the area where pollution could reach a borehole extraction point within 50 days. Zone 2 is considered the Outer Protection Zone and covers pollution that would likely take 400 days to travel to the borehole. Zone 3 is the Total Catchment and relates to the total area needed to support removal of water from the borehole.

A daughter directive of the European Water Framework Directive (Directive 2000/60/EC) which will replace current groundwater specific legislation provides for more stringent protection of groundwater.



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## Conclusions and Recommendations

### **A.35 Conclusions**

The risk of flooding within the study area largely arises from river and surface water flooding, with a limited amount of sewer and groundwater flooding.

Limited urban areas of Edenbridge are currently at risk of flooding from a 1 in a 50 year flood event. Development areas have not currently been identified by Sevenoaks District Council, but once identified the sequential test should be applied to direct any development away from higher flood risk areas. Where this is not possible the exception test must be passed.

### **A.36 Recommendations**

#### **A.36.1 Site Allocation Process**

It is recommended the outputs from this study are used as an evidence base from which to direct new development where possible to areas of low flood risk (Flood Zone 1). Where development cannot be located in Flood Zone 1, the flood maps should be used to apply the Sequential Test to the remaining land use allocations.

Where the need to apply the Exception Test is identified, due to there being an insufficient number of suitable sites for development within zones of lower flood risk, the scope of the SFRA will need to be widened to a Level 2 assessment. The need for a Level 2 SFRA cannot be fully determined until the Sequential Test has been applied. It is recommended that as soon the need for the Exception Test is established, Level 2 SFRA(s) are undertaken by a suitably qualified engineer so as to provide timely input to the overall LDF process.

#### **A.36.2 Council Policy**

Council policy is essential to ensure that the recommended development control is imposed consistently and ultimately leads to sustainability with respect to flood risk management. It is recommended that the current Council policy is reviewed in light of PPS 25 and this SFRA to ensure a consistent policy is being promoted with regard to flood risk, and the following key considerations are adhered to:

- Seeking to protect the functional floodplain from development.
- Directing vulnerable development away from flood affected areas

- Ensuring all new development is 'Safe', meaning that dry pedestrian egress through the floodplain and emergency vehicular access is possible.
- Promoting the application of sustainable drainage techniques for all new development.
- Supporting flood alleviation measures under consideration by the Environment Agency by safeguarding possible sites for flood storage and other channel works.

Seeking developer contributions via Section 106 planning obligations to fund (or part fund) strategic flood risk management facilities and bring benefit to the wider community

#### *A.36.3 Emergency Planning*

It is recommended that Sevenoaks District Council continues to review its emergency planning procedures taking account of the findings of the SFRA to ensure that safe evacuation and access for emergency services is possible during times of flood, both for existing developments and those being promoted as possible sites within the LDF process. It is further recommended that Sevenoaks District Council work with the Environment Agency to promote the awareness of flood risk and encourage communities at risk to sign-up to the Environment Agency flood warning service.

#### *A.36.4 Future Updates to the SFRA*

The SFRA should be retained as a 'living' document and reviewed on a regular basis in light of better flood risk information and emerging policy guidance. It is recommended that outputs from the future studies are used to update future versions of the SFRA report and associated maps once these studies have been approved by the Environment Agency. The following study should be incorporated once approved:

- Edenbridge Flood Study (Environment Agency/Sevenoaks District Council) – will provide refined PPS 25 Flood Zones for the River Eden.

## References

Defra 2004. Strategy for Flood and Coastal Erosion Risk Management: Groundwater Flooding Scoping Study (LDS 23) Final Report

Defra. Making Space for Water. Groundwater flooding records collation, monitoring and risk assessment (reference HA5). Main Summary Report

Development and Flood Risk, a Practice Guide Companion to PPS 25 (2007)

Environment Agency 2006. Groundwater Protection: policy and practice. Underground, under threat: The state of groundwater in England and Wales.

National SUDS Working Group, 2004. Interim Code of Practice for Sustainable Drainage Systems

Planning Policy Statement: Planning and Climate Change (supplement to PPS 1)

Planning Policy Statement 25: Development and Flood Risk (2006)

SUDS – Design manual for England & Wales (CIRIA C522)

SUDS – Best practice manual (CIRIA C523)

SUDS – hydraulic, structural and water quality advice (CIRIA C609)

The Groundwater Regulations 1998. Statutory Instrument 1998. No 2746  
Environmental Protection

The SUDS Manual, (CIRIA C697)

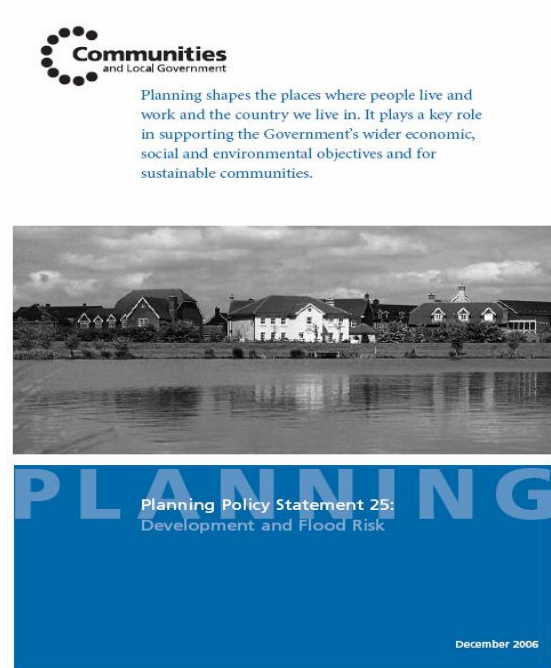
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## A. Detailed Assessment of Planning Context

### a. National Planning Policy

The Government has updated its planning advice contained within Planning Policy Guidance Notes (PPGs) with the publication of new style Planning Policy Statements (PPSs). As they are policy documents PPSs carry more weight than their predecessors.

PPS 3: Housing (December 2005) specifically mentions the need to have regard to SFRAs when local authorities are producing development plan documents relating to housing.



In December 2006 the Government published PPS 25: Development and Flood Risk (a restatement of PPG 25). Refer to Appendix B for details of this policy. It reflected the general direction set out in 'Making Space for Water' (Defra, 2004), the evolving new strategy to shape flood and coastal erosion risk over the next 10-20 years (see Glossary of Terms).

PPS 25 advises that regional planning bodies preparing Regional Spatial Strategies (RSSs) should include a broad consideration of flood risk from all sources, and set out a strategy for managing it in accordance with policies and plans prepared under the Water Framework Directive. Local planning authorities should prepare local development documents in their Local Development Frameworks (LDFs) that set out policies for the allocation of sites and the control of development which avoid flood risk to people and property where possible, and manage it elsewhere. The guidance also advises that flood risk should be considered alongside other spatial planning issues such as transport, housing, economic growth, natural resources etc and that the findings of the SFRA should inform the sustainability appraisal of the LDF.



A supplement to PPS1 dealing principally with climate change and the objective of reducing CO2 emissions was published in December 2007. In relation to flood risk, it requires developers to recognise flood storage areas, and give priority to the use of SUDS. "In deciding which areas and sites are suitable, and for what type and intensity of development, planning authorities take into account: known physical and environmental constraints on the development of land such as sea level rises, flood risk and stability, and take a precautionary approach to increases in risk that could arise as a result of likely changes to the climate".

### **b. Regional Planning Policy**

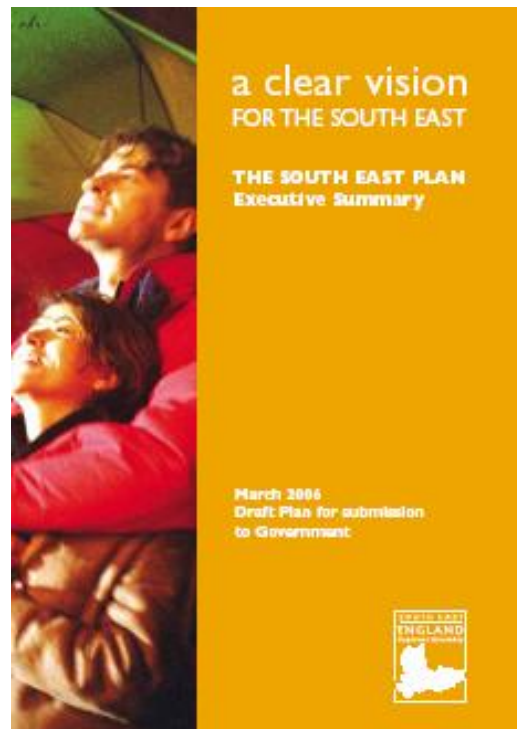
#### *i. Regional Planning Guidance for the South East (RPG9)*

Regional planning policies provide the overarching framework for the preparation of a LDF. Regional Planning Guidance for the South East (RPG9) covers the period up to 2016 and sets out the housing requirement for each county within the region.

#### *ii. The South East Plan*

Under the Planning and Compulsory Purchase Act 2004, RPG9 is to be replaced by a new Regional Spatial Strategy, entitled the South East Plan. The South East Plan has been prepared by the South East England Regional Assembly (SEERA) and was submitted to the Government in March 2006. It sets out the vision for the region through to 2026.

The South East Plan Examination in Public sets out a housing requirement for the Sevenoaks district which requires some 3,300 dwellings to be built between 2006 and 2026. In addition the RSS sets out policy guidance covering a range of matters to be reflected in LDFs. It is a requirement that development plan documents prepared under the LDF including the Core Strategy are in general conformity with regional planning policy.





The South East Plan also includes policies on sustainable natural resource management, which highlights important issues for the South East region being water resources, river water and ground water quality management, flood risk management etc. Specifically Policy NRM3 covers Sustainable Flood Risk Management, indicating that the sequential approach to development in flood risk areas will be followed. In addition, the policy states that local authorities and developers, with advice from the Environment Agency, should undertake a Strategic Flood Risk Assessment. This should have regard to climate change.

**c. Local Planning Policy**

*i. Sevenoaks District Local Plan*

The Local Plan adopted in March 2000 recognises the importance of achieving sustainable development and the role played by natural resources such as water. Chapter 5 of the local plan “Natural Resources” provides details of how the Council sees development proposals contributing towards the aim of achieving sustainable development within the District and the following highlights those parts of the plan that relate to the role of water resources and minimising flood risk :-

Para 5.9 - “The Local Planning Authority will not wish to see any development take place at a level where the properties would be liable to flooding. It will be essential to take land drainage considerations fully into account, where directly or indirectly, they involve land that may be liable to flooding”

Policy NR2 stresses the need to appraise the flood risk for new development sites with the Environment Agency. The policy states that *“In the consideration of development proposals, the Local Planning Authority will take into account the recommendations of the Environment Agency on all aspects of land drainage including pollution control. Development within river flood plains which would increase the risk of flooding on a site of elsewhere, will not be permitted unless the flood risk is alleviated.”* Although this policy shows an ongoing commitment by Sevenoaks District Council in safeguarding development on the floodplain, this particular policy has not been saved and carried beyond September 2007 due to being superseded by PPS 25.

*ii. Local Development Framework and Sustainability Appraisal*

With the introduction of LDFs in 2004, Sevenoaks District Council identified the need for three Development Plan Documents (DPD) to be produced:

- The Core Strategy
- Balanced Communities
- Development Control Policies



The detailed timeframes for the preparation of these is set out in the Council's Local Development Scheme which can be viewed at the following location:  
[http://www.sevenoaks.gov.uk/environment/planning/plans\\_policies/default.asp](http://www.sevenoaks.gov.uk/environment/planning/plans_policies/default.asp)

The first DPD to be prepared is the Core Strategy, which will not only set out the spatial development strategy for the district, but will also indicate the broad distribution of future development. The role of this SFRA is to inform the decision making process to determine the best and most sustainable options for the spatial development strategy. Further more detailed work may be required to determine more precise locations appropriate for development pending the undertaking of the Sequential Test.

The practice guide companion to PPS 25 advises that "The Core Strategy LDD should include clear, strategic and robust policies for the management of flood risk within the local authority area taking climate change into account."

As previously recognised flood risk is one of many factors to influence the spatial planning process it is however necessary to maintain a balance between flood risk considerations and other sustainable development drivers. This is undertaken through the Sustainability Appraisal process.

The purpose of Sustainability Appraisal is to promote sustainable development through the integration of social, economic and environmental considerations. It is now a requirement of the Planning and Compulsory Purchase Act 2004 for LDFs to undergo sustainability appraisal incorporating the requirements of the Strategic Environmental Assessment (SEA) Directive.

In relation to water, an integrated approach to the management of water is a key aim of the EU Water Framework Directive (Water Framework (England and Wales) Regulations 2003), which aims to integrate sustainable water planning and management. The Water Framework Directive applies to all surface and ground water bodies with significant effects for spatial and development management planning. A new system of river basin management plans (RBMP) will be statutory plans that set out the actions required to meet the Water Framework Directive with the overall aim of achieving good water status. RBMPs are strategic plans, and will be subject to Strategic Environmental Assessment and Appropriate Assessment under the Habitats Directive. All these processes are based on multi-criteria analysis to enable correlation between the objectives. RBMPs will need to



take into account existing studies and reports such as this Level 1 SFRA and the CFMPs being prepared.

The original Sustainability Appraisal (SA) Scoping Report for Sevenoaks District's LDF was completed by Scott Wilson and Levett-Therivel in June 2005. This has recently been updated to take account of new national and regional planning guidance documents and the emerging LDF evidence base. With regard to flood risk, the Report acknowledges that, whilst the Environment Agency's efforts have led to more houses being protected to a better standard, the Agency is still faced with a considerable number of planning applications every year in flood risk areas and around 60,000 properties in Kent remain at risk from flooding.

The Scoping Report identifies two Sustainability Appraisal objectives that relate to flood risk:

- SA Objective no. 2 - To reduce and manage the risk of flooding and any resulting detriment to public well being, the economy and the environment.

This Objective focuses on reducing the risk of homes and other buildings from flooding and ensuring that the impacts of flooding are minimised. This could be promoted through, for example, siting new housing away from flood risk areas and ensuring that new developments incorporate sustainable drainage systems.

- SA Objective no. 11 - To promote sustainable forms of development and sustainable use of natural resources.

This Objective focuses on ensuring that development is carefully planned to minimise adverse economic, social and environmental effects and that the District's use of natural resources is reduced. This could be promoted through, for example, ensuring that new development is situated away from flood risk areas.

Furthermore it is important to recognise the value of water and water features in their wider context of providing opportunities for recreational use and connections with the green infrastructure network, in addition to their biodiversity value. The Kent Biodiversity Action Plan (1997, with latest implementation plan 2001) identifies a number of actions in relation to water, primarily to protect and enhance habitats.



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## B. PPS 25 and its Practice Guide Companion

### *a. Outcomes of the Strategic Flood Risk Assessment Process*

The broad planning objectives of PPS 25 described in *Appendix A*, effectively set the scope for the specific outcomes of the SFRA process. The SFRA, in turn, then informs forward planning and development control decisions that ensure the objectives set out above can be achieved.

It is important to reiterate that PPS 25 is not applied in isolation but as part of the planning process. The formulation of flood risk policy and the allocation of land for future development must also meet the requirements of other planning policy. Clearly, a careful balance must be sought in these instances, and the SFRA aims to assist in this process through the provision of a clear and robust evidence base upon which informed decisions can be made.

### *b. The Sequential Test*

In seeking to allocate a specific type of development or land use, planning authorities should apply the Sequential Test to demonstrate that there are no reasonably available, appropriate sites in areas with less risk of flooding.

Preference should be given to locating new development in Flood Zone 1 (see *Appendix C*) because this zone has the lowest risk of flooding. If there is no reasonably available site in Flood Zone 1, the flood vulnerability (or level of resilience to damages from flooding) of the proposed development can be taken into account in locating development in Flood Zone 2 and then, if no appropriate sites are available, Flood Zone 3. Within each Flood Zone new development should be directed to sites with lower flood risk (towards the adjacent zone of lower probability of flooding) from all sources as indicated by the SFRA.

### *c. The Exception Test*

If, following application of the Sequential Test, it is not possible for the development to be located in zones of lower probability of flooding consistent with wider sustainability objectives, the Exception Test can be applied. This Test provides a method of managing flood risk while still allowing necessary development to occur.



The Exception Test is only appropriate for use when there are large areas in Flood Zones 2 and 3, where the Sequential Test alone cannot deliver acceptable sites, but where some continuing development is necessary for wider sustainable development reasons.

It is possible that, even when applying the sequential and exception tests, a local planning authority cannot reasonably allocate in its Local Development Documents all the requirements for new development imposed by the Regional Spatial Strategy. However, such a conclusion should be based on firm evidence and be supported by the Environment Agency.

***d. The Practice Guide Companion***

The practice guide companion to PPS 25, published in February 2007, is as a 'living draft' web-based consultation paper. It is comprehensive and incorporates many recommendations from previous Guidance documents. Refer to:

<http://www.communities.gov.uk/planningandbuilding/planning/planningpolicyguidance/planningpolicystatements/>.

The guide reaffirms the adoption of a risk-based approach to flooding by following stepped hierarchical measures at all stages in the planning process.

Avoidance/prevention is always the first measure, followed by substitution, control and finally mitigation. The Sequential Test of PPS 25 is the most important flood risk management tool for spatial planning, as it implements the high level measures of avoidance/prevention and substitution.

***e. Levels 1 and 2***

A Level 1 SFRA is defined in the Practice Guide Companion to PPS 25, as a desk based study using existing information to allow application of the Sequential Test. The principal tasks undertaken during a Level 1 SFRA are to understand the planning context of developments, collating data relating to flood risk management and historical flood events and outlining key controls and mitigations for development in the study area. This is a Level 1 SFRA assessment.

Where the need to apply the Exception Test is identified, due to there being an insufficient number of suitably available sites for development within zones of lower flood risk, the scope of the SFRA may need to be widened to a more detailed Level 2 assessment.



A Level 2 SFRA often includes 2D modelling and breach/overtopping analysis for certain locations. Most of the watercourses within Sevenoaks District are unprotected, with the River Eden in Edenbridge being the main exception. The defences at this location are currently below the 1 in 100 year return period flood standard. As a result, a Level 2 SFRA may be required if infill development is proposed behind this defence or downstream. However, this cannot be fully determined until the Sequential Test has been undertaken on all possible site allocations.

A Level 2 is also likely to be of value in informing the LPA in dealing with windfall planning applications, that is, those on land not allocated in the development plan. This information, however, will not necessarily negate the need for a site specific flood risk assessment, the responsibility for which would fall upon the potential developer.



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## C. Environment Agency Flood Zones

### *a. Introduction*

A more detailed understanding of the Environment Agency Flood Zones and their limitations is important, as these are often used (unless more accurate flood outlines are available) for the production of SFRA flood maps and form the basis for appraising flood risk at a development site level.

### *b. Environment Agency Flood Zones*

#### *i. Probability of Flooding*

The Environment Agency flood maps replicate zones of low, medium and high flood risk and the functional flood plain. The range of probabilities covered by each of these flood zones is defined in PPS 25, in terms of annual average probability of flooding from rivers and the sea. These definitions are included in the SFRA mapping Tiles A to H of this report. The term 'average' means that, for example, a flood that has a 100% (or 1 in 1) probability of occurrence, will over a number of years have occurred once a year on average, although in any given year it may have occurred more than once or not flooded at all.

There are many methods that estimate the probability of occurrence of a flood, based on historical events, measurements of flows, modelling studies, etc. In the case of the functional floodplain, it may be possible for this to be drawn on a map by combining the flood extents of many frequent historical flood events (up to the 5% probability event). For more extreme flood events (lower probability events), it will be increasingly necessary to rely on modelling to determine the extents as there will typically not be many sufficiently accurate records available.

Historically the Environment Agency and its predecessors have kept formal maps of tidal and fluvial flooding to the standards required by legislation. Originally this mapping simply recorded flood events, but in 2001, PPG 25 (the predecessor of PPS 25) imposed a duty on the Environment Agency to produce flood zone maps which showed the predicted extent of tidal and fluvial flooding for the high, medium and low flood zones. The Environment Agency flood zones are published on their website at the following location: <http://www.environment-agency.gov.uk/maps/info/floodmaps>, and are updated on a quarterly basis as improved modelling and recent events provide data for refining flood extents.



ii. *Environment Agency Fluvial Maps*

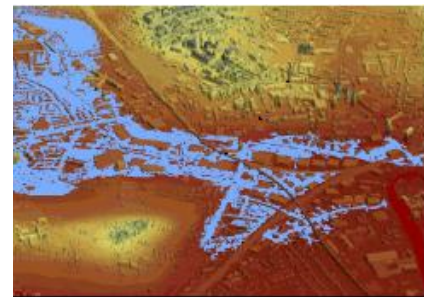
Data for fluvial Flood Zones 3 and 2 is derived from a number of sources (the functional floodplain was not previously defined). Some observations of flooding by the Environment Agency's predecessors are included, for instance the extent of the severe 1947 floods. Most fluvial flood outlines are derived from the "JFlow" generalised computer modelling, which is a 'coarse' modelling approach (Ref. 31 and 32).

Caution must be exercised in interpreting JFlow derived flood outlines due to the large number of assumptions incorporated into the JFlow model. For instance, at some locations the river centreline incorporated into the model was found to be erroneous with the result that the associated flood plains deviate from the natural valleys.

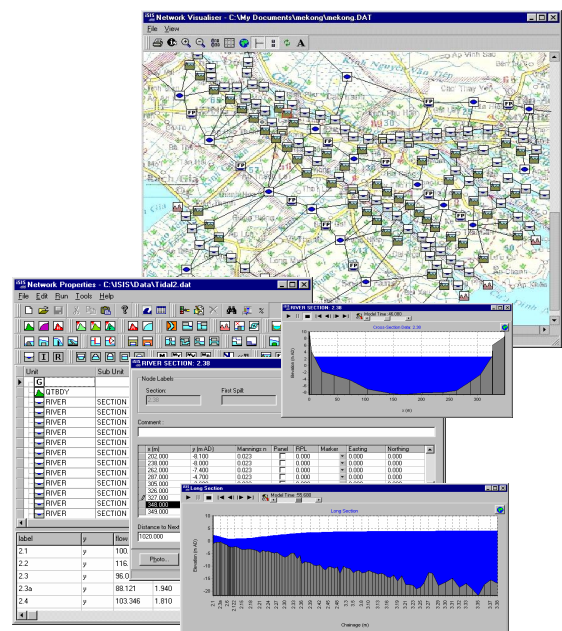
iii. *Updates of the Environment Agency Flood Maps from Modelling*

In many places the results of flood mapping studies have superseded the JFlow model. Generally these studies included high quality hydrological research, surveyed river cross sections, and more precise digital modelling such as ISIS, TuFlow and HecRas.

Although fluvial flooding is dependent on the standard of maintenance of watercourses and structures, the degree of maintenance allowed for tends to vary from model to model, with the result that flood maps based on modelling do not offer a consistent approach in this respect. As a consequence, serious blockages occurring during a flood might produce much more flooding than shown on previous modelling for a similar hydrological event.



Output from a 2D TuFlow model



ISIS Software Graphic Interface



*iv. Updates of the Environment Agency Flood Maps from Recent Events*

Records of recent flood events have been used to modify the flood map. In these cases the Environment Agency has determined the return frequency of the observed event and modified the appropriate flood zone accordingly.

When evidence of flooding is based on aerial photographs, there is often uncertainty about a) whether the flooding has emanated from the river or is the result of other land drainage, b) the precise flood return period and c) whether the flooding was the result of blockage or some other maintenance factor. Occasionally therefore, flood zone modifications based on observed flooding are unreliable.

*v. Other Forms of Flooding in the Environment Agency Flood Maps*

Although PPG 25 and PPS 25 advise that the flood zone maps, which are primarily intended as a planning tool rather than a definitive record, should only show tidal and fluvial flooding, in practice many show other sources of flooding. In Hampshire for instance, much flooding derived from groundwater sources is included, both in dry valleys and isolated ponds. These groundwater flooding outlines are derived from both JFlow and observations.

*vi. Non Main River flooding in the Environment Agency Flood Maps*

Inland Flood Zone maps show some non main river watercourse flooding as well as main river watercourse flooding. "Main rivers" are principal watercourses defined by Section 93 of the Water Resources Act, 1991 and shown on a formal map held by the Environment Agency – the Environment Agency flood zones. Larger ordinary watercourses are shown on the background Ordnance Survey mapping.

There is no precise definition of how much non main river watercourse related flooding is included. If no flood plain is shown for a catchment that is less than 3 square kilometres in area, it should be presumed that the area has not been modelled and/or it has not been recorded (as opposed to assuming that flooding has not occurred or would not occur).



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## D. Environment Agency Flood Zones

Ref. No	Subject & Type of data	Source	Date	Author	Summary Description	Used for
SSFRA/001	1 in 10,000 and 1 in 25,000 OS maps and layers for Sevenoaks District Council	Environment Agency (CD)	Aug 2007	Environment Agency	GIS files showing geographical features related to Sevenoaks.	Production of figures in reports and planning tool
SSFRA/002	Flood Zones, Flood Warning Areas, DTMs, hydraulic model data, main river layer	Environment Agency (removal hard drive)	Aug 2007	Environment Agency	DTMs based on SAR and LiDAR data, geo-referenced results and flood extents from detailed and broad based models.	Production of figures in reports and planning tool
SSFRA/003	Historic flooding GIS files	Environment Agency (CD)	Sept 2007	Environment Agency	GIS files containing flood events database, historical flood maps	Production of figures in reports and planning tool
SSFRA/004	Southern Water Flood History data with X, Y and Postcode (spreadsheets)	Southern Water (email)	10 Sept 2007	SW, Barry Luck	Records of flooding in the last 10 years for events more frequent than 20 years	Show sewage flooding



<b>Ref. No</b>	<b>Subject &amp; Type of data</b>	<b>Source</b>	<b>Date</b>	<b>Author</b>	<b>Summary Description</b>	<b>Used for</b>
SSFRA/005	Thames Water flood history data	Thames Water (email)	30 October 2007	TW, Steve Dummer	Records of flooding in the last 10 years for events more frequent than 20 years	Show sewage flooding
SSFRA/006	Hampshire Groundwater Flooding data	Environment Agency (email)	30 Nov 2007	Environment Agency	Records of flooding in the last 10 years	Show groundwater flooding

