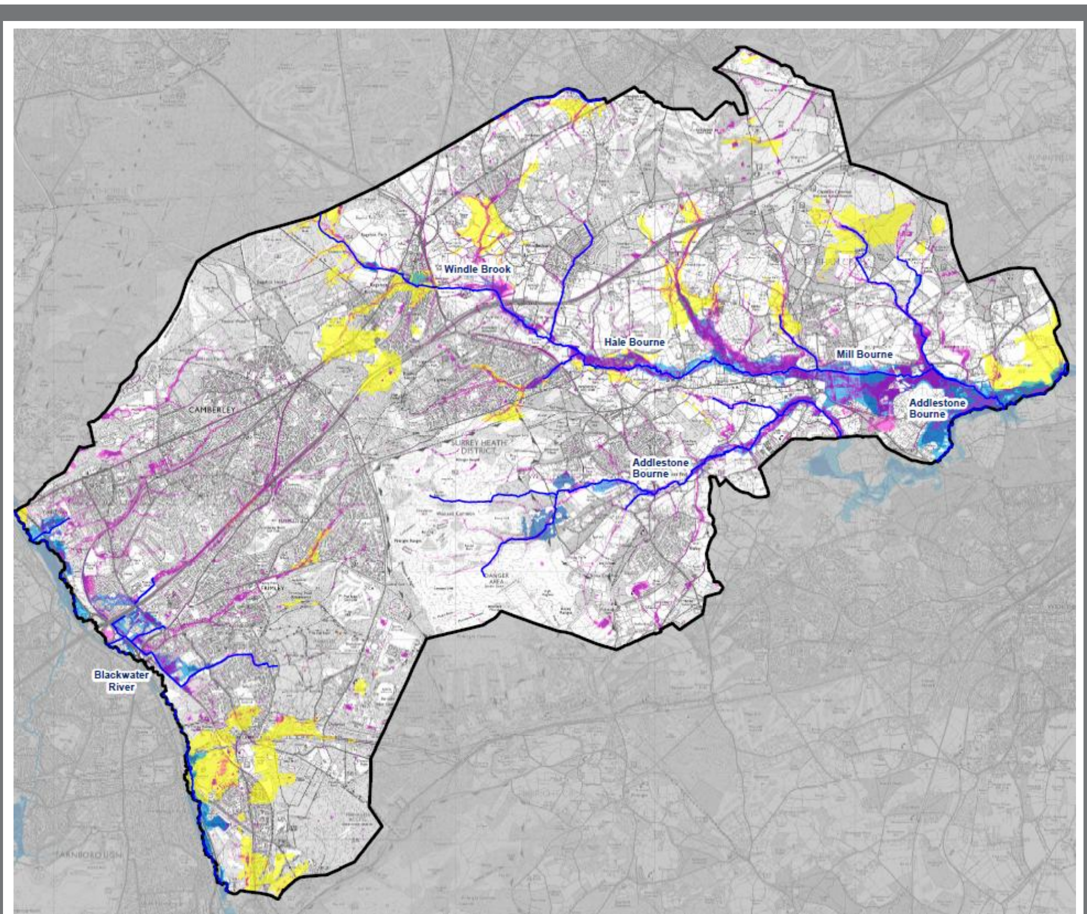
CAPITA

SURREY HEATH BOROUGH COUNCIL

Surrey Heath County Council Strategic Flood risk Assessment Volume 2 Technical Report

October 2015



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Executive Summary

Introduction

This report is a Strategic Flood Risk Assessment (SFRA) for Surrey Heath Borough Council (SHBC). This SFRA is an update to the SHBC SFRA (2008) and has been prepared in accordance with current best practice, the National Planning Policy Framework (NPPF) and its accompanying Flood Risk and Coastal Change Planning Practice Guidance (PPG). It utilises a number of new datasets that were not available at the time of the 2008 SFRA, including revised hydraulic modelling along the Blackwater River Tributaries, the Updated Flood Map for Surface Water and Reservoir Flood Mapping. This is Volume 2, The Technical Report, which should be read in conjunction with Volume 1 – the Decision Support Document and Volume 3 – The Catchment and Flood Risk Maps.

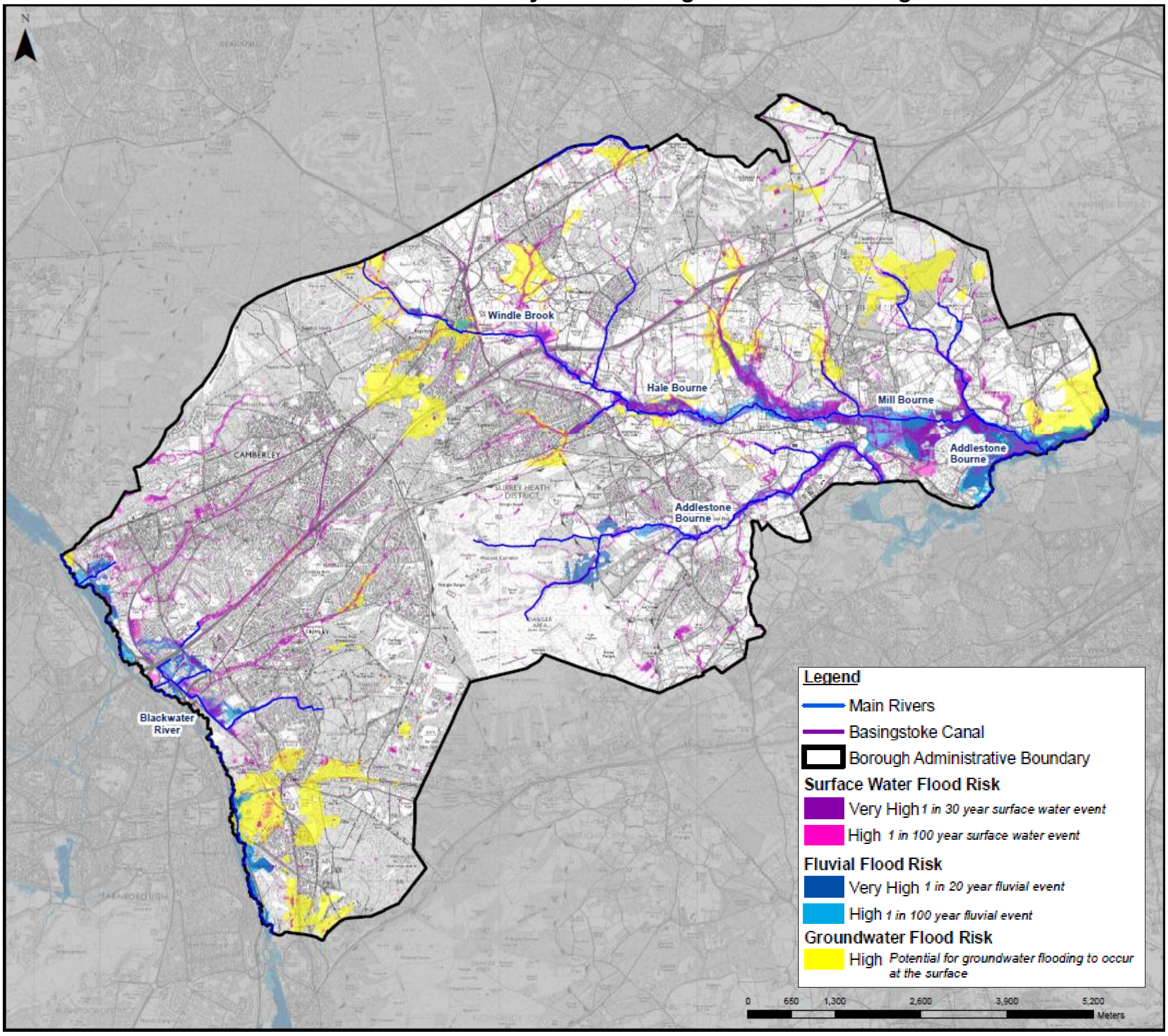
This updated SFRA will form part of the Evidence Base to support the New Local Development Plan Document. This SFRA is an update of the separate Blackwater Valley SFRA and the Bourne Catchment SFRA carried out in 2008, and provides a concise document to help support the evidence base and assist the Council in selecting appropriate sites for allocation for housing.

Flood Risk in Surrey Heath

Type of Flood Risk	Summary	Further information
Fluvial	The EA Flood Maps for Planning, Historic Flood incidents and detailed modelling outlines were used to evaluate fluvial flood risk across the Borough. Fluvial flood risk is detailed along the river valleys of the Blackwater and Bourne catchment areas including some main-river designated tributaries. In the Bourne catchment floodplains are wide, with large areas at risk, however much of this land is undeveloped. The **floodplains of the Blackwater River are more developed, with higher property densities at medium to high risk.**	Volume 2, Chapter 4 Volume 3, Figure 4, 5, 6 & 7
Surface Water	The UFMfSW has been used to assess surface water flood risk across SHBC as there are very limited details on recorded incidents. Similarly to the fluvial extents, large undeveloped floodplains are shown as at medium risk of surface water flooding. Developed areas at high risk include parts of the **A30 through Camberley**, and **central parts of Bagshot, Lightwater** and **Chobham.**	Volume 2, Chapter 5 Volume 3, Fig 8, 9 & 10
Sewers	The developed western side of the borough will experience more sewer flood incidents, as denser drainage networks increase the probability of sewer flooding incidents. Areas to the east of the borough are more reliant upon the watercourse network for surface drainage. There are no combined (surface/foul) sewers within SHBC however, due to the age of some properties foul drainage systems can also accommodate incorrectly connected surface water flows. This leads to overload and surcharge of the foul drainage in some areas.	Volume 2, Chapter 7 Volume 3, Fig 11
Ground water	Most of the study area is at low risk of groundwater flooding due to the underlying sandstone geology. There is elevated flood risk from groundwater at **Mytchett**, and **Central Chobham**, in-particular where close proximity of watercourses saturate surrounding ground.	Volume 2, Chapter 8 Volume 3, Fig 12

Artificial Sources	There are very few incidents of flooding from the Basingstoke Canal or from the breach of reservoirs. The Basingstoke Canal has discharge channels to convey excess water away when the levels within the canal rise too high. These discharge points can cause problems to neighbouring boroughs, as well as failure within the borough at **Frimley Green**. The upper reaches of the Basingstoke Canal are a navigable natural watercourse and surface water connections are known to be present throughout its length. The Basingstoke Canal is therefore subject to high volume flows from heavy or prolonged rainfall. Due to the low probability of occurrence, flood risk from reservoirs is considered extremely low along the Blackwater River.	Volume 2, Chapter 9 Volume 3, Fig 13

Areas of Surrey Heath at High Risk of Flooding



Note: The information in this map is available in more detail in Volume 3, Figure series 14

Fluvial Flood Risk and Functional Floodplain Definition

PPG states that Local Planning Authorities (LPA's) should identify the definition of Flood Zone 3b within the SFRA, in discussion with the Environment Agency (EA). Within Surrey Heath, Flood Zone 3b will be defined using the 5% AEP model outline from available hydraulic models. Where detailed model outlines and the definition of the 5% AEP outline is unavailable, Flood Zone 3 from the Environment Agency Flood Maps for Planning should be used to define the Functional Floodplain. The extent of the Functional Floodplain is discussed further in Chapter 4, and is represented in the map series in Volume 3, Figure 5.

Managing Surface Water

SHBC, the Local Planning Authority (LPA) will be responsible for local planning policies and decisions on planning applications relating to major development. SHBC will also have to ensure that sustainable drainage systems for the management of run-off are put in place, unless demonstrated to be inappropriate. As the Lead Local Flood Authority (LLFA) Surrey County Council (SCC) will act as a statutory consultee and SHBC should consult SCC on the management of surface water and satisfy themselves that the proposed minimum standards of operation are appropriate. It should be ensured through the use of planning conditions or planning obligations that there are clear arrangements in place for ongoing maintenance over the lifetime of the development. Additional guidance on the application of SuDS in managing surface water can be found in Volume 1, Section 4.3.4 and in Appendix B of this document. The flow chart below outlines how the relationship with the LLFA and the LPA will work in practice.

If SHBC identifies there are any surface water drainage implications for the proposed major development, they should consult SCC

↓

SCC will provide a technical assessment of the proposed surface water drainage system (including any proposed SuDS) to SHBC within 21 days

↓

SHBC will consider SCC's response as part of determining the planning application and will put in place robust and sustainable arrangements for the maintenance of SuDS

Climate Change Impacts in Surrey Heath

From the available modelling, an increase of 20% in the volume of flow in the fluvial inflows to the hydraulic model shows very minimal increase in the extent of areas at risk of fluvial flooding. It is expected that climate change is likely to increase intense rainfall events, which in the urbanised parts of the Borough is likely to increase surface water flooding due to impermeable surfaces and the current capacity of the drainage network.

1. Introduction

1.1 Background

In 2008, two Strategic Flood Risk Assessments (SFRA's) were completed for the two main river catchments within the Surrey Heath Borough Council (SHBC). The Blackwater Valley catchment SFRA was prepared in conjunction with Hart District Council. The Bourne catchment SFRA was prepared by Woking Borough Council. Based on the evidence within these SFRA's, SHBC adopted a Core Strategy and Development Management Policies DPD in February 2012. SHBC is now in the process of updating its evidence base to facilitate the preparation of a new local development plan document. Capita Property and Infrastructure were commissioned in January 2015 to combine the two existing SFRA's for SHBC to create one, updated evidence base to assist the Council in selecting appropriate sites for allocation for housing, and other types of land use.

This SFRA has been updated to align the document with the new National Planning Policy Framework (NPPF, March 2012) and its associated technical guidance; Flood Risk and Coastal Change, Planning Policy Guidance (PPG, March 2014). The update will also include newly available datasets, including the Blackwater Tribs modelling study (2014), the Updated Flood Map for Surface Water (2014), and updated historical flood incident information.

This report is a full technical report documenting the assumptions, processes and assessment undertaken in the development of the SFRA. It is intended to serve as a transparent record of the decisions and methodology that led to the outcomes of the SFRA.

1.2 SHBC SFRA Structure

This updated SFRA is formed of three parts. This is Volume 2, the Technical Report, which provides a detailed technical analysis of the flood risk from all sources in SHBC. Volume 1, the Decision Support Document outlines the how to use the SFRA in carrying out the Sequential Test, outlines relevant planning policies and recommendations and provides guidance for planners and developers. Volume 3 includes the flood risk maps, which represent as much of the data gathered as part of this update to visually display flood risk across the study area. The maps should be used in conjunction with this document, as well as Volume 1, and are referred to within the relevant chapters.

2. Study Area Overview

The Surrey Heath SFRA covers an area of 94.8 km^2, as shown below in Figure 2-1. There are two main catchments, the Blackwater River (Loddon Catchment) in the west and the Bourne Catchments in the east. The main settlements and urban areas in the west are Camberley, Frimley, Frimley Green and Mytchett which are within close proximity to the River Blackwater. In the east, the villages of Lightwater, Bagshot, Windlesham, Chobham, West End and Bisley lie in close proximity to the Bourne and its tributaries.

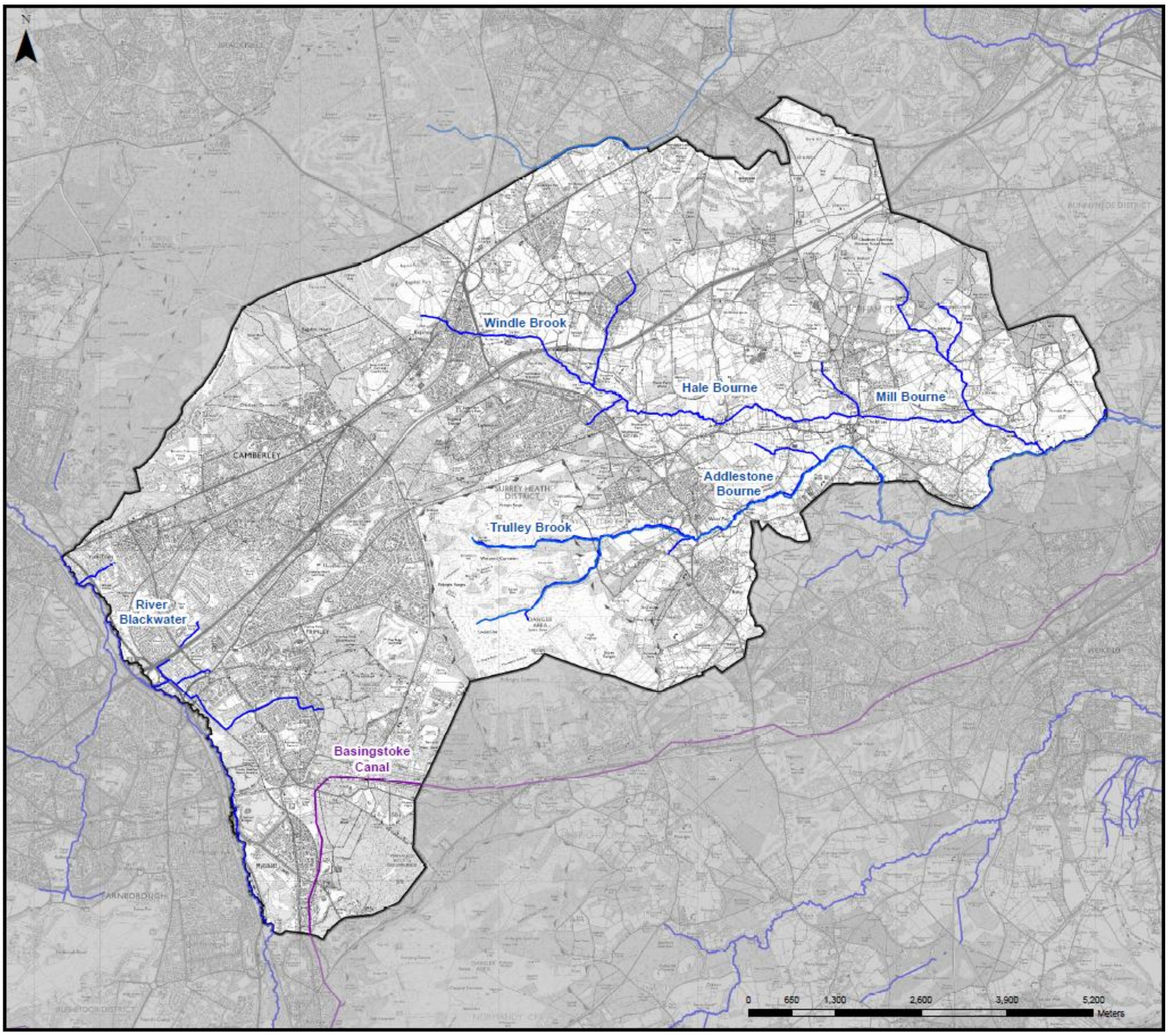


Figure 2-1 – Surrey Heath Study Area

The borough is divided into two basic catchment areas dictated by the high ground known as the Chobham Ridges The ridges are an elevated topographical line of approximately 120m elevation that divide the borough (along The Maultway B3015) and contributes to the nature of surface water run-off. The surface water is conveyed primarily within minor open watercourses before confluence into main-river or the sewerage network. In all cases, the flows towards the 2 rivers are subjected to large areas of run-off and the resulting surge flows affect villages throughout the Borough. It is therefore imperative that any future development considers the impact downstream and provides suitable attenuation.

2.1 Hydrology

2.1.1 Blackwater (Loddon) Catchment

In the west of the Borough lies the Blackwater River. This watercourse rises on the south-western fringe of Aldershot, forming the boundary between Rushmoor and Guildford, before entering Surrey Heath adjacent to the A331 between Farnborough and Mytchett. The Blackwater flows along the south west border of the Surrey Heath and Rushmoor Boroughs, although the original route of the river was changed in places when the A331 was constructed. The Blackwater River accepts flows from the eastern side of the Chobham Ridges and flows north until Frimley Railway Station where the flows are conveyed around the elevated M3 at junction 4 off the A331. Surface water drainage around the Frimley Station area was extensively modified with the construction of the A331 and the confluence of tributary connections from the Balmoral Ditch, Lyon Way Ditch and France Hill Ditch can cause flooding problems to residential and commercial property. The Blackwater River then continues north, flowing back and forth over the Rushmoor Surrey Heath boundaries, picking up connections from Riverside Way and Doman Road.

The Balmoral Ditch, Lyon Way Ditch and France Hill Ditch are the primary watercourse routes conveying flows from the Chobham Ridges. Flows converge to the east of the railway before flowing under the railway lines towards the Blackwater River at Frimley Business Park. The Blackwater flows out of the study area just south of Hawley. The Blackwater is about 35 km long from source in Aldershot to confluence with the River Loddon in Hart.

2.1.2 Bourne Catchment

The Bourne catchment is sourced from land lying east of the Chobham Ridges, divided into two main catchment areas collecting flows from the north and south of the borough. From the north, villages of Bagshot, Lightwater, Windlesham, West End (part) and Chobham (part), all confluence into the Mill Bourne running north of Chobham village centre. From the south the villages of Bisley, part of West End and part of Chobham, confluence into the Addlestone Bourne running south of Chobham village centre.

The two Bourne rivers then flow along separate paths around Chobham before their confluence into the Addlestone Bourne at the SHBC Woking Borough Boundary.

After the Hale Bourne confluence with the Addlestone Bourne the flows continue up through to the village of Addlestone and eventually meet the Woburn Park Stream which leads it to the Chertsey Bourne. There is a connection to the River Wey at Weybridge, but a sluice gate is in place. The Addlestone Bourne flows beneath the M25 and a railway line by Addlestone on its course to drain into the Chertsey Bourne. The main tributaries are the Parley Brook and Knaphill Brook.

2.2 Topography

The topography of a catchment has a significant impact on the mechanisms and processes of flooding. The topography of the study area is shown in Volume 3, Figure 2. The catchment dividing line is a large ridge running north to south approximately half-way through the borough, known as the Chobham Ridges. This high ridge line separates the more urbanised west side of the borough draining into the Loddon catchment; from the more rural east side of the borough draining into the Bourne catchment. . Elevations vary along this ridge line, from approximately 95 – 140m AOD with respective falls to 60m AOD at the Loddon catchment and as low as 20m AOD at the Bourne catchment.

2.3 Geology

The Blackwater River rises as springs in Bagshot Beds (sandstone) overlying London Clay. The catchment geology mainly consists of Braklesham Beds (sandstones which overly the Bagshot Beds). Within the Study area, the main bedrock geology of the Blackwater catchment is the sedimentary Bracklesham Group and Barton Group, which are undifferentiated sands, silts and clays.

In the centre of the catchment through Lightwater, the main underlying bedrocks in underlying the Bourne catchment are Windlesham Formation sands, silts and clays. To the east Bagshot Formation sands underlie the lower reaches of the Bourne catchment.

2.4 Infrastructure

The main transport infrastructure link within the study area is the M3, which bisects the Borough from the north east boundary to the south west boundary. This does not determine a divide in catchment areas however as the watercourse routes traverse the M3. The M3 also generates a large volume of surface water run-off which is generally un-attenuated. Any surge flows may be experienced as a result of these un-attenuated flows. The main London to Southampton railway also crosses through the Borough in the south west corner. The Reading to Guildford railway runs to the east of the River Blackwater, through Mytchett, Frimley and Camberley. The bridges, tunnels, embankments, and culverts associated with these transport links are often inefficient and unable to cope with the expanding urban drainage systems. Any watercourse or floodplain intercepted by railway will have a significant effect on flooding processes.

Other major roads in the area include the A30 A325, A322, A319 and the A331. The A331 runs alongside the Blackwater and has a significant effect on the Blackwater River connections and floodplain. The A325 at Frimley is elevated over the Blackwater River, Railway, A331 and Station Road. This section of highway spans the river floodplain but also, due to the elevated highway compounding the restriction of overland flows, properties (residential and commercial) in Station Road and Lyon Way Industrial Estate can be susceptible to flooding. The A322 runs north-south, on the eastern side of the borough, passing through Bisley, West End, Lightwater, Bagshot and Windlesham. Localised problems are known along the A322 route where main-river and minor watercourses also traverse the land.

The A319 runs from the A322 through parts of West End, Windlesham and Chobham. During times of heavy or prolonged rainfall the A319 at Chobham can be closed due to surcharge of the Mill Bourne River north of Chobham Village Centre. Flooding of the A319 at Chobham can be prolonged, restricting vehicle access through the village.

The only major sewerage works in the study area is situated in Doman Road, Camberley. This facility is owned by Thames Water Utilities Ltd and is located partially within the Blackwater River designated flood plain.

3. Asset and Structure Data

3.1 Introduction

Defences are built to help reduce the occurrence, and therefore consequences of flooding. Some structures provide flood defence benefits, however they are also built to manage low flows or are part of the infrastructure network. These assets can be owned, operated and maintained by the Environment Agency, Local Authorities, private business and/or local residents. This Chapter summarises some of the defences identified within Surrey Heath.

In addition to defences, infrastructure such as major roads and railway lines influence river flows. Significant modifications were made to the Blackwater River to facilitate the construction of the A331. The M3, A30, and railway network cross the main watercourses in the study area. Although these features are not considered flood defences, they influence flood flow routes and floodplain extents.

In some instances, river processes can be modified over time by defences (such as river walls, flood storage areas, flood alleviation channels and embankments) and by undertaking maintenance activities (such as river dredging). However, the close proximity of river, road and rail networks does restrict the options for efficient draining of some areas and careful consideration should be made for development proposals located anywhere within the designated floodplain.

3.2 Flood Defences

As part of this commission, an extract from the Environment Agency Asset Information Management System (AIMS) was provided to identify the flood defences and structures within the Study Area. The main defences and structures have been mapped in Volume 3, Figure 3. A list of the critical flood defence infrastructure across the borough has been highlighted in Table 3-1.

The list and details below are intended to provide a guide to the control of surface water within the borough. This list should be considered as live, with additional flood defence measures being continuously undertaken. The locations of balance ponds and flood defence measures are relative to the problems associated with that catchment; or specific to defend property. Any changes to the catchment, such as increased development, can potentially increase flood risk and will require careful consideration. In all cases, any redevelopment within a catchment area that relies upon existing balancing facilities will be required to fully attenuate surface water and return discharge rates equivalent to the pre-developed greenfield run-off rates within the development proposal.

Table 3-1 – Descriptions of the main flood defences within Surrey Heath

Type of defence	Name of Defence	Location	Asset Owner
New and Revised Flood Defence Measures	Bagshot Recreation Ground Bund	School Lane Bagshot	Parish Council
	Chobham Common Bunded Tracks	Chobham Common	SWT
	Clearsprings Bund	Clearsprings, Lightwater	SHBC
	Coxhill Green Pond	Station Road, Chobham	SWT
	Glovers Ponds	Chobham Common, Chobham	SWT
	Gordons School Hollow and Bund	Streets Heath, West End	Private
	Hammonds Ponds - Middle	Lightwater Country Park, Lightwater	SHBC

Type of defence	Name of Defence	Location	Asset Owner
	and Lower Ponds		
	Lightwater Country Park Attenuation Bunds	Lightwater Country Park, Lightwater	SHBC
	Milford Green Pond	Sandpit Hall Road, Chobham	SWT
	Staple Hill Pond (in progress)	Staple Hill, Chobham	SWT
	Station Road Frimley (56) Reinforced Embankment	Station Road, Frimley	Private
	West End Recreation Ground Hollow	Streets Heath, West End	Parish Council
Historic Bunds	Kalima Traveller Site - Boundary Bund	Chertsey Road, Chobham	SCC
	Alphington Pond	Alphington Avenue, Frimley	SHBC
	Frimley Fuel Allotments Hollow/Pond	Frimley Fuel Allotments, Field Lane, Frimley	SHBC
	Hammonds Pond – Upper	Lightwater Country Park, Lightwater	SHBC
	Tomlins Pond	Tomlins Avenue, Frimley	SHBC
	Watchetts Lake	Verran Road, Camberley	SHBC
Thames Water Balance Pond Locations	Balmoral Drive	Frimley	TWU
	Clews Lane	Bisley	TWU
	Fuchsia Way	West End	TWU
	Ludlow Close	Frimley	TWU
	Nasturtium Drive	Bisley	TWU
	Red Road / Burdock Close	Lightwater	TWU
	Turpins Rise / Mill Pond Road	Windlesham	TWU
	Waggoners Hollow	Bagshot	TWU

3.3 Chobham Flood Alleviation Scheme

In 2010, a Flood Relief Study commenced to review the flooding issues in Chobham South and surrounding areas. The Chobham Flood Alleviation Study (Chobham FAS - formally known as Chobham South) has been constructed to partially help attenuate surface water in the area. The Chobham South FAS is currently at the final design stage with flood and flow modelling being undertaken as a joint project between SHBC, SCC and EA. The modelling is reviewing the proposals put forward by SHBC to revise the extent of floodplain through Chobham village centre by controlled flooding of land now under SHBC ownership, and to undertake various minor work proposals around the village that will be viable following the revisions to floodplain. The modelling process will ascertain the viability of the proposals and help to provide a business case that will take advantage of allocated DEFRA funding. It should be noted that any developments upstream of this area will need to consider any change in risk, and potential changes from the modification of Flood Zone classification following completion of the project.

3.4 Other Structures along the Watercourse

The AIMS database extract identifies the structures along the watercourses in Surrey Heath. These are owned and maintained by a number of stakeholders, including riparian owners, such as the Environment Agency, Surrey County Council, Thames Water or Surrey Heath Borough Council. These structures include bridges (vehicular, pedestrian, pipe and railway bridges), flood monitoring instruments (gauges and manholes) and flow control structures (sluice gates, outfall pipes and control gates). Riparian owners can find out when they need to apply for Flood Defence consent at the following website: https://www.gov.uk/flood-defence-consent-england-wales

3.5 Maintenance

The Environment Agency has permissive powers (but not a duty) to maintain and improve watercourses designated as 'Main River' and associated structures for the efficient passage of river flow and the management of water levels.

The AIMS database holds information on the operating authority responsible for the maintenance of the channel and or defences, for each of the reaches and defence structures along the channels. Culverts under roads are generally the responsibility of the Highway Authority.

Riparian owners have various rights and responsibilities which include a duty to maintain any watercourse (all streams, ditches and river channels) that pass through, or possibly adjacent to their land ownership. Rights and responsibilities of Riparian owners are set out in Volume 1, section 4.6.

The AIMS database extract identifies at least 11.5 km of known land along the River Blackwater and its tributaries that are maintained channels. Maintenance is primarily undertaken by the EA can refer to de-silting, clearing embankments or clearance of trees and vegetation. To the south of Coleford Bridges, the Blackwater River is mostly privately maintained, however the Environment Agency has overarching authority for the management of flows within all main-river.

4. Flood Risk from Rivers

4.1 Overview

The Surrey Heath SFRA study area lies within the catchments of the Loddon (the Blackwater River), and the Bourne. This chapter will assess and discuss the risk of river (fluvial) flooding within the borough from these watercourses, through reference to historical fluvial flooding records, Environment Agency Flood Maps and detailed hydraulic modelling studies. A background to fluvial flooding and its presentation in this SFRA has also been provided.

4.1.1 Causes and Classifications

Fluvial flooding from rivers occurs when water levels rise higher than bank levels, causing excess water to surcharge and spill across adjacent land (floodplain). The main reasons for water levels rising in rivers are:

- intense or prolonged rainfall causing runoff rates and flow to increase in rivers, exceeding the capacity of the channel. This can be exacerbated by wet antecedent (the preceding time period) conditions and where there are significant contributions of groundwater;
- constrictions in the river channel causing flood water to backup;
- snow melt;
- blockage of structures or the river channel causing flood water to backup; and
- High water levels and/or locked flood gates preventing discharge at the outlet of the river.

The consequences of river flooding depend on how hazardous the flood waters are and what the receptor of flooding is. The hazard of river flood water is related to the depth and velocity, which depends on:

- the magnitude of flood flows;
- size, shape and slope of the river channel;
- width and roughness of the floodplain; and
- types of structures that cross the channel.

Flood hazards can vary greatly throughout catchments and even across floodplain areas. The hazard posed by floodwater is proportional to the depth of exposure, the velocity of flow and the speed of onset of flooding. Hazardous river flows can pose a significant risk to exposed people, property and infrastructure. Whilst low hazard flows are less of a risk to life (shallow, tranquil water), they can disrupt communities, require significant post-flood cleanup and can cause costly and possibly structural damage to property.

4.1.2 Probability of fluvial flooding

The probability of fluvial (river) flooding is described in this SFRA using the Annual Exceedance Probability (AEP). This is sometimes known as the ‘annual probability’ of flooding. A flood event described as a 1% AEP has a 1% (or 1 in 100) chance of occurring in any given year. This could alternatively be described as a 100 year return period flood event, that is, it is an event that is likely to occur, on average, once every 100 years.

The assessment of risk from fluvial sources in this SFRA is focused on four different probability flood events summarised below in Table 4-1. The flood risk extents have been based primarily on available detailed modelling (outlined in Table 4-1), and on the Environment Agency Flood Map for Planning dataset, where additional information is needed.

Table 4-1 - Fluvial flood events considered in this SFRA

Annual Exceedance Probability (AEP) of flood event	Return Period of flood event	Watercourse used in the assessment of fluvial flooding *(Date indicates year the modelling study was published)*
0.1 % AEP	1 in 1000 years	• Blackwater Tribs (2014)
1%+CC AEP	1 in 100 years plus Climate Change (see Section 4.1.3)	• Blackwater River (2007) • Addlestone Bourne (2007) • Blackwater Tribs (2014)
1% AEP	1 in 100 years	• Blackwater River (2007) • Addlestone Bourne (2007) • Blackwater Tribs (2014)
5% AEP	1 in 20 years	• Blackwater River (2007) • Addlestone Bourne (2007) • Blackwater Tribs (2014)

4.1.3 Climate Change Considerations

There is increasing concern about the impacts of climate change on the global environment. The nature of climate change at a regional level will vary. In the UK projections indicate that climate change will result in more frequent, short duration, high intensity rainfall and more frequent periods of long duration rainfall. These changes are likely to result in the more frequent occurrence of all types of flooding, including fluvial, surface water, sewer and groundwater flooding. All of which are relevant to the Surrey Heath SFRA study area.

The Planning Practice Guidance for Flood Risk and Coastal Change states that 'A Strategic Flood Risk Assessment is a study carried out by one or more local planning authorities to assess the risk to an area from flooding from all sources, now and in the future, taking account of the impacts of climate change, and to assess the impact that changes or development in the area will have on flood risk'. The latest guidance recommends a 20% increase in peak river flows is used to assess the impacts of climate change on rivers for time horizons between 2025 and 2115 (PPG, 2014). Climate change is represented by the 1 in 100 year annual probability flood event, with an additional 20% increase in peak river flow inflows. Where detailed modelling is available, the 1% AEP plus climate change outline has been mapped to show increased flood risk from climate change. These results have been acquired by adding 20% of the flow to the 1% AEP event (refer to Table 4-1), This is shown in the detailed models in Volume 3 Figure series 4.

The potential impacts of climate change are an important aspect of uncertainty relevant to flood risk estimation. Government guidance suggests that the impacts of climate change can be managed by either monitoring change in risk and adapting in the future as the need arises (Managed Adaptive Approach) or acting now to manage the eventuality (Precautionary Approach).

4.1.4 Definition of Flood Zone 3b

The Functional Floodplain comprises land where water has to flow or be stored in times of flood. In line with NPPF, all new development should be kept outside of the Functional Floodplain, with the exception of certain 'water compatible' land uses (e.g. recreational and conservation uses), as well as essential transport/utilities infrastructure that have no viable alternative location. The Exception Test must be passed for essential infrastructure developments to take place in this zone.

For the purpose of this SFRA, where available, the 5% AEP flood outline has been used as an indication of those areas which may be acting as Functional Floodplain. Where the 5% AEP flood outline is unavailable, the Environment Agency Flood Zone 3 outline has been used to define the functional flood plain. Flood risk betterment should be sought for redevelopment within these areas, and there should be no increased in development vulnerability or intensification in use. Volume 3, Figure 5 shows the functional floodplain outline, as well as the remaining SFRA Flood Zones, as described in Section 4.2.4 and 4.3.4.

4.1.5 Actual and residual flood risk

Actual risk provides information on flooding, when the impact of existing flood defences is considered (assuming that they operate as they are supposed to). The actual risk of river flooding is usually assessed using the 1% AEP flood event, with defences in place.

In recognition that engineered flood reduction measures cannot completely eliminate flood risk, there is a need to be aware of the residual risk generated by an event more severe than that for which the defences have been designed leading to a breach or failure of the flood defences. Accordingly, this risk assessment usually considers the flooding associated with an extreme event (such as a 0.1% AEP) or flooding that may result from climate change.

4.2 Fluvial Flood Risk Datasets

4.2.1 Historic Records

Historical fluvial flooding records are represented in Volume 3 Figure 6. This map displays the EA dataset, 'Recorded Flood Outlines' and an approximate flood outline determined using the Surrey County Council (SCC) 'Property Flooding Incidents' database.

The Recorded Flood Outlines (RFO) dataset provides a comprehensive record of historical fluvial flood extents, determined from discussions, surveys and aerial photography. This is limited to the quality of data and does not represent all past flooding. The dataset was most recently updated in August 2013.

Historic flooding recorded by the SCC was provided in property and highway flooding incident databases, during the production of this SFRA. Property incidents with an identified fluvial source were used to provide approximate flood extent outlines for the 2006, 2007, 2009 flood events. This includes more recent flooding than what is included in the EA RFO dataset. The SCC highway flooding database highlights roads which have experienced flooding, but this does not identify either the reasons or sources of flooding.

4.2.2 Environment Agency Flood Risk Maps / Flood Maps for Planning

The Environment Agency holds a dataset referred to as the EA Flood Maps for Planning, which contains Flood Zone extents for all catchments greater than $3km^2$ in size. These represent different probability events and are defined in Table 4-2. The Environment Agency Flood Zones for Surrey Heath are shown in Volume 3 Figure 7 of this SFRA, and are available online[1].

The zones are primarily based on the results of their national generalised broad scale modelling (JFLOW). In some locations they are also based on historic information. Where detailed hydraulic modelling has been carried out, results are fed into the outlines (At the time of writing this SFRA update the Blackwater Tributary outlines had not yet been included in the EA Flood Maps). The detailed hydraulic modelling will supersede JFLOW results where they are available. Flood Zones are the starting point of the Sequential Test (discussed in greater detail in Volume 1, Chapter 5) and refer to the probability of river and sea flooding only, ignoring the presence of existing defences.

Table 4-2 – Planning Practice Guidance Flood Zone Definitions

Flood Zone	Return Period	Probability	Definition
Flood Zone 1	<0.1 % AEP	Low	Land having a less than 1 in 1,000 annual probability of river or sea flooding. *(Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3)*
Flood Zone 2	0.1 % AEP	Medium	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or Land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. *(Land shown in light blue on the Flood Map)*
Flood Zone 3a	1 % AEP	High	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding. *(Land shown in dark blue on the Flood Map)*
Flood Zone 3b	**See Section 4.1.4**	The Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. *(Not separately distinguished from Zone 3a on the Flood Map)*

[1] http://maps.environment-agency.gov.uk/wiyby/wiybyController?x=357683.0&y=355134.0&scale=1&layerGroups=default&ep=map&textonly=off&lang=_e&topic=floodmap

4.2.3 Detailed Hydraulic Modelling

There are several detailed hydraulic modelling studies completed on watercourses in the study area, the Blackwater River and its Tributaries, and the Bourne River and tributaries. The fluvial flood extents from each are shown in Volume 3 Figure 4, as supplied by the EA. These studies were all commissioned by the EA, and vary in their outputs and study structures:

Addlestone/Hale Bourne (2007) - Mott MacDonald was initially commissioned to complete a study of the Addlestone Bourne and Hale Bourne rivers under the Strategic Flood Risk Management Framework (SFRM) Contract in July 2006. However, following a significant flood event in August 2006 that exceeded the modelling study flood risk outlines, a review and update was commissioned in November 2006. The modelling study was completed using a 1D model built in ISIS, and by splitting the overall catchment into six sub-catchments. The principal outputs included a hydrological assessment that could be used for detailed flood frequency analysis and a hydrodynamic model that could be utilised for flood and flow studies, channel and structure capacity assessment and for testing operating strategies for structures (e.g. sluices) and flood management plans. The study produced flood risk maps for 20% to 1% AEP flood events (including the climate change scenario) not considering the effect of blockages, i.e. residual risk.

Blackwater (2007) - The Environment Agency completed the Blackwater River Flood Risk Mapping study in October 2007. The study produced flood maps for the Blackwater catchment between Aldershot and the rivers confluence with the River Loddon. The study utilised a hydrological routing model of the Loddon catchment (including the River Loddon, River Whitewater, Blackwater River, and Basingstoke Canal) and involved the development of a hydraulic model of the Blackwater River. Both models were developed using the software package ISIS. The study produced 20%, 5%, 1% and 1% plus climate change flood extents for the undefended and defended case. The only structure considered a defence within the Blackwater model was the Cove Brook Flood Alleviation Scheme (located at the upper extent of the Blackwater in Rushmoor BC). The Environment Agency used the 1% undefended flood extents from the Blackwater study, to update Flood Zone 3 on the current Flood Map in 2008.

Blackwater Tribs (2014) - The Environment Agency commissioned JBA Consulting to undertake a Flood Risk Mapping Study of a number of the Blackwater River Tributaries, located within the towns of Yately, Sandhurst and Frimley, which span the counties of Berkshire, Hampshire and Surrey. Model package 10 (Doman Road Stream) and 12 (Francis Hill, Lyon Way and Balmoral Ditch) fall within the Surrey Heath SFRA Study Area. ISIS-TUFLOW models of the modelled tributaries were constructed and used to produce flood extents for a range of return period events, the outputs of which will be used by the Environment Agency to update the Flood Map and in channel levels will be used to update NaFRA. (NaFRA is the National Flood Risk Assessment, which provides an indication of flood risk at a national level.)

The models were simulated for the following events--20%, 5%, 1%, 0.1% AEP design events. In addition to this, climate change runs were produced using the 100 year return period, and increasing peak flows by 20 per cent. Flow estimates for all models within Surrey Heath were derived using JFlush, a method which is suited to small, urbanised catchments. Model 1, being more rural used the FEH Statistical method. Modelled flood outlines, maximum flood water depths, water levels, velocities, and hazard grids have been produced; the outlines have been used to define the SFRA Flood Zones, as detailed in Table 4-3.

The uncertainties associated with assessing flood risk from the Environment Agency Flood Risk Maps and the detailed modelling are identified within Appendix A.

4.2.4 SFRA Fluvial Flood Risk Mapping

In line with NPPF and PPG, Table 4-3 defines the model outlines and return period definitions that have been used to produce and define each SFRA Flood Zone. They combine the available detailed modelling and EA Flood Zones to provide complete and more accurate definitions for use in the Sequential Test. The SFRA Flood Zones are shown in Volume 3, Figure 5. These SFRA outlines are essentially an update of the EA flood maps for planning, as they consider future flood risk from climate change, and differentiate the Functional Floodplain within the standard Flood Zone 3.

Table 4-3 – Model outlines used to define SFRA Flood Zones.

SFRA Flood Zone	Blackwater	Blackwater Tributaries	Addlestone Bourne	Mill and Hale Bourne	All Other Watercourses
SFRA Flood Zone 2	EA Flood Zone 2	0.1% AEP event	EA Flood Zone 2	EA Flood Zone 2	EA Flood Zone 2
SFRA Flood Zone 3 1 % AEP plus Climate change	1% AEP + CC event	1% AEP + CC event	Not defined – displays EA Flood Zone 3	1% AEP + CC event	Not defined – displays EA Flood Zone 3
SFRA Flood Zone 3a	1% AEP event	1% AEP event	EA Flood Zone 3	1% AEP event	EA Flood Zone 3
SFRA Flood Zone 3b	5% AEP event	5% AEP event	EA Flood Zone 3	5% AEP event	EA Flood Zone 3

4.3 Fluvial Flood Risk

4.3.1 Historical Fluvial Flooding

Historic events within the Blackwater catchment include September 1968, February 1990, October 1993, November 2000, August 2006 July 2007 and January 2009,. In the Bourne catchment, are known to flood more frequently. Historic events recorded at these locations include September 1968, February 1990, October 1997, November 2000,August 2006, July 2007 and January 2009,.

The Surrey County Council Property flooding database has recorded flood incidents within Frimley Windlesham and Chobham post 2003.

Surrey Heath Borough Council has a more extensive list of property affected by flood but due to the age of some records, the specific details in some areas are not wholly complete. Additional properties are known to be affected by flood, however there is a reluctance for some residents to acknowledge any problems associated with their property.

The implementation of flood defences and alleviation schemes, such as the Chobham Village Centre Flood Alleviation Study should help alleviate and reduce the impact of flooding. Therefore, historic flood incidents should be considered anecdotal and used to help review ‘problem areas’ but section 4.3.2 and 4.3.4 should be used to inform risk more appropriately. The developer will still have to demonstrate potential impacts and ensure they do not increase flood risk or damage existing / built defences and schemes.

4.3.2 Fluvial Flood Risk across Surrey Heath

For the purposes of this SFRA, this section discusses the areas at medium and high risk, indicated by the derived SFRA Flood Zones, defined in Section 4.2.4. This section also describes the areas at very high risk, that fall within the 5% AEP model outlines. This analysis focuses onthe Main River network, as identified on the flood risk maps. These areas of risk are shown in Volume 3, Figure 5.

SFRA Flood Zone 2 – Medium Risk

- The A331 runs alongside the **Blackwater** River and, in places, its tributaries pass under the railway and the A331, restricting the overland flow options and exacerbating flooding. South of the M3 the Blackwater River lies primarily to the east of the highway and often adjacent to lakes (old gravel extraction pits) such as Quays, Coleford Bridges and the Mytchett lakes fall within SFRA Flood Zone 2, however most of these areas are undeveloped, and/or wetland areas. Around the M3 junction 4 at Frimley the tributary connections to the river have to pass under the A331 and Railway lines to discharge into the river. In-particular, the area around Lyon Way industrial Estate is susceptible to long term flooding due to the extensive catchment area draining through the land compounded by a boundary of raised land and the limited discharge options available. Further North, the sewerage treatment works at Doman Road and the industrial areas around York Town are at medium risk of flooding. In places, the SFRA Flood Zone 2 outlines extend over 500m out of bank from the main watercourse, towards a primarily urban area.

- Along the **Windle Brook** (modelled within the Mill and Hale Bourne study), central parts of Bagshot, along Guildford Road, are at medium risk of flooding. There is a risk of fluvial flooding where the Windle Brook intersects the A30 (London Road), but the most vulnerable properties are located downstream of this point, through the urban estates adjacent to the Windlebrook main-river. To the west of Bagshot, there are large expanses of rural land at risk of flooding from the 0.1% AEP event. The SFRA Flood Zone is over 700 m wide in some parts, but there are very few properties at risk.

- Residential properties in Lightwater are affected by surface water run-off from high ground, accumulated with discharge from the M3 motorway. Properties located along the natural valley line through Lightwater may be affected by surcharge from the piped and open watercourses. To the south east corner of Lightwater properties are at medium risk of fluvial flooding from surcharge of the **Lightwater Stream**. There is also risk of flooding along the A322 dual carriageway where this watercourse crosses the road and joins the Windle Brook. The Sewerage treatment works (NGR 493765, 162200 in this area fall within SFRA Flood Zone 2 and are at medium risk.

- Along the **Hale Bourne**, there are large areas of woodland and rural / agricultural fields at a medium risk of flooding. Although the extent of these areas is large, there are very few properties or infrastructure at risk. Northwest of Chobham village centre, where the Hale Bourne confluences with Clappers Brook forming the **Mill Bourne**, where the floodplain becomes more significant. Flooding that was previously controlled around a working Mill Pond is no longer contained due to the loss of the mill and the associated flow controls. This exacerbates flooding around Chobham Village Centre and usually affects vehicles using the A319. Immediately east of the village centre, flood zones between the Mill Bourne and Addlestone Bourne connect within SHBC SANGS. Along Gracious Park Brook and Chobham Brook, the Flood Zone 2 outlines are relatively narrow, and only rural land is at medium risk of flooding.

- Along the **Addlestone Bourne,** there are large expanses of land at a medium risk of flooding, however there are very few properties currently at risk. Where the Addlestone Bourne re-enters the study area (at the confluence with the Mill Bourne), there are further expanses of rural and agricultural land at a medium risk of flooding although, again, these areas are mostly undeveloped. Some properties lying to the south of the Mill Bourne at Philpot Lane are at fluvial risk.

SFRA Flood Zone 3 – High Risk

- Along the **Blackwater River** and **Tributaries**, SFRA Flood Zone 3 outline is much smaller than the Flood Zone 2 outline, and there are very few properties at high risk. However, the Sewerage works in Doman Road, south of York Town, does fall within Flood Zone 3 and is at high risk of flooding.

- Along the **Windle Brook** in Central Bagshot, urban areas north of Guildford Road between Bridge Street and New Road, are at high risk of flooding. Further downstream along the Windle Brook, the SFRA Flood Zone 3 is considerably narrower than SFRA Flood Zone 2, with very few properties at high risk.

- In the south east of Lightwater, properties are at high risk of flooding from the **Lightwater Stream**.

  Where Halebourne Lane crosses the **Hale Bourne**, the road and a few properties are at high risk of flooding. At Chobham, where the Addlestone Bourne runs close to the Hale Bourne, there is a large area at very high risk, particularly if peak flows from both watercourses coincide across open ground, breaching the individual catchment areas.
- Along the Addlestone Bourne, there are fewer properties at high risk of flooding but disruption to the highway is expected. Particular consideration should be given where the river crosses under Beldam Bridge Road; where the river runs in close proximity to the highway in Pennypot Lane; and at the ford vehicle crossing in Lovelands Lane. The ford in Lovelands Lane can quickly become impassable to all vehicles when flows are increased. The Addlestone Bourne also breaches at Castle Grove Road, within Chobham Vilage Centre, affecting the highway and residential property.

- The confluence between the Hale Bourne and the Addlestone Bourne is at the borough boundary with Woking BC, At this location the land is primarily undeveloped and there is much less land at high risk than at medium risk of fluvial flooding although some nearby properties remain vulnerable.

SFRA Flood Zone 3b – The Functional Floodplain – Very high risk

- The areas that fall within Flood Zone 3b along the **Blackwater** River and its Tributaries are very narrow, mostly limited to the drainage ditches and areas of wetland. At Mytchett, the functional floodplain outlines are confined to undeveloped areas which are mostly parks and ponds, with very few developed areas and properties at high risk of flooding as a result of the defended reaches. The extent of Flood Zone 3b remains mostly very close to the top of bank level along the Blackwater River through Frimley Green, except for areas where the embanked railway line and road networks cause out of bank flooding. At Watchmoor Park industrial estate, Flood Zone 3b extends up to 100m out of bank across the floodplain, to the south of the Sewerage Works, but the areas at very high risk of flooding are mostly lakes and parkland areas.

- Along the **Blackwater Tributaries**, there are some developed areas at high risk of flooding. Some properties where the natural channel and culverted sections of the small tributary channels are more likely to flood. The Lyon Way and Albany Park industrial Estates are at high risk of flooding, Areas of the light industrial estates along Doman Road and Glebeland Road are at very high risk of flooding from river back-up within the small tributary watercourse.

- There are areas at high risk of flooding from the **Windle Brook** which experiences additional flows from a large urban catchment at Wardle Close. The functional floodplain remains very close to the top of bank, and areas where it extends out of bank are often rural and undeveloped. There is a large area of land at very high risk of flooding along Clappers Brook (to the east of Halebourne Lane) where the flows from the M3 motorway contribute to the functional floodplain being up to 250 m wide. Most of these areas are rural and there are very few properties, however there is a risk to agricultural land and an increased risk to downstream property experiencing the surge flows emanating from the M3 motorway.

  Many properties within Chobham are at high risk of flooding. Flows from upstream villages and the M3 motorway accumulate into a surge flow which can reach Chobham some hours after rainfall. In-particular properties within the village around the A319 (Bagshot Road, High Street and Chertsey Road) are the most vulnerable with the roads often closed to traffic due to flood levels and the associated problems. Some properties further downstream, lying between the Hale Bourne and Addlestone Bourne Rivers, are also considered to be high risk from a combined flood plain reaching across open fields.

- The functional floodplain of the **Addlestone Bourne** is very small along most of the stretch within the study area. At the upper reaches of the main tributary, the **Trulley Brook**, Flowing from West End and Bisley, there are some areas at high risk, including properties around Donkey Town. Again, most of the land is rural and undeveloped land but can be subject to large catchment area run-off.

- At the confluence of the **Addlestone Bourne** and the **Mill Bourne**, the Functional Floodplain extends up to 500 m wide around the Emmets Mill area. Most of the land at high risk is currently farmland although some residential properties south of the Mill Bourne can be affected.

4.3.3 Climate Change Considerations

As shown in Volume 3, Figure 3, along the River Blackwater channel, there are many defences and man-made structures, which confine the 1% AEP plus climate change outlines to mostly the same, in bank, extents as the 1% outlines. Additional detailed modelling for the Blackwater Tributaries also shows that increased flows from climate change may only increase very small areas of land at a medium risk of flooding, including areas around York Town, Watchetts Park, Lyon Way and Albany Park industrial estates.

Within the Bourne catchments, the increased flows as a result of climate change are also very similar to the 1% AEP outlines. Through Chobham, there are a few properties to the south of Chertsey Road that become at medium risk considering the impact of climate change. There is a significant increase in the modelled impacts of climate change on river levels.

4.4 Management of Fluvial Flood Risk

4.4.1 Flood Warnings in SHBC

The Environment Agency operates a flood warning service for areas at risk of flooding from rivers and the sea. Rainfall and river levels are monitored in these areas to forecast the probability of flooding, and warnings are issued if flooding is forecast. Flood warning and evacuation procedures can reduce the risk of people being exposed to flood water and minimise the consequences of flooding. According to the AIMS database, there are 20 monitoring instruments in the Surrey Heath SFRA study area, of which five are active gauging stations. An online service for property owners is available through the EA website[2]. The flood warning areas are also mapped online[3].

The EA provide a flood warning service for the Addlestone Bourne, River Blackwater and Mill Bourne, which are within the Surrey Heath SFRA study area. There are flood alert areas within the SFRA study area for these watercourses and these would be used when water levels along the river are forecast to overtop the banks.

A Flood Warning is issued when the Environment Agency anticipates flooding to property. Flood warnings are issued for specific flood warning areas within a river catchment. There are six flood warning areas within the SFRA study area including:

- Windle Brook and Bournes
- Hale Bourne and Addlestone Bourne at Chobham;
- Mill Bourne at Emmetts Mill;
- Hale Bourne from the M3 to Clappers Lane (Windlebrook is Hale/Mill Bourne)
- Blackwater River (Loddon) at Aldershot and Farnborough
- Blackwater River (Loddon) at Camberley and Sandhurst.

4.4.2 Flood Alleviation Schemes in SHBC

As detailed in Section 3.3, the EA and SCC are working in partnership to develop a Flood Alleviation Scheme for Chobham South.

The Chobham South FAS is proposing to restore historic features and modify existing surface water systems to better cope with surge flows reaching the village from surrounding land. Properties will be better protected and areas of flood plain will be revised in-line with the project but no outcome is guaranteed. Review of the proposals is being undertaken in 2015/16 with modelling reviews to ensure no detrimental effect. Any new developments within this area will still need to consider the change in residual and actual risk, and potential modification of the Flood Zone classification following completion of the project cannot be considered until the work has been completed.

4.4.3 Surrey Local Flood Risk Management Strategy

Surrey County Council, as the Lead Local Flood Authority, has a duty to manage flood risk from surface water, groundwater and ordinary watercourses. Whilst the management of main-river is the responsibility of the EA, SCC (as LLFA) is responsible for management of the minor watercourses across Surrey Heath. A coordinated approach with the Surrey Heath drainage engineer is also necessary to help manage fluvial flood risk. Management practice includes maintenance of channel flows and upkeep of defence structures, as detailed in Table 3-1 Management of the channel and flood defences will impact the level of flood risk within Surrey Heath.

[2] https://flood-warning-information.service.gov.uk/

[3] http://maps.environment-agency.gov.uk/wiyby/mapFromCMSCodes?topic=fwa&lang=_e&codes=065WAF113&layerGroup=2

5. Flood Risk from Surface Water

5.1 Overview

The Surrey Heath SFRA study area includes the developed urban areas all of which have significant areas of impermeable surface such as roads, pavements and driveways. These are all likely to contribute to surface water runoff and subsequently present a significant risk of surface water flooding. This chapter will provide a brief background to the definition and causes of surface water flooding and assess the flood risk in the study area using historic records and the Environment Agency Updated Flood Map for Surface Water.

5.1.1 Causes and Classifications

Surface Water is classified several ways, as:

- Rainfall that infiltrates into the soil but resurfaces further down the hill;
- The water in lakes, marshes and reservoirs; and
- Water flowing over the ground surface that has not entered a natural channel or artificial drainage system is classified as surface water runoff or overland flow.

The latter, surface water runoff/overland flow occurs when intense, often short duration rainfall is unable to soak into the ground or enter drainage systems. The volume and rate of surface runoff will usually depend on catchment size, geology, slope, climate, rainfall, saturation, soil type and vegetation. Poorly drained material that is saturated, parched or frozen has a higher runoff potential and is more likely to cause flooding.

Surface water runoff can cause localised flooding in natural valleys as normally dry areas become inundated and accumulations in natural low spots where water may collect.

Drainage basins or catchments vary in size and shape, which has a direct effect on the amount of surface runoff. The amount of runoff is also a function of geology, slope, climate, rainfall, saturation, soil type and vegetation. Geological considerations include rock and soil types and characteristics, as well as degree of weathering. Porous material (sand, gravel, and soluble rock) absorbs water more readily than fine-grained, dense clay or unfractured rock, and has a lower runoff potential. Poorly drained material has a higher runoff potential and is more likely to cause flooding. Urban settlements often have large areas of impermeable surfaces, such as roads, pavements and driveways, which behave similarly to poorly drained materials.

Surface water flooding can occur in rural and urban areas, but usually causes more damage in the latter. Urban areas can be inundated by flow from adjacent farmlands. Flood flow routes include the land and water features over which floodwater flows. These flow routes include drainage channels, rail and road cuttings. Flood management infrastructure can also serve as a flood pathway. Developments that include significant impermeable surfaces, such as roads and car parks may increase the occurrence of surface water runoff. Urban areas usually have extensive drainage or sewer systems where blockage or constraints can exacerbate surface water flooding. Developments which are close to artificial drainage systems, or located at the bottom of hillslopes, in natural valley lines and hollows, may be more prone to flooding. This may especially be the case in areas that are downslope of land that has a high runoff potential including agricultural land, impermeable areas and compacted ground.

Flooding from land can also occur when structures used to manage flooding fail. This could be a failure of maintenance not allowing a system to drain between events; or a failure of the structure where the resulting uncontrolled discharge can cause flooding not usually experienced.

5.1.2 Impacts of Surface Water Flooding

Surface water flooding can affect all forms of the built environment, including:

- Residential, commercial and industrial properties;
- Infrastructure, such as roads and railways, telecommunication system and sewer systems;
- Agriculture;
- Amenity and recreation facilities.
  Transport links / Highway

Often surface water flooding can be short-lived, lasting only as long as the rainfall event. However flooding may persist in low-lying areas where ponding occurs. Flooding may occur as sheet flow or as rills and gullies causing increased erosion of agricultural land. This can result in 'muddy floods' where soil and other materials are eroded and washed onto roads and into properties, requiring extensive clean-up.

Both rural and urban land use changes are likely to alter the amount of surface water in the future. Future development is also likely to change the status-quo with the potential for greater numbers of people and/or developments exposed to flooding. All development to provide sufficient surface water management and no development within the borough is to cause, or exacerbate, the levels of flooding experienced.

5.2 Surface Water Flood Risk Datasets

5.2.1 Historic Records

Historic flooding recorded by Surrey County Council was provided in their Wetspot database. The SCC Wetspot database also highlights roads which have experienced flooding. Surrey Heath Borough Council also provided detailed local knowledge throughout the production of the SFRA update.

5.2.2 Updated Flood Map for Surface Water

The Updated Flood Map for Surface Water (uFMfSW) GIS data has been provided by the Environment Agency. The dataset contains information for predicted surface water flooding extents, which are shown in Volume 3 Figure 8. These maps are more detailed than the second generation flood map for surface water (known as the Flood Map for Surface Water FMfSW), and have been generated based on a JFLOW model using a 5m grid size and detailed hydrology. The updated surface water flood map model includes representation of buildings, structures and road networks. The dataset shows areas that are at risk of surface water flooding for the 3.3% AEP, 1% AEP and 0.1% AEP event outlines. It is important to note that quantifying surface water flood risk depends on many other factors, including antecedent conditions and drainage maintenance conditions. Historic records of surface water flooding may indicate an increased risk; however, attention to the problems in these areas may change the associated risk through time.

Information on surface water flooding mechanisms and known hotspots was also collected from the Surrey LFRMS, the Surrey PFRA[4] and the previous SFRAs.

[4] http://new.surreycc.gov.uk/__data/assets/pdf_file/0004/16753/PFRA.pdf

5.3 Surface Water Flood Risk

5.3.1 Historic Surface water Flooding

Surrey County Council has outlined the following four roads as identified wetspots which are being considered for capital highway drainage schemes over the next five years. It is likely that these roads are subject to fluvial and surface water flood risk.

- Guildford road (Bagshot)
- Lightwater By-pass (Broadway Rd bridge)
- Bridge Road (Frimley)
- Station Road (Frimley)

The Preliminary Flood Risk Assessment, carried out in 2011, highlighted that there are 12 places above flood risk thresholds within Camberley. Based on the FMfSW, the places above flood risk thresholds have been defined using 1 km grid squares where at least one of the following flood risk indicators is above the threshold given below:

- Over 200 people at risk (based on 2.34 people per property)
- 1 or more critical services
- 20 or more non residential properties

Camberley was the 5th most affected urban area within the Surrey Council area. The 2006 and 2007 flood events seen across Surrey Heath were mostly attributed to surface water flooding from overland flow paths, followed by fluvial flooding once the rivers and public/private drainage systems had reached capacity.

Correspondence within the 2008 SFRA carried out for Surrey Heath highlighted that drainage from development behind the railway embankment at Lyon Way in Frimley, can only flow through limited options within the railway embankment. During high rainfall surface water at this location is backed up and surcharge flooding occurs around Lyon Way and Albany Park Residential properties in Station Road, Frimley, may also be affected.

5.3.2 Updated Flood Map for Surface Water

The Environment Agency Updated Flood Map for Surface Water (uFMfSW) shown in Volume 3 Figure 8, indicates multiple isolated areas within the Surrey Heath SFRA study area which are at medium to high risk from surface water flooding, based on the 1% AEP event and 3.3% AEP event outlines respectively. Whilst the 0.1% AEP outline was provided, indicating low flood risk, this is an exceptionally unlikely surface water flood event that covers a very large proportion of the borough. For the purposes of this SFRA analysis only for extents for the 1% AEP and 3.3% AEP events have been discussed.

The most common areas to experience increased surface water flood risk are along roads, depressions (valley lines), and land adjacent to watercourses.

The uncertainties associated with assessing flood risk from Updated Flood Map for Surface Water are identified within Appendix A.

5.3.3 Climate Change Considerations

Future climate change projections indicate that more frequent short-duration, high intensity rainfall and more frequent periods of long duration rainfall are to be expected. Studies into the impact of climate change on surface water are ongoing. Research from the Living with Environmental Change study led by NERC (2013) may feed into UK Flood Risk and Coastal Erosion Risk Management Strategy. Indirect impacts of climate change on land use and land management may also change future flood risk.

In the absence of certainty, NPPF advocates a precautionary approach. Sensitivity ranges are suggested for peak rainfall intensities over various time horizons. As our understanding of the impacts of climate change improves, these guidelines are likely to be revised. It is imperative that the SFRA is reviewed appropriately.

It is recommended that as part of the future Surface Water Management Plan documents, the 1% AEP plus Climate change scenario is used to analyse future flows and surface water flood risk.

5.4 Management of Surface water Flood Risk

Sustainable Drainage Systems are recognised as an essential management strategy for surface water. As of 6th April 2015, Local Planning Authorities will be responsible for the delivery of SuDS across Surrey Heath. Volume 1, Chapter 4 provides further information on the policy surrounding SuDS. Appendix B of this document also outlines more detailed information on SuDS techniques, including how they can be used to manage surface water flood risk, how to incorporate them into the planning process. This guidance also includes who to achieve other environmental benefits including water quality. The following sections outline where different SuDS techniques may be suitable within the different regions of the study area.

5.4.1 Application of SuDS Systems

5.4.1.1 Available Datasets

The British Geological Society (BGS) produce a range of datasets which provide information surrounding the suitability of the ground for infiltration SuDs, The selection and design of an appropriate system depends on the properties of the ground and in particular the following four factors:

- the presence of severe constraints that must be considered prior to proposing use of infiltration
- the drainage potential of the ground
- the potential for ground instability when water is infiltrated
- the protection of groundwater quality

The Infiltration SuDS Map is based on 15 nationally derived subsurface property datasets, some of which are a result of direct observations, whilst others rely on modelled data.

The dataset is structured using the above four factors, and allows consideration of the subsurface permeability, the depth to groundwater, the presence of geological floodplain deposits, the presence of artificial ground, ground stability (soluble rocks, collapsible ground, compressible ground, running sand, shallow mining, landslide and shrink/swell clays), potential for pollutant attenuation and the Environment Agency's source protection zones.

The maps show data at 1:50,000 scale. Surrey County Council provided a licence for Surrey Heath to use the following data.

5.4.2 Infiltration SuDs Map: Detailed

The detailed map provides the data layers described above, along with a further 20 individual, bespoke data layers. These data layers provide information on the properties of the ground, which can be used to guide local SuDS planning and design.

The data can be used to determine the likely limitations present at a site and make preliminary decisions on the type of infiltration SuDS that may be appropriate. We anticipate that this map will be used by planners, developers, consultants and SuDS Approval Bodies.

5.4.3 Drainage Summary Map

The summary map comprises four summary layers, providing an indication of the suitability of the ground for infiltration SuDS. The layers summarise: the presence of severe constraints; the drainage potential of the ground; the potential for ground instability as a result of infiltration and the susceptibility of the groundwater to contamination. The layer is derived from the following datasets:

- Infiltration constraints summary
- Superficial deposit permeability
- Superficial deposit thickness
- Bedrock permeability
- Depth to water level
- Geological indicators of flooding

This map is anticipated to be of use in strategic planning and not for local assessment. It does not provide specific subsurface data or state the limitations of the subsurface with respect to infiltration, confirmation of these details will still need to be checked on-site, using BRE365 guidance, to ascertain suitability.

This dataset has been used to assign areas with the classifications assigned in Table 5-1:

Table 5-1 – Drainage Summary Map classifications

Score	Description	Typical Storage Capacity
1	Highly compatible for infiltration SuDS	The subsurface is likely to be suitable for free-draining infiltration SuDS
2	Probably compatible for infiltration SuDS	The subsurface is probably suitable for infiltration SuDS although the design may be influenced by the ground conditions
3	Opportunities for bespoke infiltration SuDS	The subsurface is potentially suitable for infiltration SuDS although the design will be influenced by the ground conditions
4	Very significant constraints are indicated	There is a very significant potential for one or more geohazards associated with infiltration

5.4.4 SuDS Suitability Assessment

For this high level SFRA study, the infiltration constraints layer within the drainage summary map has been analysed to provide a summary of the locations suitable for infiltration SuDS techniques across Surrey Heath Borough Council, the data contained within the detailed SuDS Map should be referred to at the detailed FRA stage to highlight any further or site specific constraints on SuDS and relevant applications for surface water management.

5.4.5 Drainage Summary Layer

The Infiltration constraints layer, which provides an indication of the extent to which the ground will be suitable for infiltration SuDS with respect to drainage, based on the geology and hydrogeology of the subsurface should be used to advise the methods and location of SuDS. Volume 3, Figure 9 shows the BGS Drainage Summary dataset across Surrey Heath Borough Council.

5.5 Adoption and Maintenance of SuDS

To ensure approval of a proposed SuDS scheme is critical that developers consult with SHBC, Highways England, Thames Water and any other applicable parties to discuss the adoption and maintenance of SuDS techniques and associated drainage infrastructure.

Sewerage undertakers are responsible for surface water and foul drainage from developments, where they are adopted into the Thames Water public sewer network. Thames Water is the sewerage undertakers throughout the study area.

The Flood and Water Management Act 2010 outlined plans to establish SuDS Approval Bodies (SABs) within county, county borough or unitary local authorities. However, the Department for Communities and Local Government (DCLG), following consultations with the Department for Environment, Food and Rural Affairs, has dropped the development of SuDS Approval Bodies (SABs) as the primary mechanism for SuDS review. The Planning Practice Guidance was updated in April 2015, following changes in the management of surface water and the different responsibilities of LPAs and LLFAs.

At the time of writing this SFRA (July 2015) the LPA in consultation with the LLFA were likely to be responsible for delivery of SuDS. It is expected that operation and future maintenance of SuDS will be delegated to management companies. However, this is to be confirmed and SHBC should be consulted for specific schemes.

When considering the adoption and long-term maintenance of SuDS techniques, it is important to emphasize that many SuDS techniques rely upon vegetation/landscaping as the primary means of handling runoff. As such, the majority of SuDS techniques can be maintained as part of a typical landscape management process, which entails tasks like litter collection, grass cutting, and visual inspection of any inlets or outlets to look for blockages.

6. Identifying Preliminary Drainage Areas

As part of this SFRA, analysis has been undertaken in order to identify areas where development may increase flood risk. This has been done by identifying preliminary drainage areas (PDAs) based on identifying hydrological catchments. A potential cumulative impact must be considered when building small developments upstream of areas at risk of surface water flooding. This should be done in collaboration between the LLFA, LPA and EA.

6.1 Defining Preliminary Drainage Areas

These areas have been defined using the Water Framework Directive Main River Catchments. These have been compared to hydrological catchment boundaries using the Flood Estimation Handbook software, to validate the catchment boundaries. The UFMfSW has also been used to validate the catchments and indicative surface water flow paths.

The catchments have been classified as preliminary drainage area, based on potential future risk, as new development could create additional runoff in the downstream part of the catchment. The PDAs are a starting point for considering potential downstream flood risk areas and the cumulative impact of development.

6.2 PDAs within Surrey Heath

Volume 3, Figure 10 shows the identified PDAs within Surrey Heath.

The Blackwater catchment is more developed and two PDAs have been identified. Camberley and York Town in the north west, Frimley and Mytchett in the south west of the borough. Within these PDAs, the UFMSW indicates a risk of surface water flooding to infrastructure and property. Increased development within the upper reaches of these catchments could increase surface water flood risk in the downstream extents of the PDAs.

In the eastern half of the study area, within the Bourne catchment, there are less properties and infrastructure at risk of surface water flooding compared to the eastern part of the study area. Two PDAs have been identified, the Mill and Hale Bourne catchment and the Addlestone Bourne catchment. The Mill and Hale Bourne PDS includes the developed areas of Camberley (east) Bagshot, Lightwater and Chobham. The cumulative impact of development within these PDAs could further increase surface water flood risk, and it is therefore imperative that surface water is maintained at Greenfield runoff rate or below.

The Water Framework Directive Layers show that the watershed boundaries do not follow the political boundaries, and highlight the importance of considering the downstream effects of developments in other neighbouring Boroughs. This also highlights the need for liaison between Boroughs and larger scale management by the LLFA.

6.3 Policy recommendations

It is recommended that SHBC develop a surface water management policy such that development within the identified PDAs must reduce surface water run-off following any development of the site. This is in line with NPPF and correspondence with the EA that future development should look to not only mitigate but reduce surface water runoff from all developments, reducing future flood risk across the Borough. Greenfield developments should maintain the predevelopment runoff rate; brownfield sites should attempt to reduce runoff rates to Greenfield rates. By identifying specific locations where additional development is expected to exacerbate flood risk, Surrey Heath Borough Council can create specific policies. SuDS techniques are important in achieving these objectives.

The identification of the PDA regions within Surrey Heath can also be used as a starting point for identifying the potential need for Surface Water Management Plans across the Borough. It is recommended that SWMPs are developed for the PDAs showing significant risk – in terms of existing impact and potential future risk. The benefits of developing these smaller scale SWMPs include:

- Detailed understanding of local flood risk and improved evidence base (this may result in a reduction of predicted risk and an increase in available developable land or vice versa)
- Ability to define robust, defendable policies that are effective at a catchment scale
- Increased ability to defend policy decisions and enforce planning conditions

7. Flood Risk from Sewers

7.1.1 Description

Flooding from sewers occurs when rainfall exceeds the capacity of available networks or when there is an infrastructure failure. Flooding from foul sewers occurs when incorrect surface water connections allow rainfall to enter and exacerbate flows which exceed the capacity. Failure can occur anywhere on the sewer network when there is a blockage or other infrastructure failure.

7.1.2 Causes and Classifications

The main causes of sewer flooding are:

- Lack of capacity in sewer drainage networks due to original under-design.
- Lack of capacity in sewer drainage networks due to an increase in demand (such as climate change and/or new developments).
- Lack of capacity in sewer drainage networks due to events larger than the system designed event.
- Lack of capacity in sewer drainage networks when a watercourse is fully culverted (lost watercourses), thus reducing the conveyed volume and removing floodplain capacity.
- Lack of maintenance of sewer networks which leads to a reduction in capacity and can also lead to total sewer blockage.
- Water mains bursting/leaking due to lack of maintenance or as a result of damage.
- Groundwater infiltration into poorly maintained or damaged pipe networks.
- Restricted outflow from the sewer systems due to high water levels in receiving watercourses.

The impact of sewer flooding is usually confined to relatively small localised areas. When flooding is associated with blockage or failure of the sewer network, flooding can be rapid and unpredictable. Flood waters from this source are also often contaminated with raw sewage and pose a health risk. The spreading of illness and disease can be a concern to the local population if this form of flooding occurs on a regular basis. There is also an impact of sewer flooding on river and ground water quality and this will have implications on achieving objectives within the River Basin Management plans which in turn feed in to the Water Framework Directive legislation.

Drainage systems often rely on a gravity assisted network, which convey water into trunk sewers of increasing size towards the lower end of the catchment. Failure of these trunk sewers can have serious consequences, often exacerbated by topography, as water from surcharged manholes will flow into low-lying land likely to be already inundated from other types of flooding.

The modification of watercourses into culverted or piped structures can result in a reduced capacity. Excess water will still be conveyed along the natural valley route where the original channel is no longer present and the new system cannot accommodate the flows.

Whilst an area affected by sewer flooding is often localised, the quality of water can be poor due to the ingress and mixing of foul sewerage systems.

Sewer flooding is likely to have a high concentration of solid, soluble and insoluble contaminants. This can lead to a reduction in the environmental quality of receiving watercourses. Flooding of contaminated land (such as landfills, motorways, and petrol station forecourts) will transport contaminants such as organics and metals to vulnerable receptors if the respective drainage systems are not designed to treat the water.

7.2 Sewer Flood Risk Datasets

7.2.1 The DG5 Register

All Water Companies have a statutory obligation to maintain a register of properties/areas which have reported records of flooding from the public sewerage system, and this is shown on the DG5 Flood Register. This includes records of flooding from foul sewers, combined sewers and surface water sewers which are deemed to be public and therefore maintained by Thames Water. Thames Water provided extracts of the DG5 register for the Surrey Heath Borough Council study area.

The aim of the DG5 levels of service indicators is to measure the frequency of actual flooding of properties and external areas from the public sewerage system by foul water, surface water or combined sewage. It should be noted that flooding from land drainage, highway drainage, rivers/watercourses and private sewers is not recorded within the register. In addition, the records do not account for the effect of any capital works designed to alleviate flooding.

7.2.2 SFRA Sewer Flood Risk Mapping

The DG5 data has been mapped within this SFRA by identifying the total number of incidents recorded within each grouped postcode area. The grouped areas consist of the first four parts of the postcode, protecting specific properties from being identified.

7.3 Sewer Flood Risk in SHBC

7.3.1 Historical Sewer Flooding

The data provided by Thames Water for use in this SFRA shows postcodes where properties are known to have experienced sewer flooding prior to January 2015. The DG5 register holds records of 91 flood incidents resulting in internal property flooding, and 129 external flooding incidents within the borough. The records indicate that internal property flooding occurs predominantly for the larger scale flooding events (5% AEP), whilst more external flooding has been reported during smaller scale events. Volume 3, Figure 11 provides a broad overview map of flood incidents in the borough as it is not property specific, instead providing information in postcode sectors (a four digit postcode).

Sewer flooding is a particularly damaging source of flooding because of the after affects associated with this type of flooding. In the study area this type of flooding is more likely to occur in dense urban areas..

The use of historic data to estimate the probability of sewer flooding is the most practical approach, however does not take account of possible future changes due to climate or future development. Historic results should also be viewed with caution as the sewer network is constantly being maintained, upgraded and improved. Thus flooding issues may be relatively short lived (<10 years). If identified by the Environment Agency or the water company as a major risk, sewer flooding will need to be assessed in greater detail in individual flood risk assessments.

The uncertainties associated with assessing flood risk from the historic sewer flood incidents are identified within Appendix A.

7.3.2 Climate Change Considerations

Climate change is expected to impact on sewer flooding due to an increase in rainfall intensity. This may require new infrastructure with greater capacity and upgrading of existing infrastructure to maintain the same level of service. The relevant climate change predictions contained with NPPF are reproduced in Table 7-1.

Table 7-1 – Predicted increase in rainfall intensity with climate change

	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	5%	10%	20%	30%

7.4 Management of Sewer Flood Risk in SHBC

Flooding from sewers or urban areas can theoretically be managed with engineering works for any size event. However such works may not be viable when in close proximity to watercourses and they are not always economically or environmentally sustainable. Improvements to urban drainage can also lead to increased or rapid rainfall runoff into rivers, exacerbating flood risk downstream and potentially transporting contaminants.

The National Planning Policy Framework recommends that Sustainable Urban Drainage Systems (SuDS) are used to decrease the probability of flooding by limiting the peak demand on urban drainage infrastructure. All new developments, are required to separate out foul drainage from surface water drainage to ensure that any flooding that does occur is not contaminated.

As part of the SHBC role in delivering SuDS, policy and guidance should promote the adoption of sustainable drainage techniques on all new developments where appropriate.

8. Flood Risk from Groundwater

8.1.1 Causes and Classifications

Groundwater flooding is caused by the emergence of water originating from sub-surface permeable strata. A groundwater flood event results from a rise in groundwater level sufficient for the water table to intersect the ground surface and inundate or flow from low lying land. Groundwater floods may emerge from either point or diffuse locations. They tend to be long in duration developing over weeks or months and sometimes lasting for days or weeks.

There are many mechanisms associated with groundwater flooding, which are linked to high groundwater levels, and can be broadly classified as:

- Direct contribution to channel flow.
- Springs emerging at the surface.
- Inundation of drainage infrastructure.
- Inundation of low-lying property (basements).

Groundwater levels rise and fall in response to rainfall patterns and distribution, with a time scale of months rather than days. The significance of this rise and fall for flooding, depends largely on the type of ground it occurs in, i.e. how permeable to water the ground is, and whether the water level comes close to or meets the surface.

Groundwater flood events have been recorded in various aquifer units (including Cretaceous Chalk, Limestones, river terrace gravels). Compared to other aquifer units, Chalk is more vulnerable to groundwater flooding because of its geological formation. It contains many pores and fissures which can result in rapid rises in groundwater levels which may take a long time to recede.

The primary controls on the distribution and timing of groundwater flooding include:

- Spatial and temporal distribution of rainfall.
- Spatial distribution of aquifer properties.
- Recharge mechanisms.
- Spatial distribution of geological structures (drift deposits, stratigraphy).
- Efficiency of the surface drainage network.

The likelihood of an area experiencing groundwater flooding can largely be determined on a broad scale through an analysis of the previous meteorological conditions and geological knowledge. This can be helped by the analysis of groundwater boreholes and historic information.

High groundwater levels can result from the combination of geological, hydrogeological, topographic and recharge phenomena. High groundwater levels can mostly be associated with the seven mechanisms described in Table 8-1. Each has been described using the source-pathway-receptor model.

Table 8-1 – Causes of high groundwater levels

Flooding phenomenon	Sources	Pathways	Receptors	Hazard	Characteristics
Rising groundwater levels in response to prolonged extreme rainfall (often near or beyond the head of ephemeral streams)	Long duration rainfall	Permeable geology, mainly chalk	People, properties, environment	Basement flooding/rural ponding	Responsible for the large majority of groundwater flooding. May occur a few days after the rainfall or up to several weeks after. Usually lasts for a number of weeks. An increase in the baseflow of channels, which drain aquifers, is often associated with elevated groundwater levels and may lead to an exceedance of the carrying capacity of these channels. Floodwaters are most often clear and so this form of groundwater flooding may be referred to as 'clear water flooding'. High groundwater levels may also inundate sewer and storm water drainage networks, exceed capacity and lead to flooding in locations, which would otherwise be unaffected. This flooding can be associated with pollution.
Rising groundwater levels due to leaking sewers, drains and water supply mains	Water in water mains, drainage and sewerage networks	Cracks in pipes/permeable strata	People, properties, environment	Basement flooding/water quality issues	Leakage from sewer, storm water and water supply networks can lead to a highly localised elevation in groundwater levels, particularly where the leak is closely associated with chalk bedrock.
Groundwater rebound owing to rising water table and failed or ceased pumping	Groundwater	Permeable geology and artificial pathways e.g. adits	Property, commercial	Basement flooding / flooding of underground infrastructure	Where historic heavy abstraction of groundwater for industrial purposes has ceased, a return of groundwater levels to their natural state can lead to groundwater flooding. This process can potentially cover large areas or maybe associated
Upward leakage of groundwater driven by artesian head	Groundwater emerging from boreholes or through permeable geology	Artesian aquifer and connection to surface	*Property*	Basement flooding / flooding at surface	Mainly associated with short duration and localised events this process can lead to significant volumes of discharge. It can occur in locations where boreholes have been drilled through a confining layer of clay to reach the underlying aquifer.
Inundation of trenches intercepting high groundwater levels	Groundwater	Permeable geology	Property	Routing of floodwaters	The excavation and fill of engineering works with permeable material can create groundwater flow paths. High groundwater levels maybe intercepted, resulting in flooding of trenches and land to which they drain.
Other – alluvial aquifers, aquifer, sea level rise	Rivers, rainfall, sea	Floodplain gravels, permeable geology	Property, environment	Basement flooding / flooding at surface/saline intrusion.	Other mechanisms of groundwater flooding include leakage of fluvial flood waters through river gravels to surrounding floodplains e.g. behind flood defences; and a rise in groundwater levels as a result of adjacent sea level rise as a result of the discharge boundary rising.

8.1.2 Impacts of Groundwater Flooding

The main impacts of groundwater flooding are:

- Flooding of basements of buildings below ground level – in the mildest case this may involve seepage of small volumes through walls, temporary loss of services etc. In more extreme cases larger volumes may lead to the catastrophic loss of stored items and failure of structural integrity.
- Overflowing of sewers and drains – surcharging of drainage networks can lead to overland flows causing significant but localised damage to property. Sewer surcharging can lead to inundation of property by polluted water. Note: it is complex to separate this flooding from other sources, notably surface water or sewer flooding.
- Flooding of buried services or other assets below ground level – prolonged inundation of buried services can lead to interruption and disruption of supply. Service ducts owned by utility companies can also act as drainage runs, conveying water between catchment areas.
- Inundation of farmland, roads, commercial, residential and amenity areas – inundation of grassed areas can be inconvenient, however the inundation of hard-standing areas can lead to structural damage and the disruption of commercial activity. Inundation of agricultural land for long durations can have financial consequences.
- Flooding of ground floors of buildings above ground level can be disruptive, and may result in structural damage. The long duration of flooding can outweigh the lead time which would otherwise reduce the overall level of damages.

Additionally groundwater flooding can cause a change in the structural properties of clay overlying chalk aquifers. This may cause costly damage to structures in the ground and the buildings that they support.

Groundwater flooding has always occurred. It generally occurs more slowly than river flooding and in specific locations. The rarity of groundwater flooding combined with the mobility of the population means that people often do not know there is a groundwater flood risk.

New developments are particularly at risk because little consideration is given to groundwater as a source of flooding in the planning process. The sparse frequency of groundwater flood events can contribute to poor decision-making. The economic and social costs of groundwater flooding are compounded by the relative long duration of events.

The nature and occurrence of groundwater flooding in England is highly variable. 1.7 million properties are vulnerable to groundwater flooding in England (Jacobs 2006). The occurrence of groundwater flooding is very local and often results from the interaction of very site specific factors, e.g. aquifer properties, topography, man-made structures etc.

In general terms groundwater flooding rarely poses a risk to life. However groundwater flooding can be associated with significant damage to property.

The predominantly sandstone bedrock across most of the SHBC study area, means that much of the Borough has a very low susceptibility to groundwater flooding.

8.2 Groundwater Flood Risk Datasets

8.2.1 Historic Records

There are very few records of groundwater flooding across the Borough. The Surrey County Council wetspot database does not attribute any of the incidents to groundwater. The Environment Agency flood incident database also does not identify groundwater as the source of any of the reported incidents. The lack of incidents recorded may not be reflective of the occurrence of groundwater flooding, as groundwater flooding may occur following prolonged rainfall events simultaneously with other types of flooding. Areas of Mytchett & Frimley Green, adjacent to the Blackwater River, were historically excavated for the extraction of gravels. This action has lead to a number of lakes being formed along the Blackwater River, expanding the relative sub-soil saturation area.

8.2.2 BGS Susceptibility to GW Flooding Dataset

Following the particularly wet winter of 2000/2001, the British Geological Survey produced a national dataset on the susceptibility of groundwater flooding. The dataset is based on geological and hydrogeological information and can be used to identify areas where geological conditions could enable groundwater flooding to occur and where groundwater may come close to the surface. It is important to note that it is a susceptibility set, and does not indicate hazard or risk.

The Environment Agency also produce an ‘Areas susceptible to groundwater flooding map’, which is based on some of the information from the BGS maps and information on superficial deposits. Again the dataset identifies susceptibility and not risk.

The British Geological Society groundwater susceptibility Maps are considered to be more detailed and accurate and have a finer resolution to the Environment Agency maps, and therefore identifying groundwater susceptibility in the borough of Surrey Heath has been done based on this dataset. The dataset is classified into four subgroups, as shown in Table 8-2.

Table 8-2 – BGS susceptibility to groundwater flooding classifications

Classification	Description
A	**Limited potential for groundwater flooding to occur:** based on rock type and estimated groundwater level during periods of extended intense rainfall.
B	**Potential for groundwater flooding of property situated below ground level:** based on rock type and estimated groundwater level during periods of extended intense rainfall. Where this may have an impact, you are advised to check that this has not been a problem in the past at this location and/or that measures are in place to sufficiently reduce the impact of the flooding.
C	**Potential for groundwater flooding to occur at surface:** based on rock type and estimated groundwater level during periods of extended intense rainfall. You are advised to check that this has not been a problem in the past at this location and/or that measures are in place to sufficiently reduce the impact of the flooding.
Elsewhere	Not considered to be prone to groundwater flooding: based on rock type.

8.3 Groundwater Flood Risk in Surrey Heath

8.3.1 BGS Susceptibility to GW Flooding Maps

The BGS susceptibility to groundwater flooding dataset has been analysed to identify areas within the Borough which are susceptible to groundwater flooding. The BGS dataset is a susceptibility dataset: it does not indicate hazard or risk and does not provide any information on the depth to which groundwater flooding occurs, or the likelihood of the occurrence of an event of a particular magnitude. It can be used to identify where groundwater flooding is more likely to occur, which has been summarised below. The BGS Susceptibility to groundwater flooding map is shown in Volume 3, Figure 12.

The underlying bedrock across most of the study area is made up of Bracklesham Group and Barton Group sedimentary geology. To the east of Chobham, the bedrock is also sedimentary clays, silts and sands, of the Thames Group bedrock. As a result of relatively impermeable bedrocks with little capacity for storage in underlying aquifers, there is very little potential for groundwater emergence within most of the Borough. Correspondence with the Environment Agency also confirmed that there is no groundwater monitoring across Surrey Heath due to the lack of underlying chalk, and groundwater flood risk is considered very low across most of the Borough.

The BGS groundwater susceptibility dataset does identify a few small pockets of areas where there is potential for groundwater flooding to occur at the surface. These locations include the wetland and parkland areas around Mytchett, areas of central and south west Bagshot, Burrowhill and Valley End and the area surrounding Fairoaks Airport. Most of these locations are on low lying land adjacent to river channels where high water tables and fluvial sand and gravel deposits allow water to easily rise at the surface

The uncertainties associated with assessing flood risk from the BGS groundwater susceptibility datasets are identified within Appendix A.

8.3.2 Climate Change Considerations

There is currently no research specifically considering the impact of climate change on groundwater flooding. The mechanisms of flooding from aquifers are unlikely to be affected by climate change, however if winter rainfall becomes more frequent and heavier, groundwater levels may increase. Higher winter recharge may however be balanced by lower recharge during the predicted hotter and drier summers.

8.4 Management of Groundwater Flood Risk in SHBC

As the Lead Local Flood Authority, Surrey County Council is responsible for managing flood risk from groundwater within Surrey Heath, in conjunction with Surrey Heath Borough Council. The SCC Local Flood Risk Management Strategy does not detail any specific management measures for groundwater flooding within Surrey; however it is recommended that along with other sources of flooding, SHBC should endeavour to record and investigate any groundwater flood incidents to enhance the historic record and understanding of the groundwater flooding mechanism across SHBC.

Groundwater flooding is often highly localised and complex; management is highly dependent on the characteristics of the specific situation. The costs associated with the management of groundwater flooding are highly vulnerable. The implications of groundwater flooding should be considered and managed through development control and building design. Whilst groundwater flood risk across most of Surrey Heath is most likely very low, possible management measures could include:

- Improved conveyance of floodwater through and away from flood prone areas
- Raising property ground or flood levels
- Providing local specific problem areas specific flood proofing
- Replacement and renewal of leaking sewers, underground drains and water supply reservoirs
- The management of SuDS techniques should also be considered in relation to groundwater levels.

Although groundwater flood risk across most of the Borough is very low, it is important it is still considered in all levels of flood risk assessments (FRAs), and is included in the detailed FRA stage. Developers should consider the following indicators that a site may be at risk of groundwater flooding.

- If the development site is near to the junction between geological strata of differing permeability.
- If the development site is located at a similar level to nearby springs, or stream headwaters.
- If the development proposals include basements or excavation into the ground.
- If the vegetation on the site suggests periodic waterlogging due to high groundwater levels.
- If nearby recorded borehole levels reach those of the site ground levels.

9. Flood Risk from Artificial Sources

9.1.1 Description

NPPF describes non-natural or artificial sources of flooding such as reservoirs, canals and lakes where water is retained above natural ground level. NPPF also includes operational and redundant industrial processes including mining, quarrying, and sand and gravel extraction as they may increase water depths and velocities in adjacent areas. In addition to this the impacts of flood management infrastructure and other structures need to be considered. Flooding may result from a facility being overwhelmed or from failure of a structure. Failure of structures can result in rapid, deep flowing water which poses a serious hazard, threatening life and potentially causing major property damage. Failure of pumps may also result in flooding.

For the purpose of the SFRA, flooding from artificial sources has been defined as that arising from failure of man-made infrastructure or human intervention that causes flooding. This includes failure of canals or reservoir embankments, as well as activities such as ground water pumping. To understand flooding from artificial sources the whole hydrological and drainage system must be considered, along with the potential for interaction with other sources of flooding.

The spatial and temporal extent of flooding from artificial sources is highly variable. For example the likelihood of a new reservoir failing is very low compared to that of a canal embankment that is more than one hundred years old. However the consequences of a reservoir failing is potentially catastrophic in comparison to a local canal embankment breaching.

Increased urbanisation, ageing infrastructure and the impacts of climate change can increase the risk of flooding from artificial sources. Table 3-1 identifies the artificial defences and structures, including some balancing ponds across Surrey Heath. Failure of these defences could result in flood risk from artificial sources.

Reservoirs are defined as artificial lakes, used to store water for various uses. They can be either modified natural structures or completely man-made. An 'attenuation' or 'impoundment' reservoir is used to prevent flooding to lower lying lands or regulate flows for abstraction and irrigation purposes. Control reservoirs collect water at times of excess (or unseasonably high) rainfall, then discharge at a rate that can be accommodated by the downstream systems.

Managed or un-managed reservoir release may increase floodwater depths and velocities in adjacent areas. Reservoir flooding may occur from total failure of the civil structure, overtopping of the available retained water level; blockage or malfunction of the water level control system not allowing the system to discharge.

9.1.2 Reservoirs Act

Reservoirs with an impounded volume in excess of 25,000 cubic metres (measured above natural ground level) are governed by the Reservoirs Act 1975 and the Flood and Water Management Act 2010. The Reservoir Act makes owners (undertakers) responsible for the safety of their reservoirs and they are obliged to ensure assessments are undertaken by appropriately qualified engineers on a routine basis.

As Enforcement Authority the Environment Agency has the following key roles:

- Surveillance - maintaining a register of reservoirs for England and Wales.
- Enforcement - achieving compliance.

For reservoirs below the threshold volume of 25,000 cubic metres above ground, regulation is managed by the Health and Safety Executive and they carry out inspections in accordance with the

Health and Safety at Work Act. The Environment Agency has a register of reservoirs and undertakers, as well as a set of risk maps for all reservoirs greater than 25,000 cubic meters.

9.1.3 The Basingstoke Canal

The Basingstoke Canal stretches between the villages of Greywell in Hampshire and Woodham in Surrey. The canal stretches for a distance of 32 miles (51km) incorporating 29 locks to raise the canal from the River Wey up to the plateau in Hampshire which was 245ft (75m) above sea level. The Basingstoke Canal is what is known as a contour canal. This means that as far as possible the canal is built around the side of the hills on a contour maybe 5m above the normal ground level. The system of following contours eventually brings the canal to the same level as the Wey Navigation at New Haw near Byfleet in Surrey. The canal is now fully navigable, and connects to the River Wey Navigation, which in turn joins the River Thames. Hampshire County Council and Surrey County Council originally managed the canal, but management and maintenance is coordinated in partnership with the Basingstoke Canal Authority. This Partnership also comprises six local funding borough and district councils: Hart, Rushmoor, Guildford, Surrey Heath, Woking and Runnymede. Hart District is further comprised of local Parishes and Fleet Town Council who contribute revenue funding to maintain the canal. The Basingstoke Canal is a SSSI designated site and, as such, no foul water should be discharged into it; and with the limited discharge options, nor should large volumes of surface water.

As shown in Volume 3, Figure 1, the Basingstoke Canal passes through the study area, entering to the south west of Mytchett, heading north toward Frimley Green and then east, through Deepcut and exits the study area in the administrative boundary of Guildford Borough Council. The canal does not interact with any main river watercourses during its short reach through the study area but does accommodate surface water connections along its length. Discharge of excess surface water within the canal is discharged through channels in Ash Vale, Pirbright etc.

9.2 Flood Risk from Artificial Sources Datasets

9.2.1 Historic Records

On September 15th 1968, maintenance neglect and a period of exceptionally heavy rain caused the canal to burst its banks in two places, an event which led to the restoration of the Basingstoke Canal. Flooding in Pirbright, Guildford, has also been attributed to discharge from the Basingstoke Canal, into a minor watercourse, when excess flows are experienced at Deepcut locks.

9.2.2 Basingstoke Canal Authority Correspondence

As part of this SFRA update, there was correspondence with the Basingstoke Canal Authority, a voluntary organisation that seeks to restore the canal. Previous data from the 2010 SFRA completed by Capita has been used, and was procured through prior consultation with the Authority. Further information regarding the canal has been inferred from available online sources. However, information regarding weir protocols, previously breached areas, maintenance regimes, and embanked reaches (which may pose a risk in the event of a breach) is not available from the Canal Authority. SHBC has recorded details of flooding to Frimley Lodge Park and Sturt Road (Frimley Green) in 2006, emanating from the Basingstoke Canal, immediately adjacent to the Frimley Lodge Park site.

9.2.3 Environment Agency Reservoir Flood Maps

In April 2008 the Department for Environment Food and Rural Affairs (Defra) instructed the Environment Agency to assess the impact of dam breach flooding from all large raised reservoirs in England and Wales registered under the Reservoirs Act 1975, and produce flood maps for Local Resilience Forums (LRFs) to use for emergency planning.

The maps provide an indication of the areas that could be affected by reservoir flooding and together with local knowledge can be used to plan for emergency response. The maps should be used to prioritise areas for evacuation/early warning and to help reservoir owners produce on-site plans and LRFs produce off-site plans. These maps were provided by the Environment Agency for use within this SFRA.

This flood map only considers embanked “large” reservoirs, and combines the flood extents from several potential breach locations.

9.3 Flood Risk from Artificial Sources

9.3.1 Historic Flooding from Artificial Sources

No information on Historic flood incidents from the Basingstoke Canal within Surrey Heath was provided by Surrey County Council. Information presented in the previous SFRA highlighted that a breach had occurred between the Deepcut Locks 26 and 27 in 1984. A 150 m stretch of embankment breached, resulting in flooding downstream in Guildford Town via surcharging of the drainage system A surface water attenuation system within Deepcut Barracks failed in August 2006, allowing flows to breach and surge into the canal before discharging into the minor watercourse channel and being conveyed onwards into Pirbright. This facility has not been replaced and the discharge into the canal is now direct and unattenuated. Anecdotal information also reported that Tomlins pond has breached its embankment in the past (no known date), resulting in water flowing via an overland route towards Alphington Pond.

Correspondence with the Basingstoke Canal Authority[5] highlighted that there have been very few known incidents within the last 20 years. As the Canal is a contour canal, construction requires that a ledge be excavated around the hill, for which the spoil is then placed on the downhill side of the excavation to form a bank to retain water. Whilst this is considered a low risk form of construction, with drainage and compacted material, there is an inherent residual risk of failure as a result of excess water logging or ground slip / movement. Volume 3, Figure 13 shows the areas subject to residual flood risk from the Basingstoke Canal. The polygons highlight the lower lying areas that would be liable to flooding in the event of embankment breach. These have been identified using OS mapping contour lines and information on the elevation of the Canal.

There is also a probability that the embankments of the canal could be breached, as in 1968 and 2007), which would cause surcharging or backing-up of surrounding drains and causes water logging and flooding of surrounding areas. In-particular, flows can discharge through Frimley Lodge Park and cause flooding under the Sturt Road railway bridge.

Increased water level within the canal is directly affected by excessive rainfall and increased surface water runoff from diverted road drains, public sewer systems and railway drainage. It should be noted however, that the Canal can also reduce flood risk in other areas by carrying surface water runoff away from main river channels and developed areas.

The section through the study area is not culverted and therefore there is no risk from poor culvert maintenance.

Embankments and containment bunds/watercourses running parallel to the canal are susceptible to failure once the channel is breached.

[5], Surrey County Council, 17th March 2015

Discharge channels are culverted away from the canal and have potential to block, misdirecting flows and forcing discharge through other connections. These connection points will require maintenance.

9.3.2 Flood Risk from Reservoirs

The Environment Agency Reservoir Flood Map has been used to identify areas at risk of reservoir flooding. Reservoir flooding is extremely unlikely to happen; there has been no loss of life in the UK from reservoir flooding since 1925. Although potentially large uncontrolled releases of water from the reservoirs could result in deep and fast moving floodwaters and place people's lives in danger, the probability of occurrence is very low, and therefore flood risk is considered as low. The extents of the breaches mapped in Volume 3 Figure 13, indicate the credible worst case scenario and are unlikely to occur at such a great extent.

Flood risk from Reservoirs across Surrey Heath is mostly very low. Only areas along the River Blackwater are at risk; there EA dataset shows no risk across the Bourne catchments.

Failure of the Mytchett Lake reservoir infrastructure has the potential to cause flooding to properties in Mytchett, along Mytchett Road. Most of the other areas subject to inundation are wetland and parkland areas. The outlines generally follow the Blackwater channel, with similar extents to the fluvial outlines.

North of the M3, failure of the Hawley Lake and the Cove Brook FSR infrastructure (outside of the study area) could cause an increased risk of flooding to the downstream regions. All of these reservoirs are to the south west of the study area, and pose a risk as a result of the confluence of the Cove Brook tributary.

The uncertainties associated with assessing flood risk from the Environment Agency Reservoir Inundation Maps and the Basingstoke Canal are identified within Appendix A.

9.3.3 Climate Change Considerations

Based on information collated as part of the UK Climate Change Projections 2009 (UKCcP09)[6], there is likely to be an increased vulnerability of reservoir flooding in response to climate change. This is most likely due to changes in yields, flood flows, water quality and source waters, based in changes in demand, river flows and rainfall events. The UKCcP09 document provides guidance on responding and adapting to climate change for reservoir management.

9.4 Management of Flood Risk from Artificial Sources

Summer Weir Protocols ensures that the adjustable sections of weirs in the Surrey section of the canal will be restored to their normal working heights to maintain full water levels in the canal. *Winter Weir Protocols* require the adjustable sections of weirs on the Surrey section of the canal to be reduced in height by 100mm to establish a flow on the canal towards the weirs. In the event of extreme rainfall or a canal emergency, the protocol states that the canal should be isolated into discrete sections, which can then be controlled via the use of sluices. In the case of an emergency it is advised in the protocol that the sluices are fully drawn to allow canal water to drain quickly. Although this would result in an immediate relief of flood risk to the area, this action does cause flooding problems elsewhere in the vicinity. In such an event the Environment Agency would be informed of this magnitude of weir movement.

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[6] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/399993/RFI7086_DG09_Guidance_Final.pdf

It is recommended that SHBC consider the flood risk from canal breach when identifying development sites.

The flood risk from reservoirs within the study area is very low, as the probability of occurrence is very low but the potential consequences are high. SHBC should attempt to avoid development within the areas that are at potential risk of inundation from reservoirs. However these generally follow well defined river channels and are similar to the areas at risk of fluvial flooding, and should be avoided where possible.

10. Conclusions

The SFRA has identified that the significant sources of flood risk within the Surrey Heath Borough Council are fluvial and surface water flooding. A summary of flood risk across the Borough from all sources is shown in Table 10-1

Table 10-1 – Flood Risk Across Surrey Heath

Type of Flood Risk	Summary	Further information
Fluvial	The EA Flood Maps for Planning, Historic Flood incidents and detailed modelling outlines were used to evaluate fluvial flood risk across the Borough. Fluvial flood risk is detailed along the river valleys of the Blackwater and Bourne catchment areas including some main-river designated tributaries. In the Bourne catchment floodplains are wide, with large areas at risk, however much of this land is undeveloped. The floodplains of the Blackwater River are more developed, with higher property densities at medium to high risk.	Volume 2, Chapter 4 Volume 3, Figure 4, 5, 6 & 7
Surface Water	The UFMfSW has been used to assess surface water flood risk across SHBC as there are very limited details on recorded incidents. Similarly to the fluvial extents, large undeveloped floodplains are shown as at medium risk of surface water flooding. Developed areas at high risk include parts of the A30 through Camberley, and central parts of Bagshot, Lightwater and Chobham.	Volume 2, Chapter 5 Volume 3, Fig 8, 9 & 10
Sewers	The developed western side of the borough will experience more sewer flood incidents, as denser drainage networks increase the probability of sewer flood incidents. Areas to the east of the borough are more reliant upon the watercourse network for surface drainage. There are no combined (surface/foul) sewers within SHBC however, due to the age of some properties foul drainage systems can also accommodate incorrectly connected surface water flows. This can lead to overload and surcharge of the foul drainage systems.	Volume 2, Chapter 7 Volume 3, Fig 11
Ground water	Most of the study area is at low risk of groundwater flooding due to the underlying sandstone geology. There is elevated flood risk from groundwater at Mytchett, and Central Chobham, in-particular where close proximity of watercourses saturate surrounding ground.	Volume 2, Chapter 8 Volume 3, Fig 12
Artificial Sources	There are very few incidents of flooding from the Basingstoke Canal or from the breach of reservoirs. The Basingstoke Canal has discharge channels to convey excess water away when the levels within the canal rise too high. These discharge points can cause problems to neighbouring boroughs, as well as failure within the borough at Frimley Green. The upper reaches of the Basingstoke Canal are a navigable natural watercourse and surface water connections are known to be present throughout its length. The Basingstoke Canal is therefore subject to high volume flows from heavy or prolonged rainfall. Due to the low probability of occurrence, flood risk from reservoirs is considered extremely low along the Blackwater River.	Volume 2, Chapter 9 Volume 3, Fig 13

Fluvial and surface water flooding are particularly problematic, with the Borough historically experiencing significant problems to some areas, however continuous effort is made by the Local Flood Risk Authorities to provide betterment to areas at risk. Volume 3, Figure 5 and Figure 8 provides an overview of fluvial and surface water flood risk in the Borough. It is recognised that much of the large scale flooding occurs in undeveloped rural land, but the urbanised areas are at increased risk of flooding from both sources.

It is recommended that SHBC liaises with SCC to embrace new policy and guidelines surrounding surface water management practices. This should be supported through the results of new Surface Water Management Plans, of which this SFRA has made recommendations on.

There is a high risk of fluvial flooding along the main river corridors of the Blackwater River and its tributaries, as well as the Bourne and its tributaries. Defence maintenance along the channels will ensure fluvial flood risk is reduced, now and in the future.

Future climate change predictions imply that surface water, sewer and groundwater flooding will become more frequent; therefore the Council will need to plan for future emergencies, become proactive in mitigating against the risk, (and provide guidance to residents on how they too can mitigate against the impacts of this type of flooding in SHBC). Application of the Sequential Test should ensure that development is steered towards areas with the lowest flood risk. Sites at a higher risk of flooding should only be considered if there are no alternative “reasonably available” sites.

Guidance has been given to the LPA on what types of development are suitable in each of these Flood Zones according to the NPPF. The information presented within this Volume should be used to support SHBC in carrying out the Sequential Test to ensure the appropriate developments can be placed in the areas of lowest flood risk. Once SHBC have carried out the Sequential Test on all of the sites identified for development, subject to meeting the requirements of the Exception Test, developers will be able to complete of an appropriate site specific FRA to conclude that development of the site is safe in respect to flood risk. It is essential that Flood Risk Assessments submitted with development proposals take into account the findings of this SFRA, and assess flood risk from all potential sources. Proposals should demonstrate safe access and egress to the development can be maintained during an extreme flood event and that development is set at an appropriate level so that the residual risks are managed to acceptable levels.

Where the site falls within an area which is classified as being at High or Medium Residual Risk, the detailed FRA should include a detailed assessment of the residual risks posed by the existing defences being breached or overtopped in an extreme event (usually the 0.1% AEP plus climate change if available). Developers should seek advice from the Council, the Environment Agency and Thames Water as to the specific requirements for assessment.

11. References

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12. Glossary

Term	Definition
Alluvium	Sediments deposited by fluvial processes / flowing water
Annual Exceedance Probability (AEP)	The probability of an event occurring within any one given year.
Attenuation	In the context of this report - the storing of water to reduce peak discharge of water
Aquifer	A source of groundwater comprising water-bearing rock, sand or gravel capable of yielding significant quantities of water.
Breach	An opening – For example in the sea defences
Brownfield	Previously developed land, usually of industrial land use within inner city areas.
Catchment Flood Management Plan	A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
Culvert/culverted	A channel or pipe that carries water below the level of the ground.
Drift Geology	Sediments deposited by the action of ice and glacial processes
EA Flood Zone 1	Low probability of flooding
EA Flood Zone 2	Medium probability of flooding. Probability of fluvial flooding is 0.1 – 1%. Probability of tidal flooding is 0.1 – 0.5 %
EA Flood Zone 3a	High probability of flooding. Probability of fluvial flooding is 1% (1 in 100 years) or greater. Probability of tidal flooding is 0.5%(1 in 200 years)
EA Flood Zone 3b	Functional floodplain
Estuary	A tidal basin , where a river meets the sea, characterised by wide inlets
Exception Test	The exception test should be applied following the application of the Sequential Test. Conditions need to be met before the exception test can be applied.
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Floodplain	Area adjacent to river, coast or estuary that is naturally susceptible to flooding.
Flood Resilience	Resistance strategies aimed at flood protection
Flood Risk	The level of flood risk is the product of the frequency or likelihood of the flood events and their consequences (such as loss, damage, harm, distress and disruption)
Flood Risk Assessment	Considerations of the flood risks inherent in a project, leading to the development actions to control, mitigate or accept them.
Flood storage	A temporary area that stores excess runoff or river flow often ponds

	or reservoirs. This is a type of attenuation storage
Flood Zone	The extent of how far flood waters are expected to reach.
Fluvial	Relating to the actions, processes and behaviour of a water course (river or stream)
Fluvial flooding	Flooding by a river or a watercourse.
Freeboard	Height of flood defence crest level (or building level) above designed water level
Functional Floodplain	Land where water has to flow or be stored in times of flood.
Freeboard	Height of the flood defence crest level (or building level) above designed water level.
GIS	Geographic Information System – A mapping system that uses computers to store,manipulate, analyse and display data
Greenfield	Previously undeveloped land. Runoff rates should be returned to Greenfield rates wherever possible or a sustainable reduction runoff rate.
Groundwater	Water that is in the ground, this is usually referring to water in the saturated zone below the water table.
Highly Vulnerable Developments	Developments that are at highest risk of flooding.
Hydraulic Modelling	A computerised model of a watercourse and floodplain to simulate water flows in rivers too estimate water levels and flood extents.
Hydrodynamic Modelling	The behaviour of water in terms of its velocity, depth and hazard that it presents. Infiltration The penetration of water through the grounds surface.
Infrastructure	Physical structures that form the foundation for development. Inundation Flooding.
LiDAR	Light Detection And Ranging – uses airborne scanning laser to map the terrain of the land.
Local Plan	
Local Planning Authority	Body that is responsible for controlling planning and development through the planning system.
Main River	Watercourse defined on a 'Main River Map' designated by DEFRA. The environment Agency has permissive powers to carry out flood defence works, maintenance and operational activities for Main Rivers only
Mitigation measure	An element of development design which may be used to manage flood risk or avoid an increase in flood risk elsewhere.
Ordinary Watercourse	An ordinary watercourse is every river, stream, ditch, drain, cut, dyke, sluice, sewer (other than a public sewer) and passage through which water flows, but which does not form part of a main river.
Overland Flow	Flooding caused when intense rainfall exceeds the capacity of the drainage systems or when, during prolonged periods of wet weather, the soil is so saturated such that it cannot accept any more water.
Overtopping	Water carried over the top of a defence structure due to the wave height exceeding the crest height of the defence.
Reach/ Upper reach	A river or stream segment of specific length. The upper reach refers to the upstream section of a river.
Residual Flood Risk	The remaining flood risk after risk reduction measures have been taken into account.
Return Period	The average time period between rainfall or flood events with the same intensity and effect.

Risk	The probability or likelihood of an event occurring.
River Catchment	The areas drained by a river
SAR	Synthetic Aperture Radar - a high resolution ground mapping technique, which uses reflected radar pulses.
Sequential Test	Aims to steer development to areas of lowest flood risk.
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
Solid Geology	Solid rock that underlies loose material and superficial deposits on the earth's surface
Source Protection Zone	Defined areas in which certain types of development are restricted to ensure that groundwater sources remain free from contaminants.
Standard of Protection	The flood event return period above which significant damage and possible failure of the flood defences could occur.
Storm surge	A high rise in sea level due to the winds of the storm and low atmospheric pressure.
Surcharge	To overload or overfill, such that water is not contained.
Sustainability	To preserve /maintain a state or process for future generations.
Sustainable drainage system	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Sustainable development	Development that meets the needs of the present without compromising the ability of future generations meeting their own needs
Tidal	Relating to the actions or processes caused by tides.
Topographic survey	A survey of ground levels.
Tributary	A body of water, flowing into a larger body of water, such as a smaller stream joining a larger stream.
UFMfSW	Updated Flood Map for Surface Water; Environment Agency flood maps that provide indication of the broad areas likely to be at risk of surface water flooding, i.e. areas where surface water would be expected to flow or pond.
1 in 100 year event	Event that on average will occur once every 100 years. Also expressed as an event, which has a 1% probability of occurring in any one year.
1 in 100 year design standard	Flood defence that is designed for an event, which has an annual probability of 1%. In events more severe than this the defence would be expected to fail or to allow flooding.

Appendix A Uncertainties in Flood Risk Assessment

When assessing risk, the impact of uncertainties associated with the predictions of the hazard and the consequences should be recognised and appreciated so informed decisions can be made.

This SFRA update addresses the inherent uncertainties and where necessary seeks to institute measures for their reduction.

The strategy for risk management requires that all phases of the planning and implementation process are fully co-ordinated. The level of detail on flood risk assigned to particular proposals will be limited by the information available at the time of the submission of respective planning applications. It should be noted that the outputs of the SFRA are only as good as the data inputs.

The Surrey Heath SFRA is owned by Surrey Heath Borough Council and should be kept as a live document, reviewed and updated as necessary as the best available information is improved or the inherent uncertainties identified are reduced. Ownership of the SFRA document and maps within SHBC will be established by the SFRA Steering Group. The implementation of measures or strategic options may change the Actual Risk, Residual Risk and Flood Hazard.

Other future uncertainties that will affect the estimate of flood risk in the Surrey Heath SFRA study area during the course of the planning an implementation of the Surrey Heath development options include (but are not limited to):

- Updated hydrological and hydraulic modelling studies
- Changes to the upstream catchment and river channel
- Changes in land use within and upstream of the study area,
- Revision of climate change predictions

It is probable that development proposals will be a focus for the collection of better data in the future and the catalyst for commissioning studies that lead to a reduction in the uncertainty in the magnitude or frequency of influential parameters, i.e. the improvement of hydrometric data, or completion of new hydraulic models on previously unmodelled reaches. A prudent response is to use the best available data at each stage of the planning process and prepare proposals that are respectively precautionary in accordance with the advice in PPG and flexible with respect to uncertainty. The need to prepare stand alone Flood Risk Assessments in support of the submission of particular planning applications will serve to highlight information that would be the trigger for a review of the Surrey Heath SFRA.

The surrey Heath SFRA is based on information that will inevitably be amended by better data, changes in the baseline condition due to development and changing institutional and policy conditions. To be robust and able to withstand challenge in the planning process there is a need to ensure the SHBC SFRA reflects conditions at the time particular evaluations are made. Failure to maintain the SFRA may reduce the effectiveness of flood risk management measures; delay plan making and development processes; and potentially lead to the neglect of flood risk considerations and the failure to capture strategic responses and interventions.

The Planning Policy Team at SHBC will have the prime responsibility for managing and maintaining this SFRA. The SFRA will be reviewed annually as part of the annual monitoring report.

Flood Risk from Rivers

The following section summarises the uncertainties and assumptions associated with the hydraulic modelling completed on the watercourses in the area:

- The flows predicted using the hydrological analyses for the Bourne catchment rely on data from a system of gauges that are generally not accurate at high flow magnitudes;
- Topographic data that is used to determine flood extents in the modelling are of limited accuracy due to the techniques used for its production. This has a significant bearing on the uncertainty and accuracy of the flood mapping produced;
- Not all flood defences may have been considered/more may have been constructed following the modelling studies; and
- Not all watercourses in the study area have been specifically hydraulically modelled for this SFRA. Quantification of flood risk on these watercourses is subject to greater uncertainty.

It is also worth noting when considering flood risk that the historic record of flooding is not complete and could be supplemented in future updates of the SFRA. Furthermore when considering the climate change scenario, the additional 20% in magnitude peak flow added to the 1% AEP flood event is not definitive and peak flows could in actuality be more or less.

Flood Risk from Surface Water

The supporting guidance document to the uFMfSW highlights the limitations inherent to the dataset. The following uncertainties therefore apply to the flood risk from surface water:

Although the uFMfSW is a significant improvement on past nationally produced surface water flood mapping, it is important not to lose sight of the limitations which remain. These include the following:

- The methodology assumed a single drainage rate for all urban areas within the nationally produced modelling unless LLFAs were able to provide better local data. Modelled flood extents are particularly sensitive to the way drainage is taken into account. Omitting large subsurface drainage elements such as flood relief culverts and flood storage can also significantly affect the modelled pattern of flooding.
- The nationally produced modelling assumes a free outfall and so does not take into account tide locking or high river levels which may prevent surface water from draining away freely.
- Limited recorded surface water flood data exists for LLFAs, so in many places LLFAs have not yet been able to validate the nationally produced modelling.
- As with many other flood models:
    - The input information, model performance and modelling that was used to create the nationally produced modelling varies for different areas. For example, in many areas, the ground level data is based on detailed LIDAR information, but where this is not available ground levels are much less accurate. Similarly, models of this type tend to perform better in steeper rural areas than in flat urban areas. These variations affect the reliability of the mapped flood extents and, in turn, the suitability for different applications.
    - UFMfSW does not take individual property threshold heights into account so the map shows areas that may potentially flood but cannot accurately predict the impacts on individual properties.
    - The flood extents show predicted patterns of flooding based on modelled rainfall. The patterns of flooding from two similar storm events can vary due to many local circumstances.

Consequently these maps cannot definitively show that an area of land or property is, or is not, at risk of flooding, and the maps are not suitable for use at an individual property level.

Flood Risk from Sewers

Assessing the risk of sewer flooding over a wide area is limited by the lack of data and the quality of data that is available. Furthermore, flood events may be a combination of surface water, groundwater and sewer flooding.

An integrated modelling approach is required to assess and identify the potential for sewer flooding but these models are complex and require detailed information. Obtaining this information can be problematic as datasets held by stakeholders are often confidential, contain varying levels of detail and may not be complete. Sewer flood models require a greater number of parameters to be input and this increases the uncertainty of the model predictions.

Existing sewer models are generally not capable of predicting flood routing (flood flow routes and receptors) in the above ground network of flow routes (for example, streams, dry valleys, and highways).

Use of historic data to estimate the probability of sewer flooding is the most practical approach; however it does not take account of possible future changes due to climate change or future development. Nor does it account for improvements to the network, including clearance of blockages, which may have occurred.

Flood Risk from Groundwater

The supporting document to the British Geological Society outlines the limitations of the dataset and highlights the importance of using the information in conjunction with other flood risk data. The following is taken from the supporting document.

The susceptibility data is suitable for use for regional or national planning purposes where the groundwater flooding information will be used along with a range of other relevant information to inform land-use planning decisions. It might also be used in conjunction with a large number of other factors, e.g. records of previous incidence of groundwater flooding, rainfall, property type, and land drainage information, to establish relative, but not absolute, risk of groundwater flooding at a resolution of greater than a few hundred metres. The susceptibility data should not be used on its own to make planning decisions at any scale, and, in particular, should not be used to inform planning decisions at the site scale. The susceptibility data cannot be used on its own to indicate risk of groundwater flooding.

Flood Risk from Artificial Sources

The reservoir flood map outline shows the largest area that might be flooded if the reservoir fails and releases all of the water it holds, which is extremely unlikely, and is a prediction of worst case scenario. Actual flood risk is considered to be much lower than these outlines show. The flood map does not include smaller reservoirs or reservoirs commissioned after spring 2009 (when mapping began).

Flood risk from the Basingstoke Canal has been assessed based on areas susceptible to breach, failure and overtopping during the 2010 SFRA. Degradation as well as maintenance of embankments will affect the risk of failure, which has not been considered in the assessment.

Appendix B Managing Surface Water with SuDS

What is the SuDS Approach?

The SuDS approach is centred on mimicking natural drainage. SuDS encourages the management of water as close to its source as possible, using features that collect, filter, store and/or infiltrate water using mechanisms similar to that found in nature. SuDS practices should be designed taking the following criteria into consideration:

- water quantity;
- water quality; and
- amenity/biodiversity.

Water Quantity

SuDS practices can play a key role in managing surface water through two mechanisms: runoff rate and storage volumes. As SuDS features often utilize pervious surfaces, they reduce runoff rates from the site compared to conventional development comprised primarily of impervious surfaces. SuDS can also help supplement the volume of water that must be stored on-site (attenuation volume) to achieve the desired runoff rate from the site. SuDS practices can store and/or infiltrate surface water into the surrounding soil, providing the necessary for attenuation storage for frequent rainfall events.

Water Quality

SuDS techniques help to improve surface water quality through the use of a 'Management Train,' which recommends incorporating a chain of techniques throughout a development, (as outlined in CIRIA C697 (Woods Ballard *et al*, 2007), where each component adds to the performance of the whole system. The Management Train approach consists of four stages:

- **Prevention** good site design and upkeep to prevent runoff and pollution (e.g. limited paved areas, regular pavement sweeping)
- **Source control** runoff control at/near to source (e.g. rainwater harvesting, green roofs, pervious pavements)
- **Site control** water management from a multitude of catchments (e.g. route water from roofs, impermeable paved areas to one infiltration/holding site)
- **Regional control** integrate runoff management from a number of sites (e.g. into a wetland).

Amenity/Biodiversity

As SuDS techniques can be integrated within the fabric of a site they provide opportunities to create amenity areas and improve the site's biodiversity. Many SuDS techniques are landscaped with grasses and/or plantings that help to create green streets, neighbourhoods and commercial/industrial properties. SuDS can also be implemented as part of multi-functional places, enabling both the management of surface water and other uses like recreation within the same space.

SuDS Techniques

There are a wide range of SuDS techniques available for use throughout the four stages of the Management Train. Techniques available to manage the quantity of surface water typically operate in combination or solely on the basis of the following two main principles:

- Infiltration
- Attenuation

The effectiveness of techniques in achieving the goals of attenuating discharges, reducing pollution and providing amenity benefit will depend on a number of other factors such as filtration, settlement and oxidation.

The SuDS Manual (C697)[7] provides a summary of SuDS techniques and their suitability to meet the three goals of sustainable drainage systems (water quantity, water quality and amenity biodiversity) and their suitability within the stages of the Management Train. Table 12-1Table B-1 presents a summary of a variety of SuDS techniques along with their suitability in achieving the goals of sustainability and their place within the Management Train.

[7] CIRIA, The SUDS Manual (C697), March 2007

Table B-1: Summary of SuDS Techniques and their Suitability to meet the three goals of sustainable drainage systems

Management Train	SuDS Technique	Description	SuDS Principle	Water Quantity	Water Quality	Amenity Biodiversity
Source, Prevention	Green roofs	Layer of vegetation or gravel on roof areas providing absorption and storage.	Attenuation	●	●	●
Source, Prevention	Permeable pavements	Infiltration through the surface into underlying layer.	Infiltration	●	●	○
Source, Prevention	Arboriculture	Additional planting of trees and or hedgerows in and upstream of areas of high risk, to intercept run off and increase infiltration.	Infiltration / Attenuation	●	●	●
Source, Prevention	Filter drains	Drain filled with permeable material with a perforated pipe along the base.	Infiltration	●	●	X
Source	Infiltration trenches	Similar to filter drains but allows infiltration through sides and base.	Infiltration	●	●	X
Source	Soakaway	Underground structure used for store and infiltration.	Attenuation	●	●	X
Source	Bio-retention areas	Vegetated areas used for treating runoff prior to discharge into receiving water or infiltration	Attenuation	●	●	●
Source	Swales	Grassed depressions, provides temporary storage, conveyance, treatment and possibly infiltration.	Attenuation	●	●	○
Source, Site	Sand filters	Provides treatment by filtering runoff through a filter media consisting of sand.	Infiltration	●	●	X
Site	Basins	Dry depressions outside of storm periods, provides temporary attenuation, treatment and possibly infiltration.	Attenuation	●	●	○
Site, Regional	Ponds	Designed to accommodate water at all times, provides attenuation, treatment and enhances site amenity value.	Attenuation	●	●	●
Site, Regional	Wetlands	Similar to ponds, but are designed to provide continuous flow through vegetation.	Attenuation	●	●	●

Key: ● – highly suitable, ○ - suitable depending on design, X – unsuitable

Design of SuDS techniques

Detailed guidance for the design of SuDS, including specific guidance for individual SuDS techniques is available in the CIRIA SuDS Manual C697, and the associated document 'Site Handbook for the Construction of SuDS, C698 (Woods Ballard *et al*, 2007a). These publications provide best practice guidance on the planning, design, construction, operation and maintenance of SuDS to ensure effective implementation within developments.

The design of SuDS measures should be undertaken as part of a drainage strategy and design for a development site. A ground investigation should form part of the SuDS assessment to determine ground conditions and the most appropriate SuDS technique(s). Hydrological analysis should be undertaken using industry approved procedures to ensure an appropriate design is developed. This should account for the effects of climate change over the lifetime of the proposed system/development and based on an agreed permitted rate of discharge from the site.

During the design process, liaison should take place with the authority responsible for the receiving water body and any organisations involved in the long term maintenance of the system. This may include liaison with Hart District Council, Guildford Borough Council, Waverley Borough Council and Woking Borough Council, the Environment Agency (West Thames Area) and Thames Water. The adjacent borough Councils should also be contacted, including Hart, Runnymede and Woking. Liaison with these organisations should focus on establishing a suitable design methodology, any restrictions and provision for the long-term maintenance of the SuDS system.

Incorporating SuDS into a site plan

The flexibility of SuDS to be placed throughout a site, to meet a variety of criteria and be integrated within the urban fabric means that it is suitable for a wide range of land use types, site topographies and geology. Often a successful SuDS solution will utilise a number of techniques in combination, providing flood risk, pollution and landscape/wildlife benefits to the site and surrounding area. This section provides some guidance on how to incorporate SuDS techniques as part of the master planning and outline planning stages. It has been adapted from C687 Planning for SuDS.

Examine site topography and geology

During this stage, characterize the existing site topography to determine natural flow paths. Bedrock and superficial geology can be used as an initial tool to determine locations where SuDS techniques should be located to maximize their infiltration potential. More in-depth analysis of soil conditions, including borehole testing and soakage testing are required to confirm the suitability of SuDS techniques and their ideal placement upon the site.

Create a spatial framework for SuDS

The next step in the planning process is to develop an estimate of impermeable (paved roadway and buildings) and permeable surface across the site. This information is used to assess pre- and post-development runoff rates and volumes, from which attenuation storage/infiltration targets can be set. The number, type(s) and size of SuDS practices can then be determined as part of the surface water management scheme at the site.

Look for multi-functional spaces

Look for areas of the site where SuDS practices could be integrated within the urban fabric, for instance locating SuDS in planned green space, within a play area.

Integrate the street network with SuDS

The street network is one of the most important areas to incorporate SuDS. Swales can be located along the road network to accept street runoff, tree planters can be configured to accept runoff from roads and car parks and the use of rain gardens and bioretention techniques can be used to create 'green streets' that improve the amenity of a property. Large below-ground storage/infiltration practices can also be located beneath the street network or car parks. Pervious pavement construction should be considered for all hard surface areas including car parks and highway.

A common concern with incorporating SuDS in developments is the belief that all SuDS are 'land hungry' and can significantly impact on the developable area of sites. By applying the principles discussed above, SuDS can be considered at the earliest opportunity, ensuring that they are integrated within the site to use as little land as possible, whilst creating multi-functional spaces that improve the amenity value of the property. In addition, SuDS can be employed on a strategic scale, for example with a number of sites contributing to large scale jointly funded and managed SuDS, however, each development site must offset its own increase in runoff; attenuation cannot be "traded" between developments.

SuDS Constraints

The underlying ground conditions of a development site will often influence the type(s) of SuDS technique suitable at an individual site. While this will need to be determined through ground investigations carried out on-site, an initial assessment of the site's suitability to the use of SuDS can be obtained from a review of the available soils/geological survey of the area.

Parts of the Surrey Heath Borough are located on sandstone which is suitable geology for the use of infiltration based SuDS. Sustainable drainage can also be achieved within areas of high groundwater by the use of ponds, swales and wetlands when managed and implemented appropriately. There are a no identified groundwater abstractions within the Borough, or Source Protection Zones, and therefore there are very few limiting factors on the types of infiltration based SuDS. It is recommended that for all sites where infiltration drainage is proposed, on-site tests are carried out to determine specific infiltration rates.

It is recommended that developers should consult SHBC, the Environment Agency, relevant service authorities and Utility Companies at the earliest stage of the development process to establish the best solution for a particular site.

During the design process, in addition to considering the properties of the underlying soils and strata it is necessary to also consider the sensitivity of the receiving water body and any previous uses of the site.

The use of SuDS can be limited based on a number of constraints, which include:

- Groundwater vulnerability and potential contamination of an aquifer;
- Current or target water quality of a receiving watercourse;
- The presence of groundwater Source Protection Zones and potential contamination of a potable water source;
- Restrictions on infiltration on contaminated land to prevent the spread of contamination; and,
- Restricted area on development sites where housing densities are high.

Groundwater Vulnerability

Groundwater resources can be vulnerable to contamination from both direct sources (e.g. into groundwater) or indirect sources (e.g. infiltration of discharges onto land). Groundwater vulnerability within the study area has been determined by the Environment Agency based on a review of aquifer characteristics, local geology and the leachability of overlying soils.

The vulnerability of the groundwater is important when advising on the suitability of SuDS. The Environment Agency is the responsible drainage authority for any discharges to groundwater and should be consulted on proposals to discharge to ground. Groundwater vulnerability for the study area can be assessed by reviewing the most up-to-date maps on the Environment Agency's website.

Groundwater Source Protection Zones

In addition to groundwater vulnerability, the Environment Agency also defines groundwater Source Protection Zones (SPZs) around groundwater abstraction points. Source Protection Zones are defined to protect areas of groundwater that are used for potable supply, including public/private potable supply, (including mineral and bottled water) or for use in the production of commercial food and drinks.

SPZs are defined based on the time it takes for pollutants to reach an abstraction point. Depending on the nature of the proposed development and the location of the development site with regards to the SPZs, restrictions may be placed on the types of SuDS appropriate to certain areas.

Any restrictions imposed on the discharge of site generated runoff by the Environment Agency will be determined on a site by site basis using a risk based approach. SPZ for the study area can be assessed by reviewing the most up-to-date maps on the Environment Agency's website.

Water Quality

Under the Water Framework Directive all member states are required to take steps to achieve good ecological status of water bodies by 2015. To achieve this, discharges to watercourses draining development areas will require pre-treatment to remove oils and contaminants. Appropriately designed SuDS can assist developments improve water quality discharges through passive treatment, whilst additionally providing ecological benefit to a development or local area. Developments should be connected to the public sewer network, unless this is proven unreasonable, to help protect water quality.

Contaminated Land

Previous site uses can leave a legacy of contamination that if inappropriately managed can cause damage to local water bodies. During the design of SuDS it is essential to have regard to the nature of potential ground contamination.

Particular restrictions may be placed on infiltration based SuDS, forcing consideration of attenuation based systems. Early discussion with the authority responsible for the receiving water body should be undertaken to establish the requirements of SuDS on contaminated sites.

High Development Densities

Where developments are required to achieve high development densities it is essential that the requirement for SuDS and their constraints are identified early in the site master planning process. High development densities can restrict the land area available for SuDS, which if mandatory can affect the ability of a site to gain planning permission.

Early consideration of SuDS enables the drainage requirements to be integrated with the design, limiting the impact they have on developable area and development densities.

Further Guidance on SuDS

- CIRIA C635 Designing for Exceedance in Urban Drainage – Good Practice (2006)
- CIRIA C687 Planning for SuDS – Making it Happen (2010)
- CIRIA C697 The SUDS Manual (2007)
- CIRIA C698 Site Handbook for the Construction of SuDS (2007)
- Communities and Local Government – Guidance on the Permeable Surfacing of Front Gardens (2008)
- London Borough of Islington - Promoting Sustainable Drainage Systems (2013)
- CIRIA C609 Sustainable Drainage Systems – Hydraulic, structural and water quality advise (2004