Crawley Borough and Upper Mole Catchment Level 1 Strategic Flood Risk Assessment

Final Report

December 2023

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Crawley Borough Council &
Horsham District Council

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Revision history

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Version 1 / March 2020	Draft Report	Anthony Masson (Crawley Borough Council) and Carol Algar (Horsham District Council)
Version 2 / June 2020	Draft report for review following updates	Anthony Masson (Crawley Borough Council) and Make Daly (Horsham District Council)
Version 3 / September 2020	Final Report	Anthony Masson (Crawley Borough Council) and Make Daly (Horsham District Council)
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Version 5 / 2023	Final updated report	Anthony Masson (Crawley Borough Council)

This report describes work commissioned by Anthony Masson of Crawley Borough Council, by an email dated 18 November 2019. Ed Hartwell, Anna Hastings, Kate Fairfield and Alistair Dale of JBA Consulting carried out this work.

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Purpose

This document has been prepared as a Final Report for Crawley Borough Council & Horsham District Council. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally

commissioned and prepared. JBA Consulting has no liability regarding the use of this report except to Crawley Borough Council & Horsham District Council.

Acknowledgements

We would like to acknowledge the assistance of Crawley Borough Council, Horsham District Council, West Sussex County Council, The Environment Agency, Thames Water and the neighbouring authorities of Reigate and Banstead Borough Council, Tandridge District Council, Mid Sussex District Council and Mole Valley District Council.

Executive summary

Introduction

The study area for this Strategic Flood Risk Assessment (SFRA) is the Crawley Borough Council area and the section of the Upper Mole Catchment which is situated within Horsham District Council. This 2023 SFRA document supersedes the previous Crawley Borough and Upper Mole Catchment Level 1 SFRA, 2020. The report has been prepared to provide comprehensive and supporting evidence for the emerging Local Plan Reviews, of the **Crawley Borough Local Plan** and **Horsham District Local Plan**, both adopted in 2015.

The SFRA update is required to be compliant with the latest guidance described in the revised National Planning Policy Framework (NPPF) (February 2019, updated July 2021) and accompanying Planning Practice Guidance (PPG, updated August 2022). The 2023 SFRA provides flood risk evidence and long-term strategy to support the management and planning of development, protect the environment and deliver infrastructure. It also supports the selection of site allocations in Local Plan reviews and provides information and guidance to be used in the preparation of Flood Risk Assessments in support of site-specific planning applications.

SFRA objectives

The key objectives of the 2023 SFRA are:

- To take account of best practice, the latest guidance and the most up to date information.
- To assess the flood risk to and from the study area from all sources, now and in the future, as well as assess the impact that cumulative land use changes and development in the area will have on flood risk.
- To be a robust piece of evidence to inform the review of the Crawley Borough and Horsham District Local Plan, so that flood risk is fully accounted for when considering allocation options and guide development to the safest areas.
- To inform the application of the Sequential Test and, if necessary, the Exception Test.
- To identify the requirements for site-specific flood risk assessment.
- To assist in the determination of the acceptability of flood risk in relation to Crawley and Horsham's emergency planning capabilities.
- To consider opportunities to reduce flood risk to existing communities and developments and recommend how the Local Plan can best influence this issue.

SFRA outputs

The Planning Practice Guidance advocates a tiered approach to risk assessment and identifies the following two levels of SFRA:

1. Level One: where flooding is not a major issue and where development pressures are low. The assessment should be sufficiently detailed to allow application of the Sequential Test.
2. Level Two: where land outside Flood Zones 2 and 3 cannot appropriately accommodate all the necessary development creating the need to apply the National Planning Policy Framework's Exception Test. In these circumstances the assessment should consider the detailed nature of the flood characteristics within a Flood Zone and assessment of other sources of flooding.

This report fulfils the Level One SFRA requirements.

To meet the objectives of the SFRA, the following outputs have been prepared:

- Assessment of all potential sources of flooding
- Assessment of the potential impact of climate change on flood risk
- An assessment of surface water management issues and the application of Sustainable Drainage Systems (SuDS)
- A review and update of new and amended data sources
- Recommendations of the criteria that should be used to assess future development proposals and the development of a Sequential Test and sequential approach to flood risk
- Guidance for developers including requirements for site-specific flood risk assessments
- Mapping of location and extent of functional floodplain
- Mapping areas at risk from other sources including surface water, sewer, ground water, reservoir inundation
- Mapping areas covered by an existing flood alert / warning
- Identification of opportunities to reduce flood risk
- High-level screening of proposed development sites against flood risk information
- Identification of flood defence infrastructure.

Summary of Assessment

Flood Risk

- West Sussex County Council has classified Crawley as a 'wet spot' within its draft Local Flood Risk Management Strategy (2021-2026), where 9,000 residential properties and business buildings are at risk of surface water flooding. The EA and DEFRA also classify Crawley as a Flood Risk Area.
- There have been several recorded flood incidents across the study area, with fluvial and surface water being the most frequent cause of flooding. More recent events have been associated with capacity exceedances or blockages of the sewer network. These sources of flooding can also occur in combination, causing a cumulative effect. Notable incidents reported by WSCC occurred in 1968, 2000 and 2012.
- Fluvial flooding from the River Mole and its tributary Gatwick Stream pose a risk to neighbourhoods in Crawley, in particular Langley Green, Three Bridges, and Forge Wood. Elsewhere in the study area, settlements are at fluvial flood risk from other watercourses (Crawter's Brook, Tilgate Brook and Stanford Brook).

- The Environment Agency's Risk of Flooding from Surface Water dataset shows that surface water flood risk is predominantly concentrated along topographical flow paths of existing watercourses, dry valleys or roads. There are also areas of pooling in lakes and ponds, for example, Tilgate Lake and Titmus Lake, although it should be noted that in some circumstances these occur because of the national approach to the modelling, rather than physical features. The last major surface water flood event occurred in June 2012, with widespread property flooding reported across Maidenbower, Furnace Green and Ifield Green.
- The GeoSmart Groundwater Flood Map shows that that the majority of the study area is at a 'negligible' risk of groundwater flooding. Some 'low' and 'moderate' risk areas are identified around Gatwick Airport, Three Bridges, Forge Wood, North Gate and Langley Green.
- There are four "large raised reservoirs" as defined in the Reservoirs Act 1975[1], located within the study area (Douster Pond, Ifield Mill Pond, Tilgate Lake and Gatwick Airport Long Term Storage Lagoon). There are an additional three "large raised reservoirs" outside the study area (Fish Pond, Worth Farm and Clays Lake), but where a breach could affect parts of the study area. Outlines from the Risk of Flooding from Reservoirs dataset show worst case inundation extents that impact the study area, however there are no recorded incidents of breach within the study area.
- There is currently one Flood Alert Area which covers the Upper River Mole, Ifield Brook, Gatwick Stream, Burstow Stream and Salfords Stream. Additionally, there are five Flood Warning Areas (FWAs) in the study area.

Flood defences

There are fluvial flood defences located along the majority of the watercourses in the study area. Types of fluvial defences include embankments, high ground, bank and channel maintenance. The standard of protection provided by these assets varies from a 20% AEP (Annual Exceedance Probability) up to a 0.5% AEP, as does their condition.

Development and flood risk

Information used to support the Sequential and Exception Tests for both Local Plans and Flood Risk Assessments has been documented, along with guidance for planners and developers. Links have been provided for various guidance documents and policies published by other Risk Management Authorities such as the Lead Local Flood Authority and the Environment Agency.

Relevant studies

There are many relevant regional and local policies which have been considered within the SFRA, such as the Thames Catchment Flood Management Plan, the Thames River Basin Management Plan, West Sussex Local Flood Risk Management Strategy and Preliminary Flood Risk Assessment. Other policy considerations have also been incorporated, such as sustainable development principles, climate change and flood risk management.

Policy Recommendations

The following recommendations to support policy are to be considered by Crawley and Horsham Councils as part of Flood Risk Management in the study area.

1 http://www.legislation.gov.uk/ukpga/1975/23

Development and planning considerations

Sequential approach to development

It is recommended that the sequential approach is adopted for all non-minor[2] future developments in the study area where there is flood risk.

New development and re-development of land should seek opportunities to reduce the overall level of flood risk at the site where possible.

Sequential and Exception tests

The SFRA has identified that areas of Crawley Borough and Horsham District are at high risk of flooding from fluvial and surface water (pluvial) sources. Proposed development sites at locations at risk of flooding will be required to satisfy the Sequential and, where necessary, Exception Tests in accordance with the NPPF. Crawley and Horsham Councils will use the information in this SFRA when deciding which development sites to take forward in the Local Plan Review.

Site-specific Flood Risk Assessments

Site specific Flood Risk Assessments (FRA) are required by developers to provide a greater level of detail on flood risk and any protection provided by defences and, where necessary, demonstrate the development satisfies part 'b' of the Exception Test.

Developers should, where required (through consultation with the Environment Agency), undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extents (including latest climate change allowances), inform flood plain and development zoning within the site and evidence, and demonstrate if required, that the Exception Test is satisfied. Where a site-specific FRA has produced modelling outlines which differ from the Environment Agency's Flood Map for Planning, a full evidence-based review (undertaken by the Environment Agency) would be required. Where the watercourses are embanked, the effect of overtopping and breach must be considered and appropriately assessed.

Any flood risk management measures required to reduce the risk of flooding to a development site should be consistent with the wider catchment policies set out in the Catchment Flood Management Plan, Flood Risk Management Plan, Local Flood Risk Management Strategy and other relevant strategies.

The most recent version of the **NPPF** was published on 20 July 2021 and sets out the Government's planning policies for England and how these are expected to be applied. This revised framework replaces the previous versions of the NPPF published in June 2019 and March 2012.

The accompanying **Planning Practice Guidance (PPG)** was published on 29 November 2016 and was updated on 25 August 2022. There are also several guidance documents which provide information on the requirements for site-specific Flood Risk Assessments:

- **Standing Advice on Flood Risk (Environment Agency)**
- **Flood Risk Assessment for Planning Applications (Environment Agency)**
- **Site-specific Flood Risk Assessment: CHECKLIST (PPG, Defra)**

As these documents are periodically updated, subsequent additions or changes to guidance and policies must be taken into account when undertaking an FRA.

It should be noted that the UK Climate Change Projections 2018 (**UKCP18**) were published on 26 November 2018. The UKCP18 projections replace the UKCP09 projections as the official source of information on how the climate of the UK may change over the next 100 years. The Environment Agency updated its **fluvial climate change allowances** on 27 May 2022, which incorporate data from the UKCP18. When undertaking an FRA, reference should be made to the most up to date climate change allowances provided by the Environment Agency.

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2 https://www.gov.uk/guidance/flood-risk-and-coastal-change#minor-development-to-flood-risk

Developers should consult with Crawley Borough and Horsham District Councils, West Sussex County Council, the Environment Agency and Thames Water as sewerage infrastructure provider, at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling, and drainage assessment and design.

Surface water management and SuDS

Planners should be aware of the conditions set by West Sussex County Council as the Lead Local Flood Authority for surface water management and ensure development proposals and applications are compliant with the **West Sussex County Council LLFA Policy for the Management of Surface Water**.

Review of planning applications

The Council should consult the latest version of the Environment Agency's '**Review individual flood risk assessments: standing advice for local planning authorities**', last updated 8 February 2022 , when reviewing planning applications for proposed developments at risk of flooding.

The Council will consult the relevant **statutory consultees** as part of the planning application assessment and they may, in some cases, also contact non-statutory consultees (e.g. Thames Water) that have an interest in the planning application.

Infrastructure and safe access

Minimum finished floor levels for development that does not include sleeping accommodation on the ground floor should normally be set to whichever is higher of the following:

- a minimum of 300mm above the The design flood level
- if finished floor levels cannot be raised in this way, additional flood resistance and resilience measures should be added to the property to protect it to at least 300mm above the estimated flood level.

This should be set out as part of a site-specific Flood Risk Assessment.

Finished floor levels for vulnerable developments (e.g., dwellings and for sleeping accommodation) should be a minimum of whichever is higher of 300mm above the:

- average ground level of the site
- adjacent road level to the building
- design flood level (1% annual probability plus climate change allowance)

Ideally, sleeping accommodation should be at first floor level or above. However, if ground flood sleeping accommodation were to be provided, raised floor levels of 300mm may not be adequate. Therefore, it may be necessary to raise finished floor levels to 600mm.

If it is not practical (for example where level for level flood plain compensation cannot be provided) to raise floor levels to those specified above, consultation with the Environment Agency will be required to determine whether alternative approaches are appropriate.

Safe access and egress will need to be demonstrated at all development sites. Emergency vehicular access (no more than 300mm depth along access routes) should be possible during times of flood.

Residual risk

Residual risk is the risk that remains after the effect of mitigation measures are taken into account. The residual risk includes the consideration of flood events that exceed the design thresholds of the flood defences or circumstances where there is a failure of the defences, e.g. flood banks collapse. Residual risks should be considered as part of site-specific Flood Risk Assessments.

Future flood management

Developments should demonstrate opportunities to create, enhance and link green assets. This can provide multiple benefits across several disciplines including flood risk and biodiversity / ecology and may provide opportunities to use the land for amenity and recreational purposes. Development that may adversely affect green infrastructure assets should not be permitted.

Potential modelling improvements

The Environment Agency regularly reviews its flood risk mapping, and it is important that they are approached by the applicant to determine whether updated (more accurate) information is available prior to commencing a site-specific FRA. Due to the publication of the **UKCP18** the Environment Agency should be contacted for the latest guidance on climate change modelling outputs for Flood Risk Assessments as these have not been taken into account in this Level 1 SFRA. Developers should consider the most appropriate climate change allowances based on guidance available at the time of a site-specific FRA being produced. Guidance on **Climate Change Allowances for Flood Risk Assessments** can be found online. Developers should appropriately assess climate change through an FRA.

Use of SFRA data

SFRAs are high level strategic documents and, as such, do not go into detail on an individual site-specific basis. This SFRA has been developed using the best available information, supplied at the time of preparation. This relates both to the current risk of flooding from rivers and surface water and where available the potential effects of future climate change. It is important that anyone using this document check for updated policy and guidance documents and flood risk information prior to using the information.

Updated modelling was completed for the Upper Mole Catchment in 2020 and this updated modelling was used within this assessment. It should be noted that the Environment Agency's Flood Zones, on their Flood Map for Planning website, may differ to the maps in the SFRA for a short period of time whilst the Environment Agency incorporate the latest modelling. Other datasets used to inform this SFRA may also be periodically updated and following the publication of this SFRA, new information on flood risk may be provided by Risk Management Authorities.

Recommendations and details on how to apply the Sequential and Exception tests using the data set out in this report are provided in Appendix L

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Abbreviations and glossary of terms

	Definition
AEP	Annual Exceedance Probability - the chance of an event with a particular magnitude occurring in each and every year
ADEPT	Association of Directors of Environment, Economy, Planning and Transport
AOD	Above Ordnance Datum
AONB	Area of Natural Beauty
BSI	British Standards Institution
CFMP	Catchment Flood Management Plan
CIRIA	Construction Industry Research and Information Association
Defra	Department of the Environment, Food and Rural Affairs
FAA	Flood Alert Area
FCRMGiA	Flood and Coastal Risk Management Grant in Aid
FRA	Flood Risk Assessment
FRMP	Flood Risk Management Plan
FSA	Flood Storage Area
FWMA	Flood and Water Management Act
FWA	Flood Warning Area
FWS	Flood Warning Service
GI	Green Infrastructure
GIS	Geographic Information Service
GSPZ	Groundwater Source Protection Zone
JBA	Jeremy Benn Associates
LFRMS	Local Flood Risk Management Strategy
LLFA	Lead Local Flood Authority - Local Authority responsible for taking the lead on local flood risk management
LPA	Local Planning Authority
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers
NFF	National Flood Forum
NFM	Natural Flood Management
NPPF	National Planning Policy Framework
NRD	National Receptor Database
NRIM	National Reservoir Inundation Mapping
NVZ	Nitrate Vulnerable Zones
Ordinary Watercourse	All watercourses that are not designated Main River. Local Authorities or, where they exist, IDBs have similar permissive powers as the Environment Agency in relation to flood defence work. However, the riparian owner has the responsibility of maintenance.
PFRA	Preliminary Flood Risk Assessment
PPG	Planning Practice Guidance

RBMP	River Basin Management Plan
Resilience measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.
Resistance measures	Measures designed to keep flood water out of properties and businesses; could include flood guards for example.
RoFSW	Risk of Flooding from Surface Water
SFRA	Strategic Flood Risk Assessment
SHLAA	Strategic Housing Land Availability Assessment - The Strategic Housing Land Availability Assessment (SHLAA) is a technical piece of evidence to support local plans and Sites & Policies Development Plan Documents (DPDs). Its purpose is to demonstrate that there is a supply of housing land in the district which is suitable and deliverable.
SFHD	Sewage Flooding History Database- Thames Water's database of sewer flooding incidents
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
TUFLOW	Two-dimensional Unsteady FLOW (a hydraulic model)
UKCP18	United Kingdom Climate Projections 2018
WFD	Water Framework Directive
WSCC	West Sussex County Council

1 Introduction

1.1 Purpose of the Strategic Flood Risk Assessment

> "Strategic policies should be informed by a strategic flood risk assessment and should manage flood risk from all sources. They should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards."
>
> (National Planning Policy Framework (February 2019, updated July 2021), Section 14 paragraph 160)

This Strategic Flood Risk Assessment (SFRA) 2023 document updates (and supersedes) the Crawley Borough and Upper Mole Catchment Level 1 SFRA (2020) prepared on a joint basis for Crawley Borough Council and Horsham District Council. The SFRA study area is shown in Figure 1-1. For this assessment, the study area consists of the Crawley Borough Council administrative boundary and the section of the Upper Mole Catchment which is situated within the administrative boundary of Horsham District Council. For the purpose of this report, this region will be referred to as the study area, and the contents and advice of this SFRA relate only to this area.

The Horsham District Council has its own SFRA which was published in January 2020. The Horsham District Council SFRA accounts for the Adur and Arun catchments but does not include the Upper Mole catchment area.

Hyperlinks to external guidance documents/websites are provided in **Green** throughout the SFRA.

Advice to users has been highlighted in **amber boxes** throughout the document.

Throughout the report, hyperlinks to relevant documents, policies and guidance have been provided and are highlighted in bold green text.

The main purpose of this SFRA update is to prepare a document that provides comprehensive and supporting evidence for the emerging Local Plan Reviews, both in terms of guiding site allocations and in the determination of planning applications. The **Crawley Borough Local Plan** and **Horsham District Local Plan** were both adopted in 2015, and the respective Local Plan Reviews will revisit the adopted Local Plans to make sure that sufficient housing, employment and supporting infrastructure will be planned to meet the needs of the area. The SFRA update was also required to be compliant with the latest definitions of flood zones as outlined in Table 1 of the updated Planning Practice Guidelines (PPG) in 2022 and to comply with updates to the National Planning Policy Framework (NPPF) in 2021. Therefore, this updated SFRA will be used to support the selection of site allocations in the Local Plan Review and to provide information and guidance to be used in the preparation of Flood Risk Assessments (FRAs) in support of site-specific planning applications. The evidence in this SFRA shall also be used to support the formulation of Neighbourhood Plans.

An **updated NPPF** was published in July 2021 and sets out Government's planning policies for England and how these are expected to be applied. This updated

Framework replaces the previous versions of the NPPF published in June 2019, July 2018, and March 2012.

The **updated PPG** was published in August 2022 and outlines an updated definition of flood zones which includes Flood Zone 3a and Flood Zone 3b (detailed later). This updated PPG superseded all previous versions (originally published in 2016).

The key objectives of the 2023 SFRA are:

- To take account of best practice, the latest guidance and the most up to date information.
- To assess the flood risk to and from the study area from all sources, now and in the future, as well as assess the impact that cumulative land use changes and development in the area will have on flood risk.
- To be a robust piece of evidence to inform the review of the Local Plans within the study area, so that flood risk is fully accounted for when considering allocation options and guide development to the safest areas.
- To inform the application of the Sequential Test and, if necessary, the Exception Test.
- To identify the requirements for site-specific flood risk assessment.
- To assist in the determination of the acceptability of flood risk in relation to the study areas emergency planning capabilities.
- To consider opportunities to reduce flood risk to existing communities and developments and recommend how the Local Plan can best influence this issue.

1.2 Levels of SFRA

The Planning Practice Guidance advocates a tiered approach to risk assessment and identifies the following two levels of SFRA:

1 Level One: where flooding is not a major issue and where development pressures are low. The assessment should be sufficiently detailed to allow application of the Sequential Test.

2 Level Two: where land outside Flood Zones 2 and 3 cannot appropriately accommodate all the necessary development creating the need to apply the NPPF's Exception Test. In these circumstances the assessment should consider the detailed nature of the flood characteristics within a Flood Zone and assessment of other sources of flooding.

This report fulfils the Level One SFRA requirements.

1.3 SFRA outputs

To meet the objectives, the following outputs have been prepared:

- Assessment of all potential sources of flooding
- Assessment of the potential impact of climate change on flood risk
- An assessment of surface water management issues and the application of Sustainable Drainage Systems (SuDS)
- A review and update of new and amended data sources
- Recommendations of the criteria that should be used to assess future development proposals and the development of a Sequential Test and sequential approach to flood risk
- Guidance for developers including requirements for site-specific flood risk assessments
- Mapping of location and extent of functional floodplain

- Mapping areas at risk from other sources including surface water, sewer, ground water, reservoir inundation
- Mapping areas covered by an existing flood alert / warning
- Identification of opportunities to reduce flood risk
- High-level screening of proposed development sites against flood risk information
- Identification of flood defence infrastructure.

1.4 Structure of this report

Table 1-1: SFRA report contents

Section	Contents
1. Introduction	Provides a background to the study, defines objectives, outlines the approach adopted and the consultation performed.
2. The Planning Framework and Flood Risk Policy	Includes information on the implications of recent changes to planning and flood risk policies and legislation, as well as documents relevant to the study.
3.The Sequential, risk-based approach	Describes the Sequential Approach and application of Sequential and Exception Tests. Outlines cross-boundary issues and considerations.
4. Climate change	Outlines climate change guidance and the implications for the study area.
5. Sources of information used in preparing the SFRA	Outlines what information has been used in the preparation of the SFRA.
6. Understanding flood risk in the study area	Introduces the assessment of flood risk and provides an overview of the characteristics of flooding affecting the district. Provides a summary of responses that can be made to flood risk, together with policy and institutional issues that should be considered. Outlines the flood warning service in the study area and provides advice for emergency planning, evacuation plans and safe access and egress.
7. Fluvial defences	Assessment of existing flood defences and flood risk management measures
8. FRA requirements and flood risk management guidance	Identifies the scope of the assessments that must be submitted in FRAs supporting applications for new development. Provides guidance for developers and outlines conditions set by the LLFA that should be followed.
9. Surface water management and SuDS	Advice on managing surface water run-off and flooding and the application of SuDS.
10. Flood warning and emergency planning	Outlines the flood warning service in the joint SFRA area and provides advice for emergency planning, evacuation plans and safe access and egress.
11. Strategic flood risk solutions	Overview of possible strategies to reduce flood risk

Section	Contents
12. Level 1 summary assessment of potential development locations	A summary of the information presented in the site screening table
13. Summary	Review of the Level 1 SFRA.
14. Recommendations	Identifies recommendations for the council to consider as part of Flood Risk Management policy.
Appendix A-J: Flood risk mapping	Maps showing flood risk information from all sources
Appendix K: Level 1 Site Screening table	Screening table showing the flood risking from all sources to the Level 1 development sites
Appendix L: Guide to using technical data	Table advising planners and developers on how to use the available flood risk information.

1.5 Consultation

The following parties have been consulted during the preparation of this Level 1 SFRA:

- Crawley Borough Council
- Horsham District Council
- Environment Agency
- West Sussex County Council
- Surrey County Council
- Thames Water
- Neighbouring authorities: (Reigate and Banstead Borough Council, Tandridge District Council, Mid Sussex District Council, Mole Valley District Council) – these can be seen in Figure 1-1.

1.6 Use and limitations of SFRA data

Appendix L contains a guide to using the technical data presented within this SFRA, further explaining how SFRA data should be used, including reference to relevant sections of the SFRA, how to consider different sources of flood risk and recommendations and advice for Sequential and Exception Tests (Appendix L).

It is important to recognise that SFRAs are high level strategic documents and, as such, do not go into detail on an individual site-specific basis. The SFRA has been developed using the best available information at the time of preparation. This relates both to the current risk of flooding from rivers, and the potential impacts of future climate change. Developers should consult the Local Planning Authority, West Sussex County Council and the Environment Agency to seek more up-to-date information for their specific site.

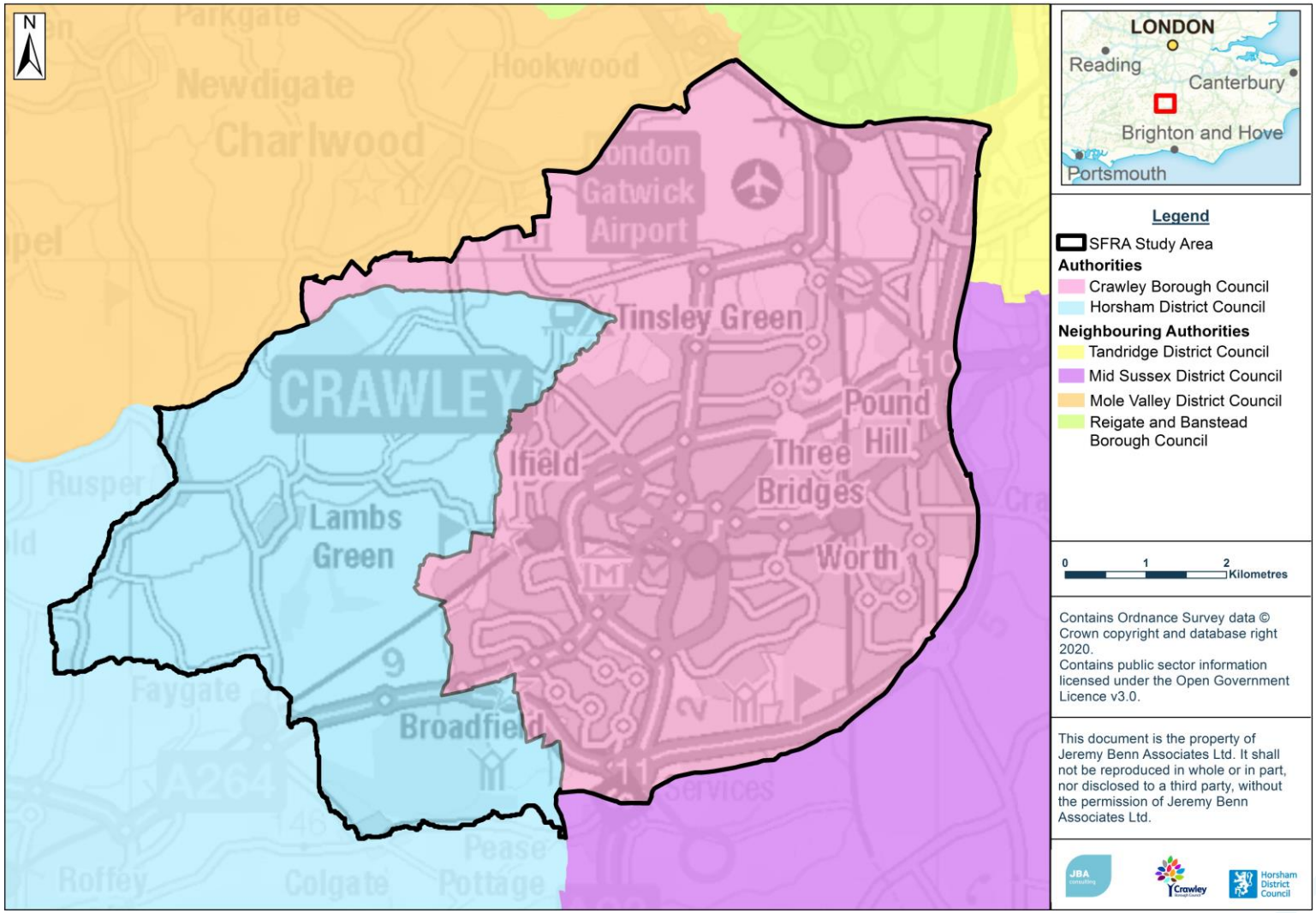
SFRAs should be a **'living document'**, and as a result should be updated when new information on flood risk, new planning guidance or legislation becomes available. New information on flood risk may be provided by Crawley Borough Council, Horsham District Council, West Sussex County Council, the Environment Agency and Thames Water. Such information may be in the form of:

- New hydraulic modelling results
- Flood event information following a flood event
- Policy / legislation updates
- Environment Agency flood map updates

- New flood defence schemes etc.

  The Environment Agency regularly reviews their flood risk mapping, and it is important that they are approached to determine whether updated (more accurate) information is available prior to commencing a detailed Flood Risk Assessment. Liaison has been undertaken with the EA to agree the methodology in preparing this SFRA.

Figure 1-1: SFRA study area and neighbouring authorities



2 Flood risk policy and strategy

This section sets out the Flood Risk Management roles and responsibilities for different organisations and relevant legislation, policy and strategy

2.1 Roles and responsibilities for Flood Risk Management in the study area

There are different organisations that cover Crawley Borough and Horsham District that have responsibilities for flood risk management, known as Risk Management Authorities (RMAs). These are shown on Table 2-1, with a summary of their responsibilities.

It is important to note that land and property owners are responsible for the maintenance of watercourses either on or next to their properties. Property owners are also responsible for the protection of their properties from flooding as well as other management activities, for example by maintaining riverbeds/banks, controlling invasive species and allowing the flow of water to pass without obstruction. More information can be found in the Environment Agency publication **'Owning a Watercourse' (2018)**.

Table 2-1: Risk Management Authorities

Risk Management Authority	Strategic Level	Operational Level	Planning role
Environment Agency	• Strategic overview for all sources of flooding • National Strategy • Reporting and general supervision	• Main rivers (e.g. River Mole, Gatwick Stream, Ifield Brook etc.) • Sea • Reservoirs	• Statutory consultee for development in Flood Zones 2 and 3
West Sussex County Council (WSCC) as Lead Local Flood Authority (LLFA)	• Preliminary Flood Risk Assessment • Local Flood Risk Management Strategy • Flood Investigations	• Surface Water • Groundwater • Ordinary Watercourses outside of IDBs (consenting and enforcement) • Ordinary watercourses outside of IDBs (works)	• Statutory consultee for major developments

Risk Management Authority	Strategic Level	Operational Level	Planning role
Crawley Borough Council and Horsham District Council	• Local Plans as Local Planning Authorities	• Determination of Planning Applications as Local Planning Authorities • Planning enforcement • Emergency planning • Managing open spaces under Council ownership	• As left
Thames Water	• Asset Management Plans, supported by Periodic Reviews (business cases) • Develop Drainage and Wastewater management plans	• Surface, foul and combined public sewers	• Non-statutory consultee
Highways authorities • *Highways England (motorways and trunk roads)* • *Highway Authority- WSCC (other adopted roads)*	• Highway drainage policy and planning	• Highway drainage	• Statutory consultee regarding highways design standards and adoptions

2.2 Key Legislation for flood and water management

2.2.1 Floods Directive (2007) & Flood Risk Regulations (2009)

The **Flood Risk Regulations** translate the **EU Floods Directive** into UK law. The EU required Member States to complete an assessment of flood risk (known as a Preliminary Flood Risk Assessment (PFRA)) and then use this information to identify areas where there is a significant risk of flooding. The threshold for designating significant Flood Risk Areas is defined by DEFRA. For these Flood Risk Areas, States must then undertake Flood Risk and Hazard Mapping and produce Flood Risk Management Plans.

The Flood Risk Regulations direct the Environment Agency to do this work for river, sea and reservoir flooding. LLFAs must do this work for surface water, Ordinary Watercourses and groundwater flooding. This is a six-year cycle of work and the second cycle started in 2017. In the instance of this SFRA, the LLFA is West Sussex County Council (WSCC).

The **West Sussex PFRA** (2011) provides information on significant past and future flood risk from localised flooding in West Sussex. An **addendum** to the PFRA was produced by WSCC in 2017.

In 2011 indicative Flood Risk Areas were identified nationally by LLFA's. None encroached on the study area. The exercise was repeated in 2018 and a further national study prepared to identify potential areas of significant flood risk ("Flood Risk Areas") – '**Review of preliminary flood risk assessments (Flood Risk Regulations 2009): guidance for lead local flood authorities in England – 25th Jan 2017'**. During this review Crawley was identified as an additional surface water **Flood Risk Area.**

At the time of this review (September 2023) it is understood that the UK Government intends to scrap the Flood Risk Regulations (2009) as part of a review into retained EU legislation. It is proposed to scrap this by 31 December 2023, as the Flood Risk Regulations duplicate existing domestic legislation, namely the Flood and Water Management Act (2010).

2.2.2 Flood and Water Management Act (FWMA) (2010)

The **Flood and Water Management Act (FWMA)** was passed in April 2010. It aims to improve both flood risk management and the way we manage our water resources.

The FWMA has created clearer roles and responsibilities and helped to define a more risk-based approach to dealing with flooding. This included the creation of a lead role for LAs, as LLFAs, designed to manage local flood risk (from surface water, ground water and ordinary watercourses) and to provide a strategic overview role of all flood risk for the EA.

The content and implications of the FWMA provide considerable opportunities for improved and integrated land use planning and flood risk management by LAs and other key partners. The integration and synergy of strategies and plans at national, regional and local scales, is increasingly important to protect vulnerable communities and deliver sustainable regeneration and growth.

2.2.3 Water Framework Directive (2000) & Water Environmental Regulations (2017)

The purpose of the **Water Framework Directive (WFD)**, which was transposed into English Law by the **Water Environment Regulations** (first published in 2003 and updated in 2017), is to deliver improvements across Europe in the management of

water quality and water resources. This is enforced through a series of plans called River Basin Management Plans (RBMP) (see section 2.3.3), which were last published in 2015 and are currently being updated.

The study area lies within the Thames River Basin District.

2.2.4 Environmental Permitting

The **Environmental Permitting Regulations (2016)** set out where developers will need to apply for additional permission (as well as Planning Permission) to undertake works to an Ordinary Watercourse or Main River. This includes flood risk activities, for example:

- on or within 8 metres of a main river (16 metres if tidal);
- on or within 8 metres of a flood defence structure or culvert (16 metres if tidal);
- on or within 16 metres of a sea defence;
- involving quarrying or excavation within 16 metres of any main river, flood defence (including a remote defence) or culvert; and
- in a floodplain more than 8 metres from the riverbank, culvert or flood defence structure (16 metres if it is a tidal main river) and you don't already have planning permission.

Environmental permits may also be required from the Environment Agency to discharge runoff, trade effluent or sewage into a main river. They may also be required in relation to groundwater activities, where there may be a risk of groundwater contamination.

2.2.5 Byelaws

Land Drainage Byelaws outline legal obligations and responsibilities when undertaking works on or close to a watercourse, for the purpose of preventing flooding, or mitigating any damage caused by flooding.

The SFRA study area is covered by the **Thames Region Land Drainage Byelaws** and enforced by the Environment Agency. These Byelaws have effect on functions relating to land drainage in the Thames Water Authority area for any Main River or sea and tidal defence.

Under the **Land Drainage Act (1991)**, Crawley Borough and Horsham District Councils also have the power to implement their own Byelaws for any Ordinary Watercourse within their authority boundary.

Compliance to the relevant Byelaws and standards must be demonstrated by any developer planning works within proximity of a water body within the study area. Further information on watercourse buffer strips actioned under these Byelaws is provided in Section 8.5.

2.2.6 Additional Legislation

Additional legislation relevant to development and flood risk in the study area include:

- The **Town and Country Planning Act (1990)** and the **Water Industry Act (1991)**. These set out the roles and responsibilities for organisations that have a role in Flood Risk Management (FRM).
- Other environmental legislation such as the **Habitats Directive (1992)**, **Environmental Impact Assessment Directive (2014)** and **Strategic Environmental Assessment Directive (2001)** also apply as appropriate to strategic and site-specific developments to guard against environmental damage.

2.3 Key national, regional and local policy documents and strategies

Table 2-2 summarises key national, regional and local flood risk policy and strategy documents and how these apply to development and flood risk. Hyperlinks are provided to external documents. These documents may:

- Provide useful and specific local information to inform Flood Risk Assessments within the local area.
- Set the strategic policy and direction for Flood Risk Management (FRM) and drainage – they may contain policies and action plans that set out what future flood mitigation and climate change adaptation plans may affect a development site. A developer should seek to contribute in all instances to the strategic vision for FRM and drainage in the District.
- Provide guidance and/or standards that inform how a developer should assess flood risk and/or design flood mitigation and SuDS.

Table 2-2: National, regional and local key flood risk policy and strategy documents

	Document, lead author and date	Relevant direct legislation	Information	Policy and measures	Development design requirements	Next update due
National	**National Flood and Coastal Erosion Management Strategy** (Environment Agency) 2020	FWMA (Section 2.2.2)	No	Yes	No	2026
	Natural Flood Management Plans (Environment Agency)	N/A	Yes	No	No	-
	National Planning Policy Framework (MHCLG) 2021	Planning and Compulsory Purchase Act 2004 as amended & The Town and Country Planning (Local Planning) (England) Regulations 2012 as amended	No	Yes	Yes	-
	Planning Practice Guidance (MHCLG) 2022		Yes	No	Yes	
Regional	**Thames River Basin Management Plan: updated 2022** (Environment Agency) 2022	WFD (Section 2.2.3)	No	Yes	No	2028
	Thames River Basin District Flood Risk Management Plan (Environment Agency) 2023	Flood Risk Regulations (Section 2.2.1) – due to be revoked in Dec 2023	No	Yes	No	2027
	Thames Catchment Flood Management Plan (Environment Agency) 2009	N/A	Yes	Yes	No	-
	Climate Change guidance for development and flood risk (Environment Agency) 2022	N/A	No	No	Yes	
Local	**Drainage and Wastewater Management Plan 2025-2050** (Thames Water)2023	N/A	Yes	Yes	Yes	
	Local Flood Risk Management Strategy (WSCC) 2021-2026. (Draft)	FWMA (Section 2.2.2)	Yes	No	No	Pending
	West Sussex LLFA Policy for the Management of Surface Water (WSCC) 2018	N/A	Yes	No	Yes	-

2.3.1 The National Flood and Coastal Erosion Risk Management Strategy for England (2020)

The **National Flood and Coastal Erosion Risk Management Strategy** (FCERM) for England provides the overarching framework for future action by all risk management authorities to tackle flooding and coastal erosion in England. The Environment Agency brought together a wide range of stakeholders to develop the strategy collaboratively. The Strategy is much more ambitious than the previous one from 2011 and looks ahead to 2100 and the action needed to address the challenge of climate change. A **progress update to the Strategy** was published in 2022 outlining what had been achieved by 2022 and the roadmap to achieving the goals set out in the Strategy until the year 2026.

The Strategy has been split into 3 high level ambitions: climate resilient places, today's growth and infrastructure resilient in tomorrow's climate and a nation ready to respond and adapt to flooding and coastal change. Measures include updating the national river, coastal and surface water flood risk mapping and the understanding of long term investment needs for flood and coastal infrastructure, trialling new and innovative funding models, flood resilience pilot studies, developing an adaptive approach to the impacts of climate change, seeking nature based solutions towards flooding and erosion issues, integrating natural flood management into the new Environmental Land Management scheme, considering long term adaptive approaches in Local Plans, maximising the opportunities for flood and coastal resilience as part of contributing to environmental net gain for development proposals, investing in flood risk infrastructure that supports sustainable growth, aligning long term strategic planning cycles for flood and coastal work between stakeholders, mainstreaming property flood resilience measures and 'building back better' after flooding, consistent approaches to asset management and record keeping, updating guidance on managing high risk reservoirs in light of climate change, critical infrastructure resilience, education, skills and capacity building, research, innovation and sharing of best practise, supporting communities to plan for flood events, develop world leading ways of reducing the carbon and environmental impact from the construction and operation of flood and coastal defences, development of digital tools to communicate flood risk and transforming the flood warning service and increasing flood response and recovery support.

The Strategy was laid before parliament in July 2020 for formal adoption and published alongside a New **National Policy Statement for Flood and Coastal Erosion Risk Management**. The statement sets out five key commitments which will accelerate progress to better protect and better prepare the country for the coming years:

1. Upgrading and expanding flood defences and infrastructure across the country,
2. Managing the flow of water to both reduce flood risk and manage drought,
3. Harnessing the power of nature to not only reduce flood risk, but deliver benefits for the environment, nature, and communities,
4. Better preparing communities for when flooding and erosion does occur, and
5. Ensuring every area of England has a comprehensive local plan for dealing with flooding and coastal erosion.

The **Flood and Coastal Erosion Risk Management Strategy Roadmap to 2026**

Describes how the National Flood and Coastal Erosion Risk Management Strategy for England will be translated into practical actions until the year 2026, and what aspirations it hopes to achieve. By defining actions, the Strategy Roadmap supports

the government's £5.2 billion Flood and Coastal Erosion Risk Management Investment Programme in decision making for allocating funds.

The Strategy Roadmap also incorporates innovating programmes to improve evidence on the costs and benefits of new resilience actions. Improving the knowledge base will help inform future approaches and investments in flood and coastal risk management. The three programmes which will address this are:

- The Flood and Coastal Resilience Innovation Programme which enables local authorities, businesses and communities to test and demonstrate innovative actions.
- The Adaptive Pathways Programme which develops long term investment plans for managing flood and coastal change to 2100 and beyond.
- The Coastal Transition Accelerators Programme which supports communities in areas at significant risk of coastal erosion to transition and adapt to changing climate.

The Strategy Roadmap describes a cross-disciplinary, multi-organisational approach to assessing and addressing flood and coastal erosion risk in England, including the funding structures, and with sensitivity to sustainability and the environment.

2.3.2 Natural Flood Management (NFM) Plans

The Environment Agency has developed **Natural Flood Management (NFM) mapping** which displays opportunities for NFM. These maps are to be used as a guide and supplemented with local knowledge to provide a starting point for discussions about NFM. NFM aims to protect, restore and emulate the natural functions of catchments, floodplains, rivers and the coast. NFM should be used on a catchment wide scale and is the linking of blue and green infrastructure.

The maps identify NFM opportunities on different catchment scales:

- National River Basin Districts
- River Basin Districts showing Management Catchments
- Management Catchments showing Water Body Catchments
- Water Body Catchments.

These catchments cross boundaries between the SFRA study area and other neighbouring authorities. Discussions about NFM should be had with catchment stakeholders in combination with local knowledge.

A further study into potential NFM prioritisation areas has been commissioned by the Thames Regional Flood and Coastal Committee for the Thames catchment. Further information on this study, which encompasses the SFRA study area, is provided in Section 11.3.

2.3.3 River Basin Management Plans

River Basin Management Plans (RBMPs) are prepared under the Water Framework Directive (WFD) and assess the pressure facing the water environment in River Basin Districts. The SFRA study area falls within the **Thames River Basin District RBMP**(2022).

The plan provides a summary of programmes of measures that help prevent deterioration to protect and improve the beneficial use of the water environment in the river basin district.

Measures are presented for each significant water management issue in the river basin district which are:

- Physical modifications

- Managing pollution from wastewater
- Managing pollution from towns, cities and transport
- Changes to natural flow and levels of water
- Managing invasive non-native species
- Managing pollution from rural areas

2.3.4 Flood Risk Management Plans

Flood Risk Management Plans (FRMPs) are part of the six-year cycle of assessment, mapping and planning required under the Flood Risk Regulations. Under the Regulations, it is a requirement for the Environment Agency to prepare and publish a Flood Risk Management Plan (FRMP) for risk from rivers, reservoirs and the sea. The FRMP process adopts the same catchments as used in the preparation of River Basin Management Plans, in accordance with the Water Framework Directive.

Accordingly, more detailed strategic information on proposed strategic measures and approaches can be found in the **Thames River Basin District Flood Risk Management Plan** (FRMP) (2016). The FRMP draws on previous policies and actions identified in the Catchment Flood Management Plans (see section 0) and also incorporates information from Local Flood Risk Management Strategies (see section 2.3.6).

The **Thames River Basin District Flood Risk Management Plan 2021 to 2027** (2022) provides a progress update which compares the 2021 classification and assessment against the 2015 classification baseline. This comparison is used to assess progress and successes and failures of the flood risk management plan to date and to strategically plan next steps.

2.3.5 Catchment Flood Management Plans

Catchment Flood Management Plans (CFMPs) are high-level strategic plans providing an overview of flood risk across each river catchment. The Environment Agency use CFMPs to work with other key-decision makers to identify and agree long-term policies for sustainable flood risk management.

There are six pre-defined national policies provided in the CFMP guidance and these are applied to specific locations through the identification of 'Policy Units'. These policies are intended to cover the full range of long-term flood risk management options that can be applied to different locations in the catchment.

The six national policies are:

- No active intervention (including flood warning and maintenance). Continue to monitor and advise
- Reducing existing flood risk management actions (accepting that flood risk will increase over time)
- Continue with existing or alternative actions to manage flood risk at the current level (accepting that flood risk will increase over time from this baseline)
- Take further action to sustain the current level of flood risk (responding to the potential increases in risk from urban development, land use change and climate change)
- Take action to reduce flood risk (now and/or in the future)
- Take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits, locally or elsewhere in the catchment.

The study area sits within the **Thames CFMP**.

Thames Catchment Flood Management Plan (2009)

The study area is covered by the **Thames Catchment Flood Management Plan (2009)**. The primary policy unit for the area is:

Policy 5- Upper Mole. Areas of moderate to high flood risk where action will be taken with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits

Subsequently, the Thames CFMP identifies a recommended strategy to address flood risk within the study area. Key actions include the safeguarding of open space, the identification of opportunities for flood storage, maintenance and improvement of river flows in urban areas, improvement of existing drainage systems, increasing resistance and resilience of buildings through redevelopment, and the development of emergency response planning.

2.3.6 West Sussex Local Flood Risk Management Strategy

The **West Sussex Local Flood Risk Management Strategy** was published in 2013. The Strategy sets out how West Sussex County Council will manage local flood risk i.e. from surface water runoff, groundwater and ordinary watercourses, for which they have a responsibility as LLFA and the work that other Risk Management Authorities are doing to manage flood risk in the County.

The Strategy sets out four objectives to guide local focus and progress, which are to:

1. Understand the areas that flood
2. Manage the flood risk in West Sussex
3. Enable people, communities, business and public bodies to work together more effectively and;
4. Put communities at the heart of what we do and help West Sussex residents during flood events and recover as quickly as possible after incidents.

An Action Plan is detailed which sets out various actions that will be taken to achieve these objectives. These include:

- Increasing the amount of evidence about local flooding that is collected and using it more wisely
- Improving surface water and groundwater flooding maps
- Creating a prioritised programme of capital flood risk management works for the county
- Avoiding increased flood and coastal erosion risk by encouraging best practice for the maintenance of assets and preventing inappropriate development
- Continuing work to improve surface water drainage across the county
- Reducing flood risk through improved warnings, local scale works and local resilience
- Improving communications between communities and public bodies
- Information sharing to improve awareness of flood risk
- Continued partnership working with other Risk Management Authorities
- Seeking the best ways of enabling Partnership Funding for schemes
- Continued flood event planning with other emergency responders
- Improving community resilience

The Strategy notes that the Council will seek to deliver sustainable drainage systems (SuDS) as part of new development in its role as statutory consultee for major planning applications and non-statutory consultee for non-major planning applications.

According to the West Sussex County Council **website** at the time of writing, an update to the LFRMS was put out for public consultation in autumn 2021. However, the publication of the 2021-2026 LFRMS has been put on hold while the Council review other strategies and plan which will likely feed in to the final LFRMS, meaning that the likely publication date of the updated LFRMS is currently unknown.

2.3.7 West Sussex LLFA Policy for the Management of Surface Water

West Sussex County Council has produced the **LLFA Policy for the Management of Surface Water** (2018) to detail their policy requirements with regards to sustainable drainage. Additionally, the document provides the regulatory context behind the policy, as well as specific guidance on how West Sussex under their role as a statutory consultee, will review drainage strategies and surface water management provisions associated with applications for development.

More information on the role of sustainable drainage in development is provided in Section 9.

2.3.8 Surface Water Management Plans

Surface Water Management Plans (SWMPs) outline the preferred surface water management strategy in a given location. SWMPs are undertaken by LLFAs in consultation with key local partners who are responsible for surface water management and drainage in their area. SWMPs establish a long-term action plan to manage surface water in a particular area and are intended to influence future capital investment, drainage maintenance, public engagement and understanding, land-use planning, emergency planning and future developments.

There are currently no Surface Water Management Plans (SWMPs) applicable to the study area. It is recommended that if SWMPs are developed to manage surface water in the study area, the outcomes and actions from these SWMPs should be considered in the context of proposed developments within the study area.

3 Planning policy for flood risk management

This section summarises national planning policy for development and flood risk.

3.1 National Planning Policy Framework and Guidance

The **revised National Planning Policy Framework** (NPPF) was published in February 2019 (and subsequently amended in July 2021), replacing the previous versions published in July 2018 and March 2012. The NPPF sets out Government's planning policies for England. It must be taken into account in the preparation of local plans and is a material consideration in planning decisions. The NPPF defines Flood Zones, how these should be used to allocate land and flood risk assessment requirements. The NPPF states that:

"Strategic policies should be informed by a strategic flood risk assessment and should manage flood risk from all sources. They should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards"

Planning Practice Guidance (PPG) on flood risk was published in March 2014 and was updated in August 2022 and sets out how the NPPF should be implemented. **Diagram 1 in the PPG** sets out how flood risk should be considered in the preparation of Local Plans.

3.2 The risk-based approach

The NPPF takes a risk-based approach to development in flood risk areas.

3.2.1 The Flood Zones

The Flood Zones are:

- Flood Zone 1: Low probability: less than a 0.1% chance of river and sea flooding in any given year
- Flood Zone 2: Medium probability: between a 1% and 0.1% chance of river flooding in any given year or 0.5% and 0.1% chance of sea flooding in any given year
- Flood Zone 3a: High probability: equal to a 1% chance or greater of river flooding in any given year or a 0.5% chance or greater of sea flooding in any given year. Excludes Flood Zone 3b.
- Flood Zone 3b: Functional Floodplain: land where water has to flow or be stored in times of flood. The identification of the functional floodplain should take in to account local circumstances and not be defined solely on rigid probability parameters. SFRAs identify this Flood Zone in discussion with the LPA and the Environment Agency. The functional floodplain comprises land having at least a 3.3% chance of flooding in any given year with existing flood risk management infrastructure operating effectively;or any land that is designated to flood (such as a flood attenuation scheme). Only water compatible development and essential infrastructure are permitted in this zone and should be designed to remain operational in times of flood, resulting in no loss of floodplain or blocking of water flow routes. This SFRA has used the 2% AEP to define the functional floodplain.

Excluding Flood Zone 3b, the Flood Zones do not take into account defences. This is important for planning long term developments as long-term policy and funding for maintaining flood defences over the lifetime of a development may change over time.

They also do not take into account surface water, sewer or groundwater flooding or the impacts of canal or reservoir failure or climate change. Hence there could still be a risk of flooding from other sources and the level of flood risk will change over time during the lifetime of a development.

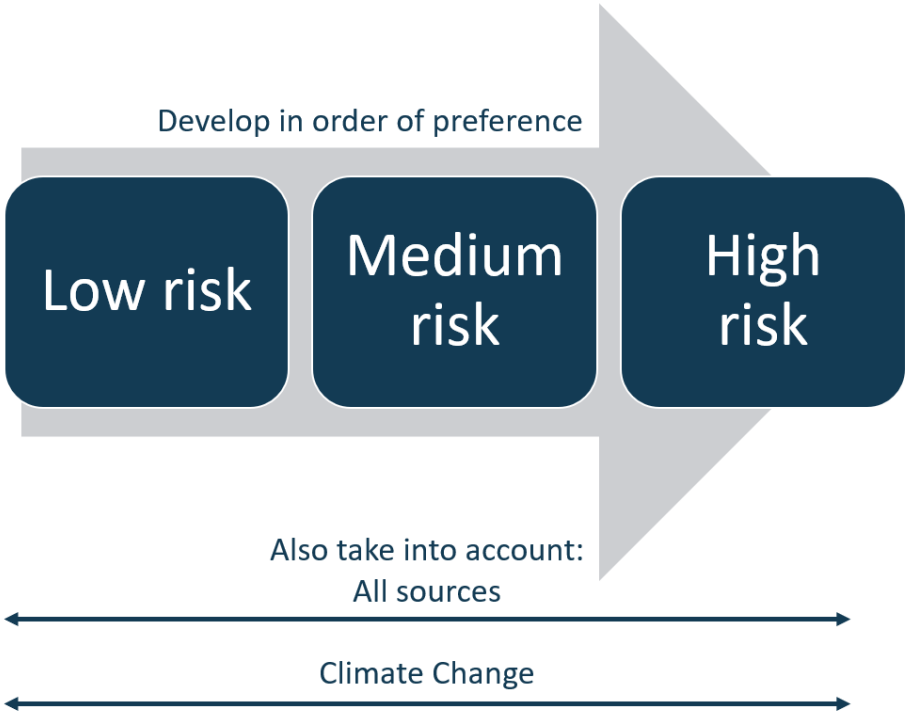
3.2.2 The Sequential Test

Firstly, land at the lowest risk of flooding and from all sources should be considered for development. A test is applied called the 'Sequential Test' to do this. Figure 3-1 summarises the Sequential Test. The LPA will apply the Sequential Test to strategic allocations. For all other developments in Flood Zones 2 and 3 developers must supply evidence to the LPA, with a Planning Application, that the development has passed the test.

The LPA should work with the Environment Agency to define a suitable area of search for the consideration of alternative sites in the Sequential Test. The Sequential Test can be undertaken as part of a Local Plan Sustainability Appraisal. Alternatively, it can be demonstrated through a free-standing document, or as part of Strategic Housing Land or Employment Land Availability Assessments.

Whether any further work is needed to decide if the land is suitable for development will depend on both the vulnerability of the development and the Flood Zone it is proposed for. **Table 2 of the PPG** shows whether, having applied the Sequential Test first, the vulnerability of development is not compatible with a particular Flood Zone and where the exception test is required to determine the suitability of that vulnerability of development to the flood zone.

Figure 3-1: The Sequential Test



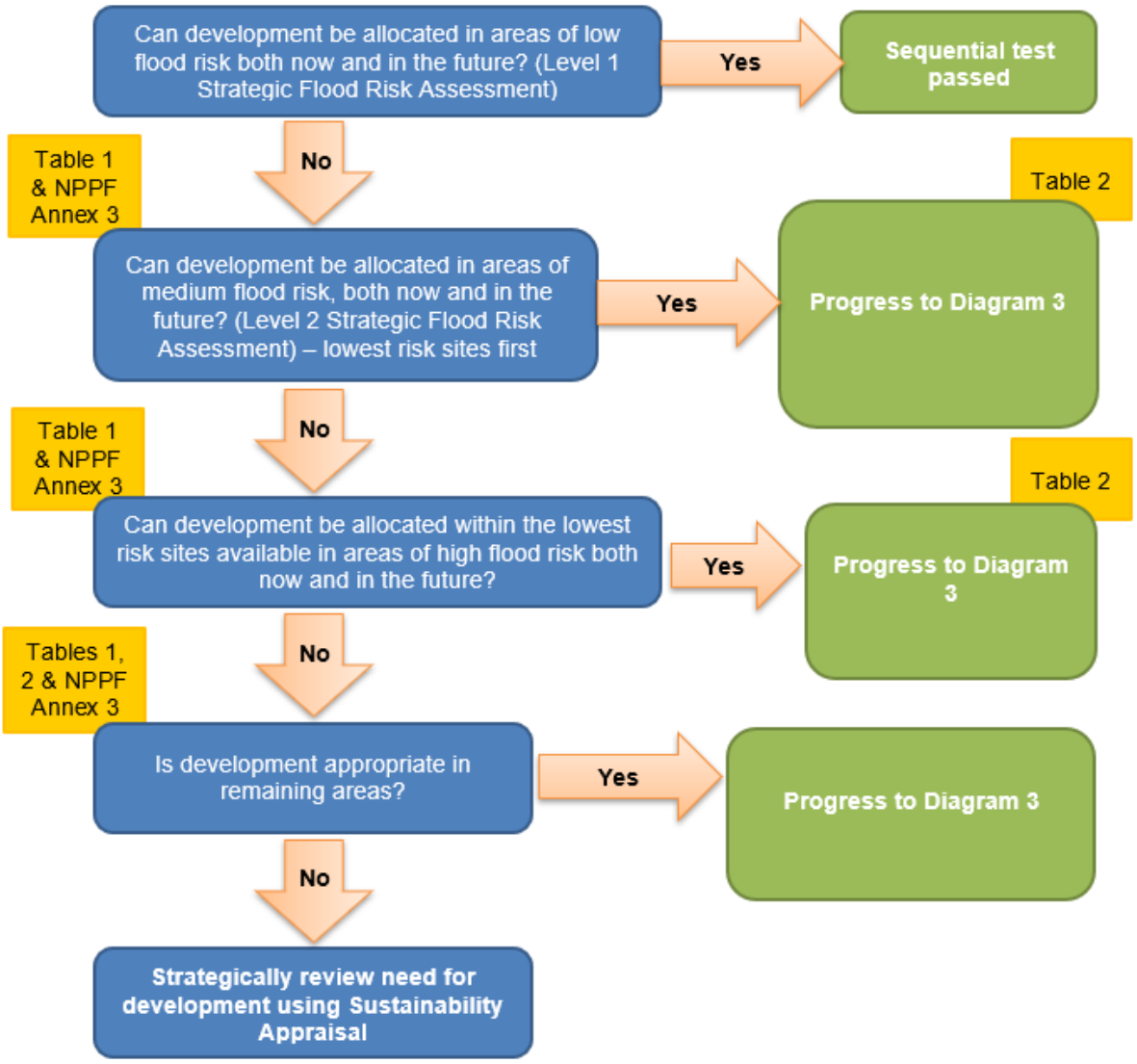
allocate. The SFRA guide to using technical data in Appendix L shows where the Sequential and Exception Tests may be of concern with the datasets, recommending what development might be appropriate in what situations.

Figure 3-2 illustrates the Sequential and Exception Tests as a process flow diagram using the information contained in this SFRA to assess potential development sites against flood zones and development vulnerability compatibilities.

This is a stepwise process, but a challenging one, as a number of the criteria used are qualitative and based on experienced judgement. The process must be documented, and evidence used to support decisions recorded.

In addition, the risk of flooding from other sources and the impact of climate change must be considered when assessing which sites are suitable to allocate. The SFRA guide to using technical data in Appendix L shows where the Sequential and Exception Tests may be of concern with the datasets, recommending what development might be appropriate in what situations.

Figure 3-2: Local Plan sequential approach to site allocation



3.2.3 The Exception Test

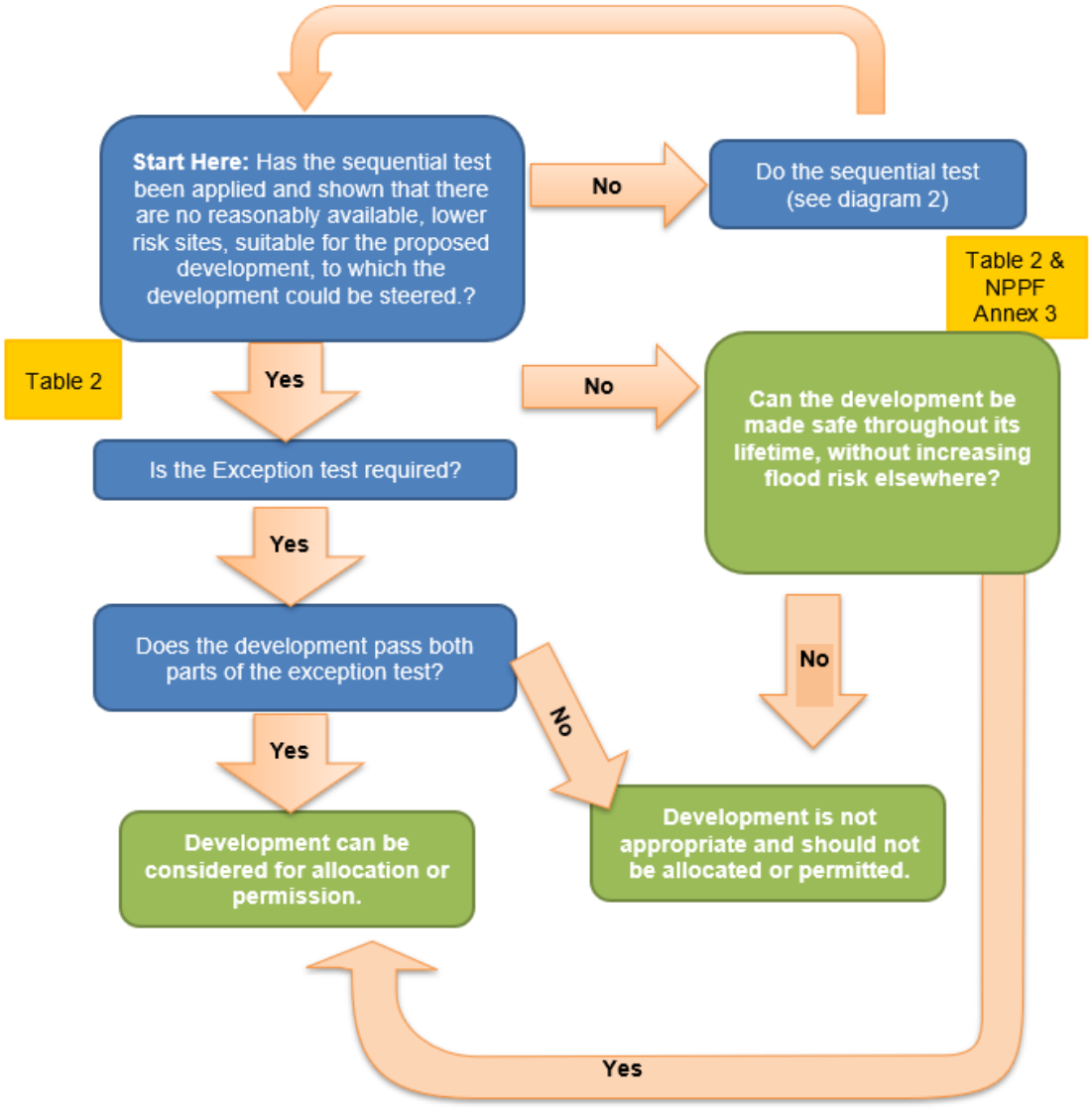
It will not always be possible for all new development to be allocated on land that is not at risk from flooding. To further inform whether land should be allocated, or Planning Permission granted, a greater understanding of the scale and nature of the flood risks is required. In these instances, the Exception Test will be required. **Diagram 3 of the PPG** (Figure 3-3) summarises the Exception Test.

The Exception Test should only be applied following the application of the Sequential Test. It applies in the following instances:

- Essential infrastructure in Flood Zone 3a or 3b
- More vulnerable in Flood Zone 3a
- Highly vulnerable in Flood Zone 2 (this is NOT permitted in Flood Zone 3a or 3b)

An LPA should apply the Exception Test to strategic allocations. For all developments, developers must supply evidence to the LPA, with a Planning Application, that the development has passed the test. This is because when a site-specific Flood Risk Assessment is done, more information on the exact measures that can manage the risk is available.

Figure 3-3: The Exception Test



There are two parts to demonstrating a development passes the Exception Test:

1. *Demonstrating that the development would provide wider sustainability benefits to the community that outweigh the flood risk*

   Local planning authorities will need to consider what criteria they will use to assess whether this part of the Exception Test has been satisfied and give advice to enable applicants to provide evidence to demonstrate that it has been passed. If the application fails to prove this, the Local Planning Authority should consider whether the use of planning conditions and / or planning obligations could allow it to pass. If this is not possible, this part of the Exception Test has not been passed and planning permission should be refused.

2. *Demonstrating that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.*

   A Level 2 SFRA is likely to be needed to inform the Exception Test in these circumstances for strategic allocations. At Planning Application stage, a site-

specific Flood Risk assessment will be needed. Both would need to consider the actual and residual risk and how this will be managed over the lifetime of the development.

3.3 Applying the Sequential Test and Exception Test to individual planning applications

3.3.1 Sequential Test

Crawley Borough Council and Horsham District Council, with advice from the Environment Agency, are responsible for considering the extent to which Sequential Test considerations have been satisfied.

Developers are required to apply the Sequential Test to all development sites, unless the site is:

- a strategic allocation and the test has already been carried out by the LPA
- a change of use - except to a more vulnerable use or where the
- a minor development (householder development, small non-residential extensions with a footprint of less than 250m^2); or
- a development in flood zone 1 unless there are other flooding issues in the area of the development (i.e., surface water, ground water, sewer flooding).

The SFRA contains information on all sources of flooding with consideration to the impacts of climate change. This should be considered when a developer undertakes the Sequential Test, including the consideration of reasonably available sites at lower flood risk.

The following appendices should be referred to when undertaking the Sequential Test:

Appendix A - Historic flooding

Appendix C - Fluvial Flood Zones

Appendix D - Fluvial climate change flood risk map

Appendix E- Surface water flood risk map

Appendix E - Surface water climate change flood risk map

Appendix F - GeoSmart Groundwater Flood Map

Appendix G - Reservoir inundation map

Local circumstances must be used to define the area of application of the Sequential Test (within which it is appropriate to identify reasonably available alternatives). The criteria used to determine the appropriate search area relate to the catchment area for the type of development being proposed. For some sites this may be clear (e.g., school catchments). In other cases it may be identified by other Local Plan policies. For some sites (e.g., regional distribution sites), it may be suitable to widen the search area beyond LPA administrative boundaries.

The sources of information on reasonably available sites may include:

- Site allocations in Local Plans
- Site with Planning Permission but not yet built out
- Strategic Housing and Economic Land Availability Assessments (SHELAAs) / five-year land supply / annual monitoring reports
- Locally listed sites for sale.

It may be that a number of smaller sites or part of a larger site at lower flood risk form a suitable alternative to a development site at high flood risk.

Ownership or landowner agreement in itself is not acceptable as a reason not to consider alternatives.

The SFRA guide to using technical data in Appendix L shows where the Sequential and Exception Test may be required for the datasets assessed in the SFRA, and how to interpret different levels of concern with the datasets, recommending what development might be appropriate in what situations.

3.3.2 The Exception Test

If, following application of the Sequential Test it is not possible for the development to be located in areas with a lower probability of flooding the Exception Test must then be applied if required (as set out in Table 2 of the PPG). Developers are required to apply the Exception Test to all applicable sites (including strategic allocations).

The applicant will need to provide information that the application can pass both parts of the Exception test:

- *Demonstrating that the development would provide wider sustainability benefits to the community that outweigh the flood risk*

  Applicants should refer to wider sustainability objectives in Local Plan Sustainability Appraisals. These generally consider matters such as biodiversity, green infrastructure, historic environment, climate change adaptation, flood risk, green energy, pollution, health, transport etc.

  Applicants should detail the sustainability issues the development will address and how these will outweigh the flood risk concerns for the site. For example, by facilitating wider regeneration of an area, providing community facilities, infrastructure that benefits the wider area etc.

- *Demonstrating that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.*

  The site-specific Flood Risk Assessment should demonstrate that the site will be safe, and the people will not be exposed to hazardous flooding from any source. The FRA should consider actual and residual risk and how this will be managed over the lifetime of the development, including:

  - the design of any flood defence infrastructure;
  - access and egress;
  - operation and maintenance;
  - design of the development to manage and reduce flood risk wherever possible;
  - resident awareness;
  - flood warning and evacuation procedures, including whether the developer would increase the pressure on emergency services to rescue people during a flood event; and
  - any funding arrangements required for implementing measures.

Developers should refer to site specific Flood Risk Assessments to identify opportunities to reduce flood risk as part of development. Reduction in flood risk could be achieved by:

- incorporating green infrastructure within the layout to make additional space or storage for flood water;

- providing Sustainable Drainage Systems that manage flood risk beyond the proposed site and above the usual standard, such as removing surface water from existing combines sewers;
- providing or making contributions to flood risk management infrastructure that will provide additional benefits to existing communities and/or by safeguarding the land that would be needed to deliver it.

As stated in Paragraph 031 of Planning Practice Guidance (Flood and Coastal Change), the Exception Test is not a tool to justify development in flood risk areas when the Sequential Test has already shown that there are reasonably available, lower risk sites, appropriate for the proposed development. It would only be appropriate to move onto the Exception Test in these cases where, accounting for wider sustainable development objectives, application of relevant local and national policies would provide a clear reason for refusing development in any alternative locations identified.

3.3.3 Cross boundary considerations

Situations may occur where a development site is situated across Local Authority boundaries, or where the development in one district or borough may impact flood risk elsewhere. Crawley Borough and Horsham District Councils should consider the impacts of development on flood risk elsewhere even if the impact of this is not within their area. In situations where cross-boundary developments are proposed, the Local Planning Authority should work closely with other Local Planning Authorities to satisfy the requirements of policies in their respective Local Plans, in consultation with statutory consultees such as the Environment Agency and the Lead Local Flood Authority.

4 Climate change

The NPPF sets out that flood risk should be managed over the lifetime of a development, taking climate change into account. This section sets out how the impact of climate change should be considered. Refer to the SFRA guide to using technical data in Appendix L for recommendations and details on how to apply the Sequential and Exception tests using the data set out in this section.

4.1 Climate change and the NPPF

The updated NPPF (July 2021) sets out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change. NPPF and PPG describe how FRAs should demonstrate how flood risk will be managed over the lifetime of the development, taking climate change into account.

The revised 2021NPPF also states that the 'sequential approach should be used in areas known to be at risk now or in the future from any form of flooding' (para 162).

4.2 Revised climate change guidance

The Environment Agency published **updated climate change guidance** on 19 February 2016 (further updated in February 2019 and December 2019, and May 2022), which supports the NPPF and must now be considered in all new developments and planning applications. The document contains guidance on how climate change should be considered when considering development, specifically how allowances for climate change should be included with FRAs. The Environment Agency can give a free preliminary opinion to applicants on their proposals at pre-application stage. There is a charge for more detailed pre-application planning advice.

4.3 Climate change allowances

By making an allowance for climate change it will help reduce the vulnerability of the development and provide resilience to flooding in the future.

The 2016 climate change guidance includes climate change predictions of anticipated change for peak river flow and peak rainfall intensity (see Table 4-1). These allowances are based on climate change projections and different scenarios of carbon dioxide emissions to the atmosphere.

Due to the complexity of projecting the effects of climate change, there are uncertainties attributed to climate change allowances. As a result, the guidance presents a range of possibilities to reflect the potential variation in the impact of climate change over three periods.

The UK Climate Predictions 2018 (UKCP18) were published on 26 November 2018. The UKCP18 projections replace the UKCP09 projections and are the official source of information on how the climate of the UK may change over the rest of this century. The Environment Agency updated the climate change allowance projections for sea level rise in 2020 and further updated the guidance for peak river levels and rainfall intensity in 2022 to account for the UKPC18 climate change projections.

4.4 Peak river flows

Climate change is expected to increase the frequency, extent, and impact of flooding which is reflected in peak river flow climate change uplifts. Wetter winters and more intense rainfall may increase fluvial flooding and surface water runoff and there may be increased storm intensity in summer. Rising river levels may also increase flood risk.

The peak river flow allowances provided in the Environment Agency **Flood risk assessments: climate change allowances** guidance show the anticipated changes to peak flow for the river basin district within which the subject watercourse is located. Once the river basin district has been identified, guidance on uplift in peak flows are provided for three allowance categories, Central, Higher Central and Upper End which are based on the 50th, 70th and 90th percentiles respectively. The allowance category to be used is based on the vulnerability classification of the development and the Flood Zone(s) within which it is located (Table 4-2, , Table 4-3).

These allowances (increases) are provided, in the form of figures for the total potential change anticipated, for three climate change periods:

- The '2020s' (2015 to 2039)
- The '2050s' (2040 to 2069)
- The '2080s' (2070 to 2125)

The time period used in the assessment depends upon the expected lifetime of the proposed development. Residential development should be considered for a minimum of 100 years, whilst the lifetime of a non-residential development depends upon the characteristics of that development. Further information on what is considered to be the lifetime of development is provided in the **Flood Risk and Coastal Change PPG**.

Land within the study area is located within the Mole Management Catchment. Maps showing the extent of River Management Basins and their associated peak river flow uplift values are **published by the Environment Agency**. The peak river flow uplifts for the **Mole Management Catchment** are provided in Table 4-1.

Table 4-1: Peak river flow allowances for the Mole Management Catchment

Allowance category	Total potential change anticipated for '2020s' (2015 to 39)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2115)
Upper end	27%	26%	40%
Higher central	16%	12%	20%
Central	11%	6%	12%

4.4.1 Which peak river flow allowance to use?

The Flood Zone and flood risk vulnerability classification should be considered when deciding which allowances apply to the development or the plan. Vulnerability classifications are found in the **PPG**. The Environment Agency guidance states that both the central and higher central allowances should be assessed in strategic flood risk assessments. Specific guidance is given for which climate change allowance estimates should be applied to Flood Zones 2 and 3a (Table 4-2) and Flood Zone 3b

(Table 4-3). For site specific Flood Risk Assessments, the central allowances should be used in most instances with the exception of 'essential infrastructure' where the guidance is to use the 'higher central' allowance.

Table 4-2: Flood Zone 2 and Flood Zone 3a peak river flow allowance guidance

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure		✓	
Highly vulnerable	Development is not permitted in Flood Zone 3a	Development is not permitted in Flood Zone 3a	Development is not permitted in Flood Zone 3a
More vulnerable	✓		
Less vulnerable	✓		
Water compatible	✓		

Table 4-3: Flood Zone 3b peak river flow allowance guidance

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure			✓
Highly vulnerable	Development should not be permitted		
More vulnerable			
Less vulnerable			
Water compatible	✓		

Currently there is no guidance on considering the impact of climate change on development located within Flood Zone 1.

4.5 Peak rainfall intensity allowance

Climate change is predicted to result in increased winter rainfall and increased summer storm intensity in the future. This increased rainfall quantity and intensity will affect land and urban drainage systems, resulting in surface water flooding, due to the increased volume of water entering the systems. The Environment Agency have developed a **peak rainfall allowances map** which shows anticipated changes in peak rainfall intensity which can be used for site-scale applications (like urban drainage design) and surface water flood mapping in small catchments (<5km^2).

The guidance suggests that direct rainfall modelling may not be suited to larger (>5km^2) catchment with rural land use. In these instances, the guidance states that the fluvial flood risk affected by climate change should be assessed using uplifts from peak river flow allowances (Section 4.4).

All rainfall intensity climate change uplifts should be applied to both the 3.3% and 1% AEP events. The recommended epoch and central and upper end allowances are based on the design lifetime of the proposed development as in Table 4-4 below.

According to the Environment Agency's mapped rainfall intensity climate change uplifts, the study area of this SFRA is found in the Mole Management Catchment. Table 4-4 shows anticipated changes in extreme rainfall intensity for both the 3.3%

and 1% AEP events in the Mole Management Catchment for small catchments and urbanised drainage sites.

Table 4-4: Peak rainfall intensity allowance for the Mole Management Catchment for the 3.3% and 1% AEP events

% Annual Exceedance Probability event	Epoch	Central allowance	Upper end allowance
3.3%	2050s	20%	35%
	2070s	20%	35%
1%	2050s	20%	40%
	2070s	25%	40%

Table 4-5: Recommended rainfall intensity climate change allowances and epochs based on the design lifetime of the proposed development.

Design lifetime	Recommended allowance	Recommended epoch
Up to 2060	Central	2050s (2022 – 2060)
Development lifetime between 2061 and 2100	Central	2070s (2061 – 2125)
Development lifetime beyond 2100	Upper end	2070s (2061 – 2125)

4.6 Groundwater

The effect of climate change on groundwater flooding problems, and those watercourses where groundwater has a large influence on winter flood flows, is much more uncertain. Milder wetter winters may increase the frequency of groundwater flooding incidents in areas that are already susceptible, but warmer drier summers may counteract this effect by drawing down groundwater levels to a greater extent during the summer months. The effect of climate change on groundwater levels for sites in areas where groundwater is known to be an issue should be considered at the planning application stage.

4.7 The impact of climate change in the study area

4.7.1 Previous studies

The **UK Climate Projections (UKCP18)** provides a number of future projections for different variables across the UK.

Thames

- Increased mean summer temperatures of over 8ºC by 2099.
- Increased mean winter temperatures of up to 7ºC or a decrease of up to 1ºC by 2099.
- Summer rainfall could decrease by over 80% or it could increase up to 20% by 2099.

- Winter rainfall could decrease by up to 10% or it could increase over 60% by 2099.

Whilst changes in trends and mean values is important, the more influential effect of climate change with respect to flood risk and drought is to increase the chance of occurrence and severity of more extreme wet and dry events.

4.7.2 Adapting to climate change

PPG Climate Change contains information and guidance for how to identify suitable mitigation and adaptation measures in the planning process to address the impacts of climate change. Examples of adapting to climate change include:

- Considering future climate risks when allocating development sites to ensure risks are understood over the development's lifetime
- Considering the impact of and promoting design responses to flood risk and coastal change for the lifetime of the development
- Considering availability of water and water infrastructure for the lifetime of the development and design responses to promote water efficiency and protect water quality
- Promoting adaptation approaches in design policies for developments and the public realm for example by building in flexibility to allow future adaptation if needed, such as setting new development back from watercourses

At county level, WSCC adopted the **Climate Change Strategy 2020-2030**in 2020. . This was supplemented by the **Climate Change Strategy Delivery Plan** which was published in 2021. These two documents outline the pledge by the County Council to reach net zero carbon emissions by 2030. This will be achieved by integrating long-term sustainable thinking in to all policies and procedures employed by West Sussex County Council, as well as cutting pollution in the district. Commitments include:

- Reducing carbon emissions
- Employing climate change resilience and adaptation strategies (including updating flood risk data, improving highways drainage, and developing a tree strategy)
- Sourcing and using resources sustainably
- Growing the local green economy

These objectives are further supported the **West Sussex County Council's Carbon Management Plan** which is a detailed report outlining specific actions and policies which will be employed to reach net zero by 2030.

A **West Sussex Life** report is published annually providing statistics and information about West Sussex that is used by the council when delivering services.

At the local level, Chapter 10 of **Horsham District Local Plan** outlines the policies of the district for meeting the challenges of climate change. For Crawley, these issues are considered in the Environment Chapter of the adopted **Local Plan (2015)** and in the Environmental Sustainability Chapter of the emerging Local Plan Review. Crawley has also produced a **Planning and Climate Change Supplementary Planning Document** to support the Local Plan. Further, Crawley declared a Climate Emergency in July 2019, and the council has pledged to reduce emissions by at least 50%, and as close to net zero as possible by 2030, and to reach net zero by 2040 at the very latest.

It is recommended that the differences in flood extents from climate change are compared by the Council when allocating sites, to understand how much additional risk there could be, where this risk is in the site, whether the increase is marginal or activates new flow paths, whether it affects access/ egress and how much land could

still be developable overall. Recommendations for development are made for the levels of risk in the SFRA guide to using technical data in Appendix L.

4.7.3 Climate change modelling outputs

For this Level 1 SFRA, the River Upper Mole (2020) Flood Modeller / TUFLOW model climate change outputs were used, which reflect the 2019 peak river flow allowances for the Thames River Basin. The model was run for the 1% AEP plus 25%, 35% and 70% increases in peak flows.

Where there is no fluvial model available, Flood Zone 2 has been used to provide indicative information on climate change. This level of assessment is suitable for a SFRA, However, detailed hydraulic modelling using topographic survey would be required at a site-specific level to confirm the flood risk to these sites.

This methodology has been reviewed to understand the impacts of the revised allowances published in 2021 and based on the UKCP18 data and a comparison between the allowances used in the SFRA and the current allowance has been made in Table 4-6 for fluvial. Overall the allowances for the River Mole show a decrease across all epochs and allowance types.

For surface water, the previous (UKCP09) recommended uplifts were 20% and 40%, which aligns closely with the latest guidance.

Consequently, the allowances used in the SFRA are appropriate as they provide a conservative estimate of the impacts of climate change on flood risk.

Table 4-6: Comparison between old and new peak river flow allowances for the 2080s epoch

	Central	Higher Central	Upper End
2019 allowances (used in this SFRA)	25%	35%	70%
Current allowances	12%	20%	40%

Climate change mapping can be found in Appendix D.

5 Sources of information used in preparing the SFRA

This chapter describes the key sources of flood risk information used within this SFRA. Refer to the SFRA guide to using technical data in Appendix L for recommendations and details on how to apply the Sequential and Exception tests using the data set out in this section.

5.1 Historic flood risk

The historic flood risk in the study area has been assessed using point information of recorded incidents provided by West Sussex County Council, the Environment Agency's recorded flood outline dataset and Thames Water's Sewer Flooding History Database (SFHD).

This has been supplemented with other information from the 2010 and 2014 Crawley and Horsham's SFRAs, West Sussex County Council's Preliminary Flood Risk Assessment, Local Flood Risk Management Strategy, Flood Investigation reports and news reports. The key considerations from these sources are outlined in Section 6.1. Historic flood mapping for the study area can be found in Appendix A. Guidance on how this information should be used to inform the Sequential and Exception Tests can be found in Appendix L.

5.2 Fluvial flooding

Flood Zones 2, 3a and 3b have been delineated for the study area as part of this SFRA. As required by the Environment Agency, Flood Zones are based on the undefended scenario with the exception of Flood Zone 3b, which includes the presence of defences on the basis that land behind existing defences is not intended to flood and therefore is not functional floodplain. The Flood Zones presented in this SFRA should be used as the basis for decision making in the Crawley Borough Council and Horsham District Council Local Plan review. This will in some circumstances update the existing Environment Agency Flood Zones.

The following categories have been used to define each Flood Zone:

- **Flood Zone 1:** Comprised of land having a less than 1 in 1,000 annual probability of river or sea flooding in any year (<0.1% AEP)
- **Flood Zone 2:** Comprised of land having between a 1 in 100 (1% AEP) and 1 in 1,000 annual probability of river flooding or 1 in 200 (0.5% AEP) and 1 in 1,000 (0.1% AEP) annual probability of sea flooding.
- **Flood Zone 3a:** This zone comprises land assessed as having a greater than 1 in 100 (>1% AEP) annual probability of river flooding or Land having a 1 in 200 or greater annual probability of sea flooding.
- **Flood Zone 3b:** This zone is defined nationally as being comprised of land assessed to have a 3.3% or greater change of flooding from any source in any given year or where water has to flow or be stored in times of flood (the functional floodplain).

Flood Zone 3b, unlike other Zones, does show flood risk that takes account of the presence of existing flood risk management features and flood defences, as land afforded this standard of protection is not appropriately included as functional flood plain. The mapping in the SFRA identifies this Flood Zone as land which would flood with a 2% chance in each and every year (a 2% AEP or 1 in 50-year event, where detailed modelling exists. This approach has been agreed with the Environment Agency and provides a robust and conservative approach to the identification of the functional floodplain.

Where the 2% AEP outputs are not available, the precautionary approach has been taken using the 1% AEP defended scenario (Flood Zone 3a). If a proposed development is shown to be within this area, further investigation should be undertaken as part of a detailed site-specific FRA to define and confirm the extent of Flood Zone 3b.

If existing development or infrastructure is shown in Flood Zone 3b, additional consideration should be given to whether the specific location is appropriate for designation as 'Functional' with respect to the storage or flow of water in time of flood.

Care should be taken when interpreting how Flood Zone 3b is predicted to change as a consequence of climate change effects. At such locations it is possible that the assessment performed to estimate the frequency of inundation (1 in 50 for Flood Zone 3b) will not include an allowance for the potential increase in standard of protection provided by flood risk management features. In these circumstances more detailed assessments should be performed when considering whether development is appropriate to understand the commitment required to improve the standard of protection and how this affects the extent of Flood Zone 3b.

Flood Zone mapping for the study area can be found in Appendix C. The map highlights where a precautionary approach has been used to identify Flood Zone 3b. Guidance on how this information should be used to inform the Sequential and Exception Tests can be found in Appendix L.

5.3 Fluvial flood risk models used in this SFRA

Table 5-1 lists the fluvial flood risk modelling used to inform the SFRA.

Table 5-1: Fluvial flood risk models used in the Level 1 SFRA

Model name	Year	Software (type)
River Upper Mole	2020	Flood Modeller/TUFLOW
Generalised main river and ordinary watercourse modelling	2004 and 2009	JFlow (2D)

5.3.1 Climate change

The **Environment Agency climate change guidance** (updated in May 2022) shows that for watercourses in the Mole Management catchment 12%, 20%, and 40%allowances should be considered for the 2080's epoch.. For further information on climate change allowances please refer to Section 4.2.

As part of this SFRA, the Environment Agency confirmed that readily available climate change modelling should be used from the Upper Mole Model, and no additional modelling was required.

Where there is no fluvial model available, Flood Zone 2 (0.1% AEP extent) has been used to provide indicative information on the potential effects of climate change. This level of assessment is suitable for an SFRA. However, detailed hydraulic modelling using topographic survey would be required at a site-specific level to confirm the flood risk to these sites.

5.4 Surface Water

Flooding from surface water runoff (or 'pluvial' flooding) is caused by intense short periods of rainfall and usually affects lower lying areas, often where the natural (or artificial) drainage system is unable to cope with the volume of water. Surface water flooding problems are inextricably linked to issues of poor drainage, or drainage blockage by debris, and sewer flooding.

Mapping of surface water flood risk in the study area has been taken from the Risk of Flooding from Surface Water (RoFSW) published online by the Environment Agency. These maps are intended to provide a consistent standard of assessment for surface water flood risk across England and Wales in order to help LLFAs, the Environment Agency and any potential developers to focus their management of surface water flood risk. The different surface water risk categories used in the RoFSW mapping are defined in Table 5-2.

The RoFSW is derived primarily from identifying topographical flow paths of existing watercourses or dry valleys that contain some isolated ponding locations in low lying areas. They provide a map which displays different levels of surface water flood risk depending on the annual probability of the land in question being inundated by surface water.

Table 5-2: Surface water risk categories used in the RoFSW mapping

Category	Definition
High	Flooding occurring as a result of rainfall with a greater than 1 in 30 chance in any given year (3.3% AEP)
Medium	Flooding occurring as a result of rainfall of between 1 in 100 (1% AEP) and 1 in 30 (3.3% AEP) chance in any given year.
Low	Flooding occurring as a result of rainfall of between 1 in 1,000 (0.1% AEP) and 1 in 100 (1% AEP) chance in any given year.
Very Low	Flooding occurring as a result of rainfall with less than 1 in 1,000 (0.1% AEP) chance in any given year.

Although the RoFSW offers improvement on previously available datasets, the results should not be used to understand flood risk for individual properties. The results should be used for high level assessments such as SFRAs for local authorities. If a particular site is indicated in the Environment Agency mapping to be at risk from surface water flooding, a more detailed assessment should be considered to more accurately illustrate the flood risk at a site-specific scale. Such an assessment will use the RoFSW in partnership with other sources of local flooding information, to confirm the presence of a surface water risk at that particular location.

The RoFSW map for the study area can be found in Appendix E. Guidance on how this information should be used to inform the Sequential and Exception Tests can be found in Appendix L.

5.4.1 Surface water flood risk with climate change uplifts

Modelling has been carried out to account for the impact of climate change on surface water flood risk in the SFRA study area. The Environment Agency 2022climate change guidance shows that increases in the peak rainfall intensity in small and urban catchments should be considered when preparing FRAs. The recommended uplifts for the Mole Management Catchment central and upper end allowances are 25% and 40% respectively for the 2080s epoch. This is a slight alteration from the 2016 climate change guidance which defined a 20% and 40% uplift for the central and upper end allowances respectively. It should be noted that the modelling and mapping for surface water flooding with climate change allowances have not been updated in the 2023 version of this SFRA due to the upper end allowance uplifts remaining the same.

The peak rainfall intensities for the RoFSW 1% AEP event have been uplifted by 20% and 40% to assess the impact of climate change on surface water flood risk in the SFRA study area. It is recommended that users take a conservative approach and consider the upper end climate change allowance only from the surface water flood risk mapping with climate change uplifts due to the lack of available modelling for the central climate change allowance.

Mapping showing the extents of the 1% AEP plus 20% and 40% climate change scenarios can be found in Appendix F. Guidance on how this information should be used to inform the Sequential and Exception Tests can be found in Appendix L.

5.4.2 Critical drainage areas

Critical drainage areas are defined by the Town and Country Planning (General Development Procedure Amendment No. 2, England) Order 2006 as "*an area within Flood Zone 1 which has critical drainage problems and which has been notified [to] the local planning authority by the Environment Agency*". These can cover wide areas within both rural and urban environments and are typically where man-made drainage infrastructure has been identified as at critical risk of failure, resulting in flooding.

No critical drainage areas have been identified within the study area.

5.5 Groundwater

GeoSmart have developed a range of Groundwater Flood Map products at the national scale. The 5m resolution GeoSmart Groundwater Flood Map has been used within the SFRA. The modelling incorporates a 5m Digital Terrain Model, with enhanced resolution at an individual property level, with the latest LIDAR data from the Environment Agency. The outputs demonstrate the relationship between terrain and "ponding" of groundwater. The Groundwater Flood Map categorises flood risk into four feature classes based on likelihood, model/data uncertainty and possible severity based on the 1% AEP model outputs.

The four risk categories are defined as follows:

- **Class 4: Negligible Risk:** There is a negligible risk of groundwater flooding in this area and any groundwater flooding incidence has a chance of less than 1% AEP. No further investigation of risk is deemed necessary unless proposed site use is unusually sensitive.
- **Class 3: Low Risk:** There is a low risk of groundwater flooding in this area with a chance of greater than 1% AEP. There will be a remote possibility that incidence of groundwater flooding could lead to damage to property or harm to other sensitive receptors at, or near, this location.
- **Class 2: Moderate:** There is a moderate risk of groundwater flooding in this area with a chance of greater than 1% AEP. There will be a significant possibility that incidence of groundwater flooding could lead to damage to property or harm to other sensitive receptors at, or near, this location
- **Class 1: High:** There is a high risk of groundwater flooding in this area with a chance of greater than 1% AEP or more frequent. It is likely that incidence of groundwater flooding will occur, which could lead to damage to property or harm to other sensitive receptors at, or near, this location.

It should be noted that the GeoSmart Groundwater Flood Map is suitable for general broad-scale assessment of the groundwater flood hazard in an area but is not explicitly designed for the assessment of flood hazard at the scale of a single property. In high-risk areas a site-specific risk assessment for groundwater flooding is recommended to fully inform the likelihood of flooding.

The GeoSmart Groundwater Flood Map of the study area can be found in Appendix G. Guidance on how this information should be used to inform the Sequential and Exception Tests can be found in Appendix L.

5.6 Sewers

Historical incidents of flooding are detailed by Thames Water through their Sewer Flooding History Database (SFHD). This database records incidents of flooding relating to public foul, combined or surface water sewers and displays properties that suffered both internal and external flooding. For confidentiality reasons, this data has been supplied on a postcode basis from the Sewer Flooding History Database (SFHD) for incidents recorded in the study area. The database covers reported incidents of sewer flooding in the last 20 years.

The SFHD for the study area can be found in Table 6-3. Mapping of this data, indicating quantities of recorded flood incidents per postcode, is shown in Figure 6-6.

In May 2023, Thames Water published its Drainage and Wastewater Management Plan (DWMP). As part of the work that went it to this plan, Thames Water completed a risk-based catchment screening. During this process the Crawley Sewage Treatment Works (CSTW) catchment was brought forward for a Baseline Risk and Vulnerability Assessment (BRAVA). The outputs of the BRAVA provide information to determine the severity, location, and type of sewage infrastructure risk. For each of the types of risk, the CSTW was assigned a risk level from Not significant (0), moderately significant (1) and very significant (2). The BRAVA demonstrated that the overall flood risk from sewers in the CSTW catchment area is low. Sewer flood risk for the 1 in 50-year (2% AEP) event has a risk score of 0 for both the present day and future (2050) scenarios. Internal sewer flood risk also has a score of 0. This means that all forms of flooding risk are currently considered as 'at or below the accepted industry thresholds'.

The main areas of concern highlighted by the BRAVA are the present-day pollution risk and storm overflow performance both present day and in the future (linked directly with pollution risks).

No drainage issues were identified by Thames Water as part of this SFRA. However, the BRAVA identified that whilst Crawley wastewater treatment works currently has adequate capacity, this is unlikely to meet future demand up to the year 2050 without investment in the infrastructure. Therefore, site specific sewer capacity assessments should be undertaken when an application is made to connect to a sewer during development.

5.7 Reservoirs

The risk of inundation due to reservoir breach or failure of reservoirs within the area has been assessed using the Environment Agency's Reservoir Flood Maps (2021)[3].

The Reservoir Flood Maps describe two reservoir flooding scenarios. A "dry day" scenario and a "wet day" scenario.

The "dry day" scenario shows the predicted flood extents if a reservoir failure were to occur when river levels are at normal levels. The "wet day" scenario shows the predicted flood extents if reservoir failure were to occur when river levels are already high and extreme fluvial flooding is already occurring. The "wet day" scenario is used to demonstrate the combined effect of fluvial and reservoir flooding due to the potential probability of reservoir failure occurring due to extreme rainfall.

[3] Environment Agency, 2021. Reservoir Flood Maps: when and how to use them. https://www.gov.uk/guidance/reservoir-flood-maps-when-and-how-to-use-them

The Reservoir Flood Maps also include a "fluvial contribution" layer, provided for context. This layer shows the fluvial flood extents which were used by the Environment Agency to calculate the "wet day" scenario. The fluvial flood extent shown is based on an extreme fluvial flood and is not the same as Flood Zones 2 and 3.

The Reservoir Flood Maps for the study area can be found in Appendix H. Guidance on how this information should be used to inform the Sequential and Exception Tests can be found in Appendix L.

5.8 Suite of maps

Mapping can be found in the appendices to this SFRA. These are presented in the following structure:

- Appendix A: Historical flooding
- Appendix B: Watercourses
- Appendix C: Fluvial Flood Zones
- Appendix D: Fluvial climate change flood risk map
- Appendix E: Surface water flood risk map
- Appendix F: Surface water climate change flood risk map
- Appendix G: GeoSmart Groundwater Flood Map
- Appendix H: Reservoir inundation map
- Appendix I: Flood Defences
- Appendix J: Flood Alert and Flood Warning Areas

5.9 Other relevant flood risk information

Users of this SFRA should also refer to other relevant information on flood risk where available and appropriate. This information is assessed in more detail in Section 2.3 and includes:

- **Thames Catchment Flood Management Plan (2009)** – see section 2.3.5 for details.
- **West Sussex Local Flood Risk Management Strategy (2013)** – see section 2.3.6 for details
- **West Sussex LLFA Policy for the Management of Surface Water (2018)** – see section 2.3.7 for details
- **Thames River Basin District River Basin Management Plan (2022)** – see section 2.3.3 for details

6 Understanding flood risk in the Study area

This chapter explores the key sources of flooding in the borough and appropriate areas within Horsham District the factors that affect flooding including topography, soils and geology. The main sources of flooding are from watercourses, surface water, sewers and culvert blockages. Refer to the SFRA guide to using technical data in Appendix L for recommendations and details on how to apply the Sequential and Exception tests using the data set out in this section.

6.1 Historical flooding

The study area has a long history of recorded flood events caused by multiple sources of flooding.

Information collated from the Environment Agency's recorded flood outlines, WSCC's 2012 recorded flood incidents, and Thames Water's SFHD datasets were assessed to understand historic flooding in the study area. This information was supplemented by local flood risk documents and news reports.

The data shows that there have been a number of fluvial floods in the area including along the River Mole, Gatwick Stream, Ifield Brook and Tilgate Brook. Langley Green, Forge Wood, Three Bridges and Furnace Green are among the areas that have been affected by main river fluvial flooding. Anecdotal information from online news sources also indicate that Broadfield Brook caused fluvial flooding in November 2022[4]. According to the Environment Agency's recorded flood outlines, flooding from Ordinary Watercourses has also affected Buckswood Drive and Horsham Road, in between Gossops Green and Bewbush, and the land currently occupied by Gatwick Airport's Northern terminal.

There have been several incidents of surface water flooding across Crawley, in the neighbourhoods of Southgate, Three Bridges, West Green, Langley Green and Broadfield, as well as in Rusper.

The majority of the study area has been susceptible to sewer flooding in the past, with Pound Hill, Maidenbower, Ifield and Rusper being some of the most frequently affected areas.

Groundwater flooding has been relatively uncommon, with only two instances having been identified by the Environment Agency, in 2001 at Bewbush and Furnace Green.

The key historical incidents of flooding identified are summarised as follows:

- **September 1968-** Fluvial flooding of critical national infrastructure in the form of the Gatwick Airport runway, resulting in the closure of the airport for several days[5].
- **Autumn 2000-** A 1 in 15-year flood event from the surcharging of an undersized temporary culvert. Widespread flooding from various sources impacted the A23 and over 70 properties across the study area. Of these, 44 were located in Maidenbower, 20 in Furnace Green and 14 in Ifield Green[6].
- **December 2008-** Fluvial flooding reported from the River Mole overtopping its banks, leading to the evacuation of a Care Home in Ifield Green[6].

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4 Sussex Live 2022. Crawley roads submerged by flooding as Met Office rain weather warning comes in to force. https://www.sussexlive.co.uk/news/sussex-news/crawley-roads-submerged-flooding-met-7779077

5 West Sussex County Council, West Sussex Preliminary Flood Risk Assessment, 2011. Available: https://www.westsussex.gov.uk/media/1626/west_sussex_pfra.pdf

6 Crawley Borough Council Level 1 Strategic Flood Risk Assessment (2014) Available: http://crawley.gov.uk/pw/web/PUB228566

- **June 2012-** An extreme rainfall event resulted in widespread surface water flooding across West Sussex, with the River Mole being one of the areas experiencing the highest rainfall. A small number of properties were impacted across Southgate, West Green, Rusper and Broadfield[7].
- **Winter 2013/14-** Surface water flooding was reported across the study area during a particularly wet winter, resulting in service disruption to Gatwick Airport[8].
- **December 2019**- Fluvial flooding led to the inundation and subsequent closure of the M23 and severe disruption to the railway network[9]
- **November 2022** – heavy rain led to surface water inundation of many roads including Brighton Road, Cheals Roundabout, and Ashdown Drive by Thomas Bennett Community College. The pedestrian underpass from Winfield Way to Brighton Road was impassable due to surface water flooding. Broadfield Brook was noted to overtop and flood the surrounding wetland and cause water to flow downslope from the brook[4]. The M23 was closed in both directions between Junction 10 for Crawley and Junction 11 for Pease Pottage[10].

Appendix A shows recorded historic flood extents provided by the Environment Agency and the location of the properties flooded in the June 2012 surface water flood event.

6.1.1 West Sussex County Council June 2012 Flood Investigation Report

A Flood Investigation Report reviewing the major flood event in June 2012 across West Sussex was prepared by West Sussex County Council in November 2012. The report identifies this as a 0.5% AEP event (across the county) that overwhelmed the drainage network, resulting in widespread surface water flooding. In the south west corner of the Upper Mole Catchment, parts of Rusper, Faygate and Lambs Green were highlighted as areas that experienced the heaviest rainfall, with over 100mm of rain experienced. Four properties were reported to have been affected within the study area. These were located on Horsham Road, Albany Road, Charlwood Road and Timberlands.

6.2 Topography, geology and soils

Crawley Borough covers an area of approximately 45 km^2 and has an estimated population of over 118,580 in 2022[11]. Horsham District covers approximately 531 km^2 with an estimated population of over 146,800[12], of which the SFRA study area encompasses 25 km^2. The largest settlement in the study area is Crawley, which consists of 14 residential neighbourhoods: Forge Wood, Langley Green, Pound Hill, Maidenbower, Three Bridges, Furnace Green, Northgate, West Green, Ifield, Bewbush, Gossops Green, Southgate, Tilgate and Broadfield.

6.2.1 Topography

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7 West Sussex County Council, Report on June 2012 Flood Event, 2012. Available: https://www.westsussex.gov.uk/media/1623/final_report.pdf

8 Environment Agency, Report on costs and impacts of the winter 2013 to 2014 floods. Available: https://rpaltd.co.uk/uploads/report_files/the-costs-and-impacts-of-the-winter-2013-to-2014-floods-report.pdf

9 Surrey Live News, 20 December 2019. Available:https://www.getsurrey.co.uk/news/local-news/m23-flooding-closed-pictures-crawley-17452281

10 ITV News, 2022. Disruption continues after heavy rainfall overnight including delays on the M23 by Gatwick Airport. https://www.itv.com/news/meridian/2022-11-16/20-cars-trapped-on-dual-carriageway-as-carriageway-floods-in-heavy-rain

11 Varbes, 2022. Population of Crawley. https://www.varbes.com/population/crawley-population

12 Office For National Statistics, Horsham National Census 2021. https://www.ons.gov.uk/visualisations/censuspopulationchange/E07000227/

As shown in Figure 6-1, the topography of the study area is comprised of lower lying ground in the north east, sloping to areas of higher elevation in the south west. The High Weald Area of Outstanding Natural Beauty (AONB) runs along the southern edge of the study area, with a topographic high of approximately 149 mAOD. The majority of the lower lying land across the central and northern areas are located between 60 and 80 mAOD.

6.2.2 Geology and soils

The geology of a catchment can be an important influencing factor on the way that water runs off the ground surface. This is primarily due to variations in the permeability of the surface material and bedrock stratigraphy.

Figure 6-2 and Figure 6-3 show the bedrock (solid permeable) formations and the superficial deposits (permeable, unconsolidated) in the study area respectively.

The bedrock layers and superficial deposits are identified as being aquifers that are classified as follows and are shown in Figure 6-4 and Figure 6-5 respectively:

- **Principal**: layers of rock or drift deposits with high permeability which therefore provide a high level of water storage
- **Secondary A**: rock layers or drift deposits capable of supporting water supplies at a local level and, in some cases, forming an important source of base flow to rivers
- **Secondary B**: lower permeability layers of rock or drift deposits which may store and yield limited amounts of groundwater
- **Secondary undifferentiated**: rock types which do not fit into either category A or B.
- **Unproductive Strata**: rock layers and drift deposits with low permeability and, therefore, have a negligible impact on water supply or river base flow.

The bedrock geology in the study area is classified as a mixture of Secondary A aquifers and unproductive strata.

The superficial deposits in the study area are classified as Secondary A aquifers, with a very small area of Secondary (undifferentiated) aquifers.

Figure 6-1: Elevation across the SFRA study area

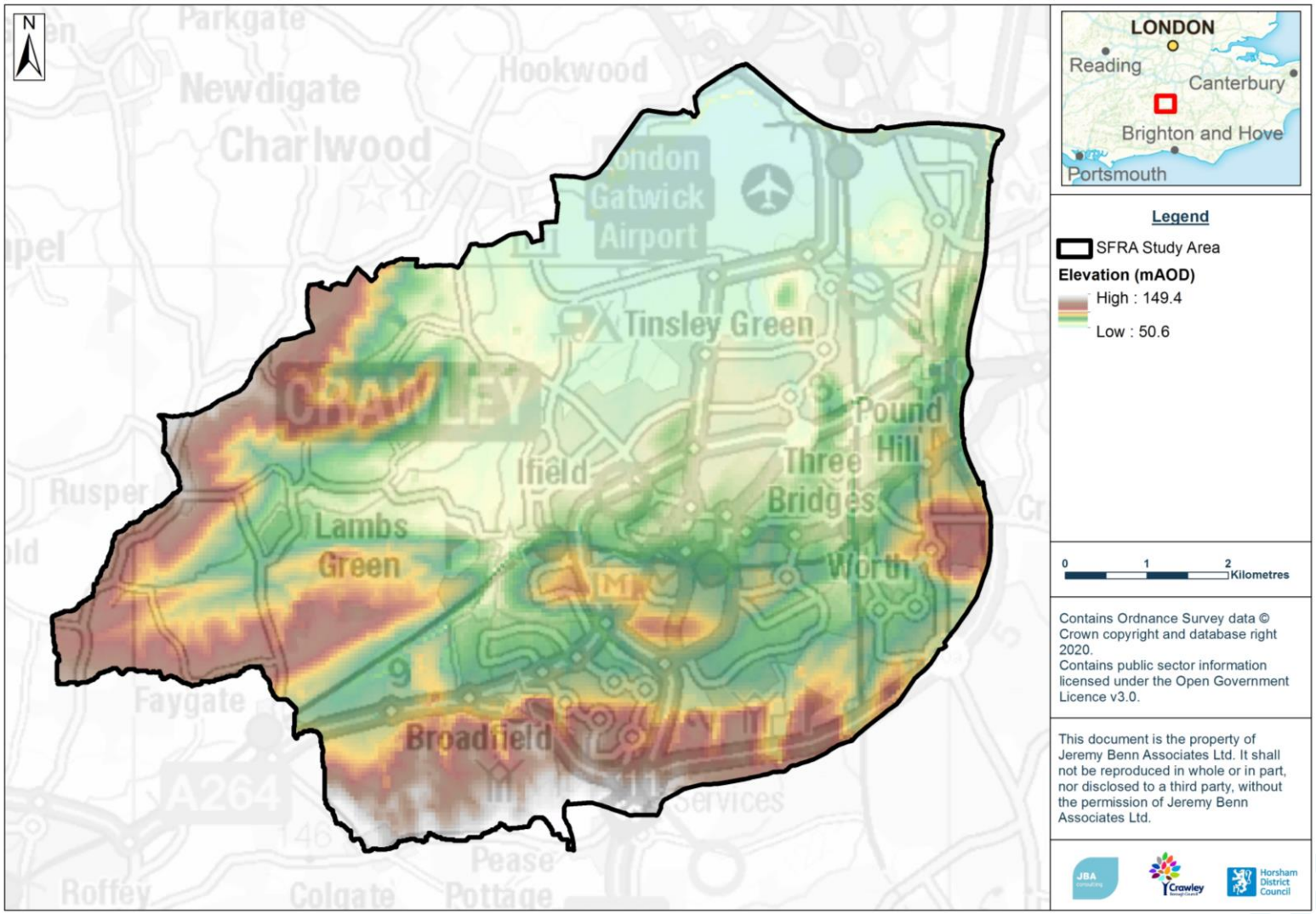


Figure 6-2: Bedrock geology in the SFRA study area

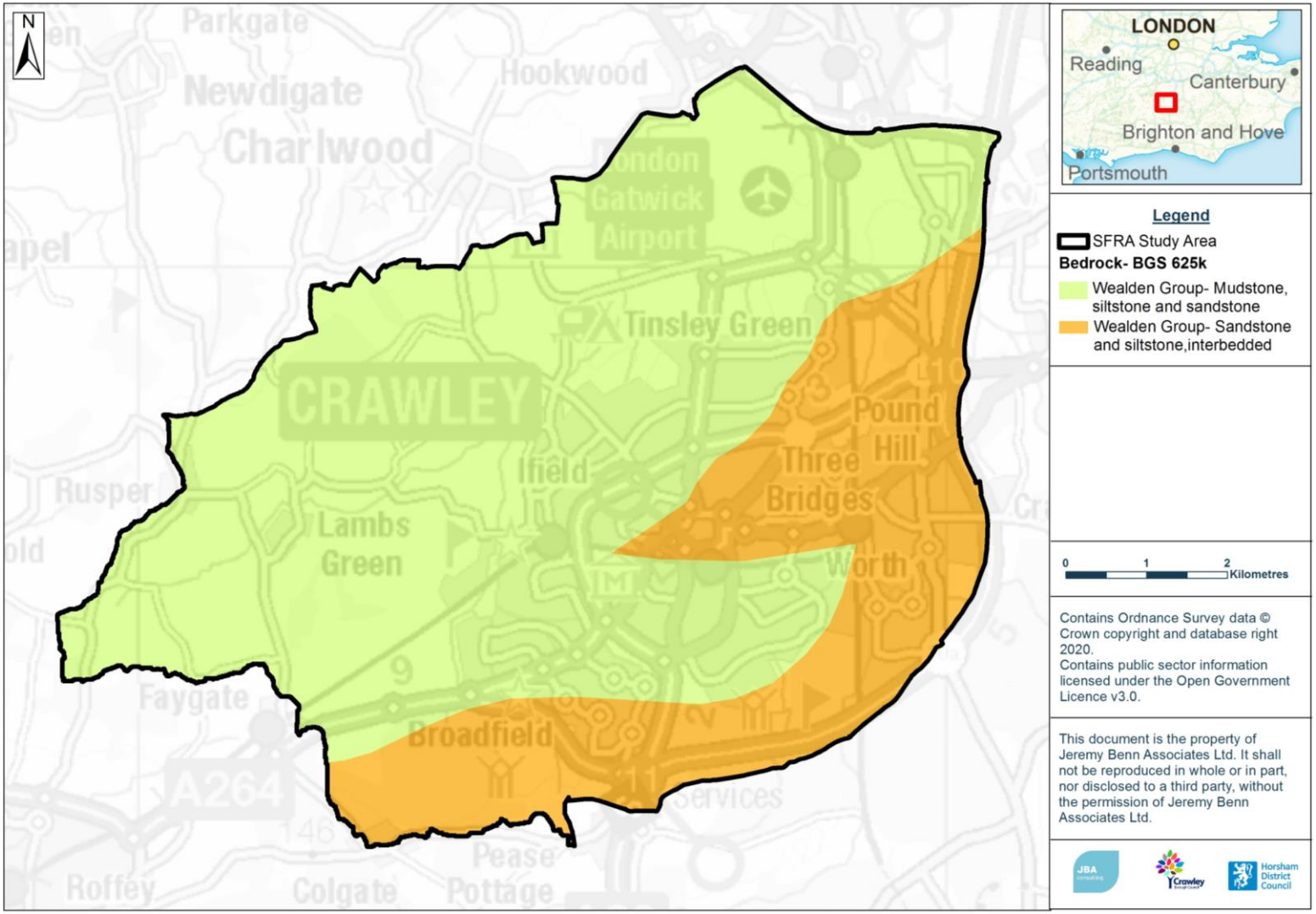


Figure 6-3: Superficial deposits in the SFRA study area

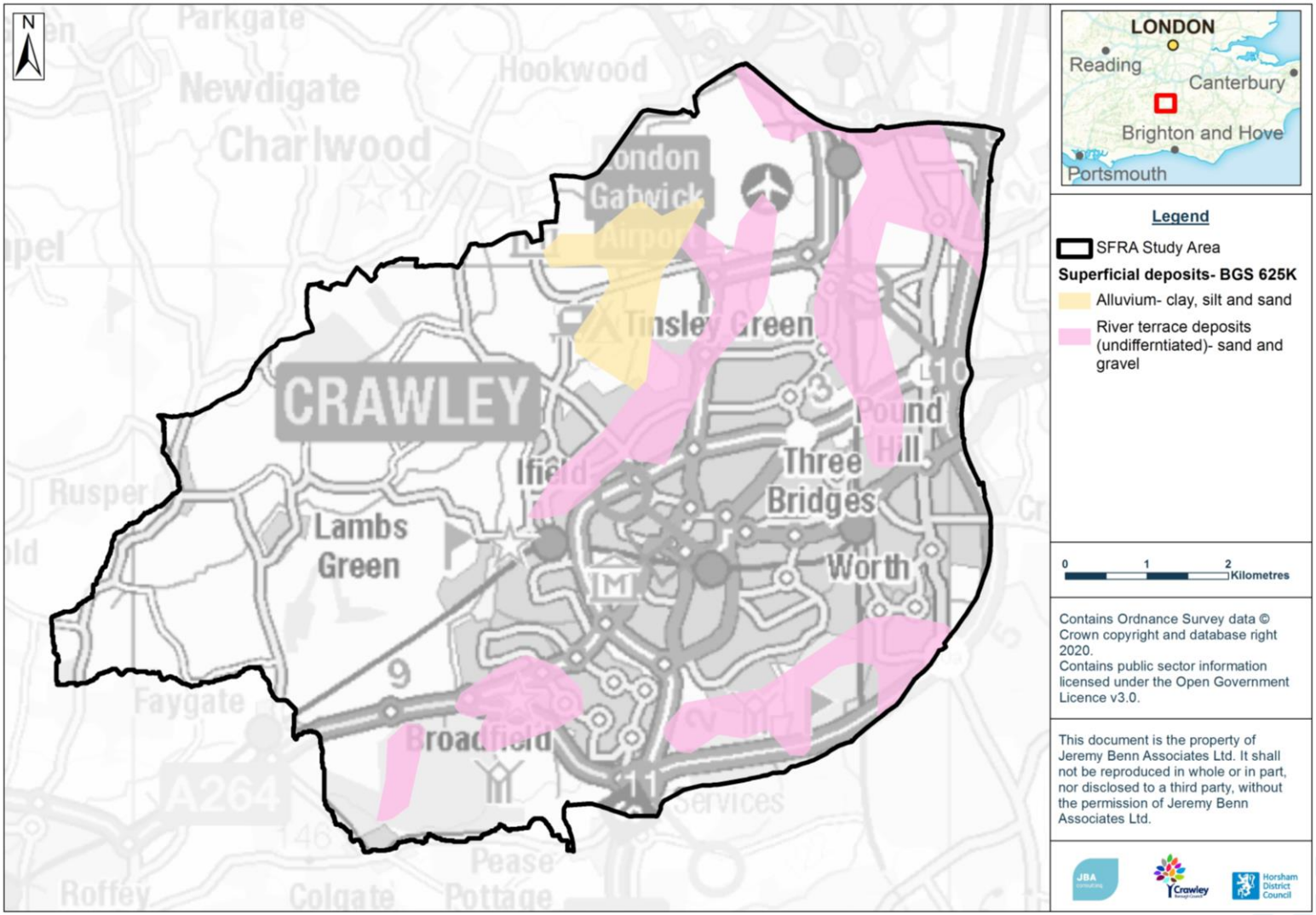


Figure 6-4: Bedrock aquifer designations in the SFRA study area

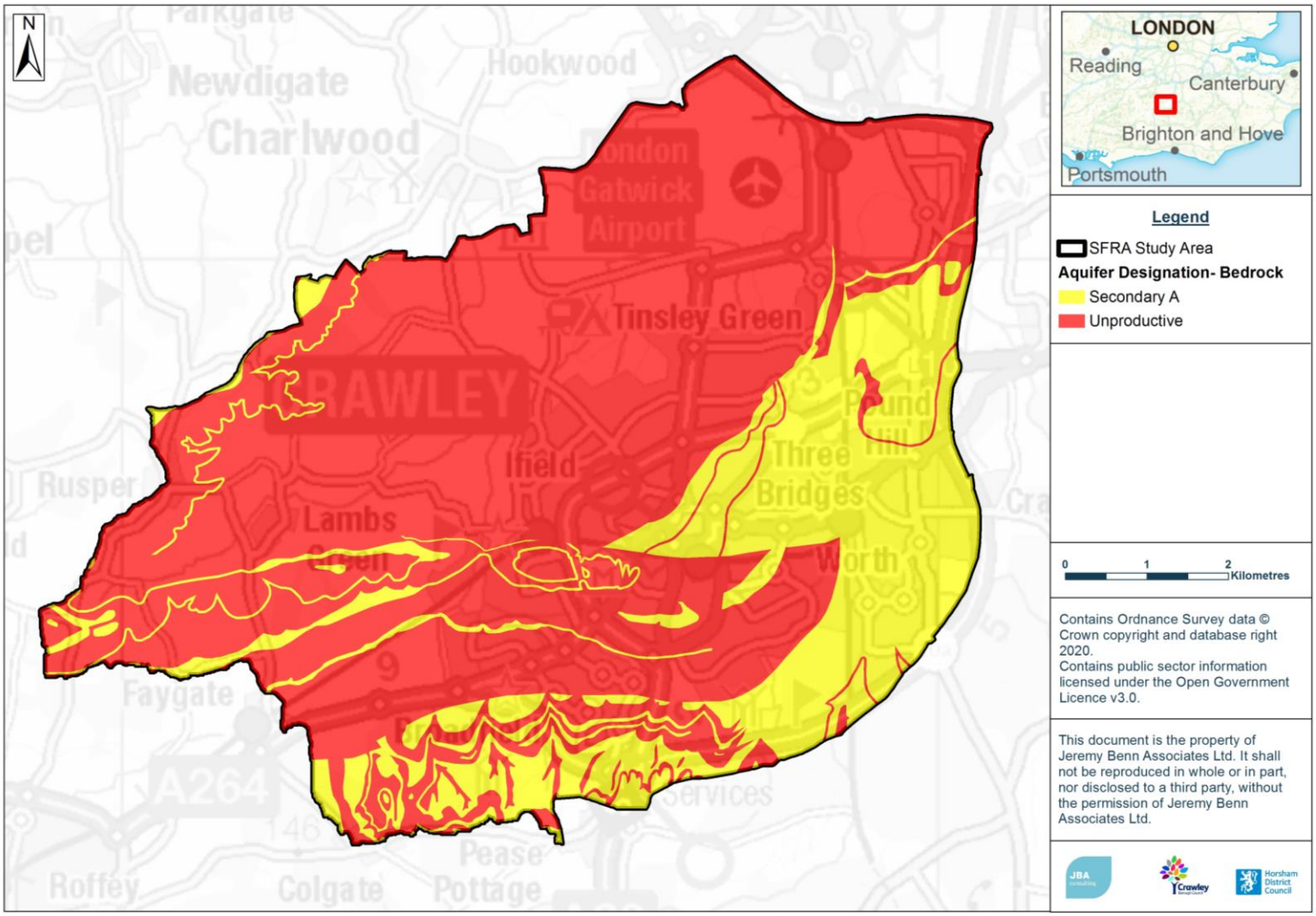
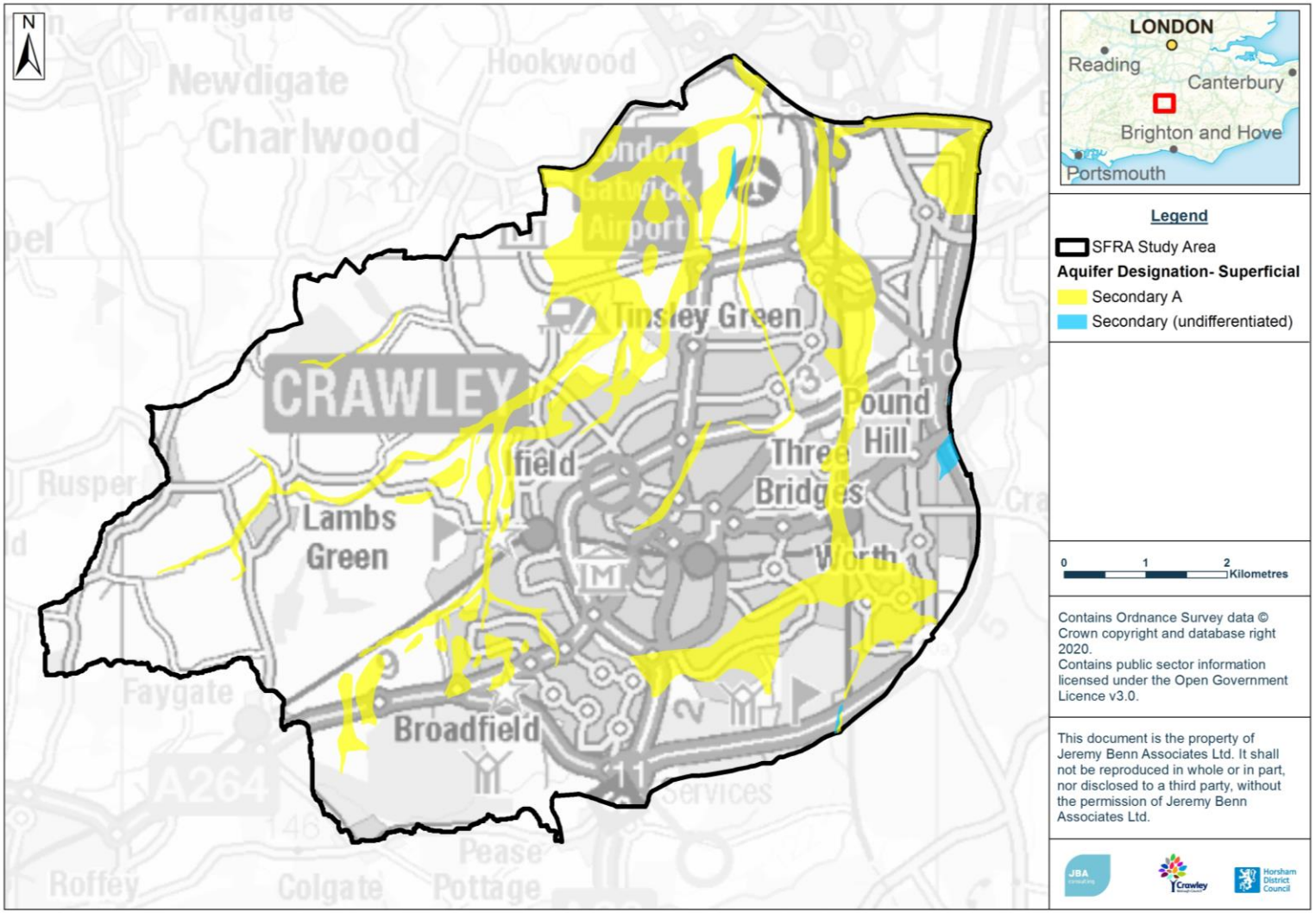


Figure 6-5: Superficial aquifer designations in the SFRA study area



6.3 Watercourses

The largest watercourse flowing through the study area is the River Mole, which enters the north of Crawley before splitting into smaller tributaries including Gatwick Stream, Stanford Brook, Tilgate Brook, Mans Brook, Ifield Brook and Baldhorns Brook.

A summary of the main watercourses in the study area is provided below in Table 6-1. Mapping indicating the location of the Main Rivers and Ordinary Watercourses can be found in Appendix B.

Table 6-1: Watercourses and channels in the study area (based on WFD catchments)

Watercourse	Description
River Mole	The River Mole, which rises in Baldhorns Close, flows south towards Ifield where it is joined by a number of tributaries, before being directed clockwise round the perimeter of Gatwick Airport. The watercourse then flows out of Crawley to the north.
Gatwick Stream	Gatwick Stream is a tributary of the River Mole, that flows north from its source at Clay Lake, through Three Bridges before joining the River Mole north of Gatwick Airport.
Crawter's Brook	Crawter's Brook is a tributary of the River Mole. It rises in the centre of Crawley near Northgate Avenue and flows north, through Manor Royal Business Park before joining the River Mole south of Gatwick Airport.
Stanford Brook	Stanford Brook is a tributary of Gatwick Stream. It enters the study area from the south east and flows north west through Maidenbower, before joining Gatwick Stream near Three Bridges.
Tilgate Brook	Tilgate Brook is a tributary of Gatwick Stream, that flows north east through Tilgate, from the southern boundary of the study area, before joining Gatwick Stream near Three Bridges.
Mans Brook	Mans Brook is a tributary of the River Mole, that flows north east from its source to the north of Ifieldwood, through Charlwood before joining the River Mole east of Gatwick Airport.
Ifield Brook	Ifield Brook is a tributary of the River Mole that drains Ifield Mill Pond. The tributary flows north through Ifield, before joining the River Mole to the east of Ifieldwood.
Douster Brook	The Douster Brook is a tributary of the Ifield Brook. It flows northwards from its source near Pease Pottage through Douster Pond and into the Ifield Brook at Ifield Mill Pond.
Broadfield Brook	The Broadfield Brook rises north of Pease Pottage and flows northwards, adjacent to Brighton Road and Crawley Avenue before heading westwards and joining the Ifield Brook at Ifield Mill Pond.
Baldhorns Brook	Baldhorns Brook is a tributary of the River Mole, that flows east from its source near Rusper through Lambs Green and Ifieldwood.

6.4 Fluvial flood risk

One of the main sources of flooding in the study area is from the River Mole and its tributary, Gatwick Stream. Fluvial flooding generally occurs concurrently with surface water flooding and sewer flooding as a response to constrictions within the drainage systems[13]. Development across the study area since the 1950's has led to the culverting of many watercourses, with some being undersized and others being prone to blockage. During heavy rainfall the presence of drainage constrictions in culverted watercourses can cause water to back up and overtop the channel or pond in an area[6].

Crawley is highlighted as the area most at risk from fluvial flooding in West Sussex, which has been identified by West Sussex County Council within their Local Flood Risk Management Strategy (2013). The key neighbourhoods at fluvial flood risk, and the source, are summarised in Table 6-2.

Table 6-2: Areas at risk of fluvial flooding

Area	Source of fluvial flood risk
Langley Green	River Mole
Forge Wood	Gatwick Stream
Three Bridges	Gatwick Stream
Furnace Green	Tilgate Brook
Tilgate	Tilgate Brook
Maidenbower	Stanford Brook
Northgate	Crawter's Brook

It should be noted that flood risk management measures (defences) are present within the study area which act to reduce the risk of flooding. Such defences potentially inhibit the function of the river floodplain as during flood events they can prevent water being stored on the land protected by the defences. This may be particularly important when considering the functional floodplain (Flood Zone 3b) for development, but the presence of such defences could also evidence that measures must be in place to make existing development and infrastructure safe. Further details on the defences in the study area are presented in Section 7 and the Flood Zones are described in Section 3.2.1

The extents of the fluvial Flood Zones are shown in Appendix C. Consideration of how climate change may influence the fluvial flood risk is presented in Appendix D.

In addition to flood risk shown by the flood risk mapping, there are a number of small watercourse and field drains which may pose a risk to development. Generalised Flood Zone mapping (where more detailed modelling investigations are not available) has only been prepared for watercourses with a catchment greater than 3km^2. Therefore, whilst these smaller watercourses may not be shown as having flood risk on the flood risk mapping, it does not necessarily mean that there is no flood risk. Sites in proximity to these watercourses may be shown to be inaccurately located in Flood Zone 1. As part of a site-specific flood risk assessment the potential flood risk and extent of flood zones should be determined for these smaller watercourses and this information used as appropriate to perform the Sequential and Exception tests.

13 West Sussex County Council, Local Flood Risk Management Strategy, 2014. Available: https://www.westsussex.gov.uk/media/1595/local_flood_risk_management_strategy.pdf

Refer to Appendix L for guidance on identifying where smaller watercourses are likely to present a flood risk.

6.5 Surface water flood risk

Crawley has previously been identified as an area with a particularly significant history of flooding, with surface water flooding occurring in Southgate, West Green, Langley Green and Broadfield during extreme rainfall events (e.g., June 2012 and November 2022) and long wet periods (e.g., Winter 2013/14).

The Risk of Flooding from Surface Water (RoFSW) map shows predicted flood extents that predominantly follow topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas and in lakes and ponds e.g., Tilgate Lake and Titmus Lake. Mapping of the RoFSW throughout the study area is provided in Appendix E.

6.5.1 West Sussex County Council Local Flood Risk Management Strategy

The WSCC's Local Flood Risk Management Strategy covers flood risk in West Sussex, from all sources of flooding, including surface water flooding. In relation to the study area the report identifies surface water flooding to pose the greatest flood risk to properties.

Crawley is identified as the residential area most susceptible to surface water flooding across West Sussex, resulting in its classification as a 'wet spot' where 9,000 residential buildings and business properties are at risk. The 2018 Preliminary Flood Risk Assessment identifies a total of 10,039 people at risk within Crawley. A high level of urbanisation, underlying low permeability clay soil and constrictions within the drainage system are all responsible for its increased susceptibility.

6.5.2 Surface water management plans

In response to WSCC's June 2012 Flood Event report, Surface Water Management Plans (SMWPs) have been developed for five key areas in West Sussex which have suffered from significant flooding in the past.

No SMWPs have currently been developed for the study area.

6.6 Groundwater flood risk

Groundwater flooding is the term used to describe flooding caused by unusually high groundwater levels. It occurs as excess water emerges at the ground surface or within manmade underground structures such as basements. Groundwater flooding tends to be more persistent than surface water flooding, in some cases lasting for weeks or months, and it can result in significant damage to property.

The GeoSmart 5m resolution Groundwater Flood Map can be found in Appendix G.

As illustrated in the mapping, the majority of the study area is predicted to be at a negligible risk of groundwater flooding as a result of the Wealden clay geology and the relatively flat topography. Some 'moderate' risk areas can be identified within the Gatwick Airport development and Three Bridges, and 'low' risk areas within Forge Wood, Northgate and Langley Green. It should be noted that as this information is based on a national dataset there may be localised differences in groundwater flood risk. Planners and developers should consult the LLFA to find out if they hold any local information.

6.7 Flooding from sewers

Sewer flooding occurs when intense rainfall overloads the sewer system capacity (surface water, foul or combined), and / or when sewers cannot discharge properly to watercourses due to high water levels. Sewer flooding can also be caused when problems such as blockages, collapses or equipment failure (such as pumps) occur in the sewerage system. Surface water inundation of manhole openings and entry of soil or groundwater may cause high flows for prolonged periods of time.

Since 1980, the Sewers for Adoption guidelines have meant that most new surface water sewers have been designed to have capacity for a rainfall event with a 1 in 30 chance of occurring in any given year (3.33% AEP), although until recently this did not apply to smaller private systems which were covered by Building Regulations for the minimum pipe bore and gradient. This means that, even where sewers are built to current specifications, they can still be overwhelmed by larger events of the magnitude often considered when looking at river or surface water flooding (e.g. a 1 in 100 chance of occurring in any given year 1% AEP). Existing sewers can also become overloaded as new development adds to their catchment, even with restrictions in place on permitted discharge, or due to incremental increases in roofed and paved surfaces at the individual property scale (urban creep). Sewer flooding is therefore a problem that could occur in many locations across the study area.

Information from the Thames Water Sewer Flooding History Database (SFHD), provided up to 2020, is shown in Table 6-3. Mapping of this data, indicating the number of recorded flood incidents per postcode, is shown in Figure 6-6.

The SFHD indicates a total of 104 recorded flood incidents; 96 of these occurred in external areas but in eight instances internal property flooding was recorded. The most frequently flooded postcodes are: RH10 3 (Pound Hill, Forge Wood and Copthorne) and RH10 7 (Pound Hill, Worth and Maidenbower) - both 21 incidents, with the majority of recorded instances occurring externally during 1 in 10 and 1 in 20-year events. However, it is important to note that these postcodes cover some areas that lie outside of the SFRA study area. Therefore, it is possible that some or all these events occurred outside the SFRA study area.

It is also important to recognise that the information does not indicate the cause of the sewer flooding incidents. Also, the register represents a snapshot in time and may become outdated following future rainfall events and when new properties are added. Risk of flooding may be reduced in some locations by capital investment to increase the capacity of the network. As such, the sewer flooding risk register is not a comprehensive 'at risk register' and updated information should be sought by developers for inclusion within Flood Risk Assessments, to enhance understanding of flood risk from sewers at a given location.

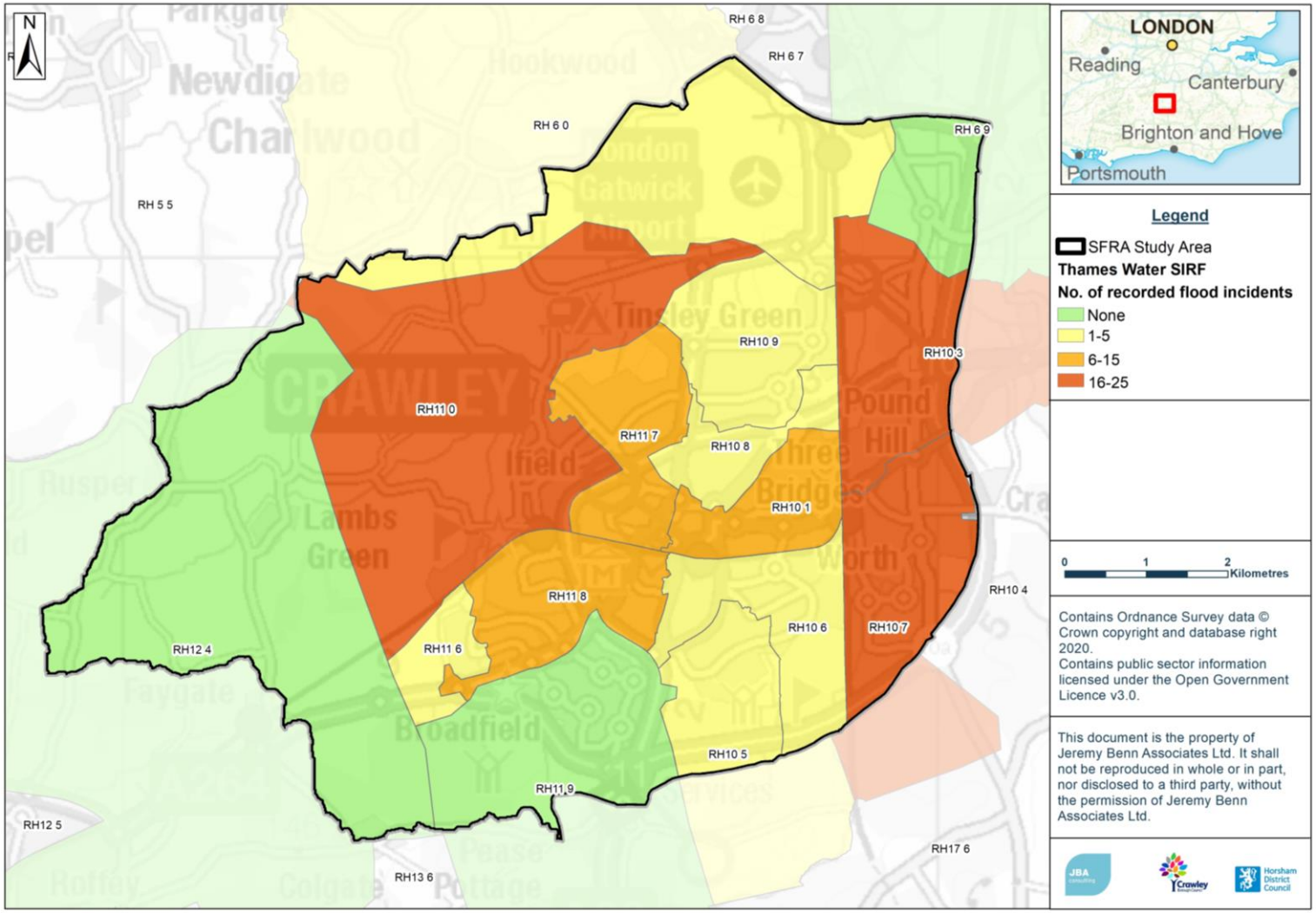
Table 6-3: Sewer Flooding History Database for the SFRA study area

Post code	Recorded flood incidents	Post code	Recorded flood incidents
RH10 1	8	RH10 9	2
RH10 3	21	RH11 0	19
RH10 5	1	RH11 6	1
RH10 6	1	RH11 7	12
RH10 7	21	RH11 8	9
RH10 8	3	RH6 0	1
Total recorded flood incidents: 104			

Note:

Post codes RH10 3, RH10 5, RH10 7 and RH6 0 cover some areas that lie outside the SFRA study area. In these instances, it is possible that the recorded flood incidents occurred outside of the SFRA study area.

Figure 6-6: Thames Water Sewer Flooding History Database records for the SFRA study area up to 2020



6.8 Flooding from reservoirs

Reservoirs with an impounded volume greater than 25,000 cubic metres are governed by the Reservoir Act 1975 and are listed on a register held by the Environment Agency. The level and standard of inspection and maintenance required under the Act means that the risk of flooding from large raised reservoirs is relatively low, although there is also potentially considerable risk within the study area from other reservoirs that fall below the volume threshold. Legislation under the Flood and Water Management Act requires the flood risk from these reservoirs to be designated.

There are seven storage areas which are classified as reservoirs within the study area as detailed in Table 6-4. Reservoir flooding is very different from other forms of flooding because it is assumed to be due to failure or breach of reservoir structures or of other impounding infrastructure. It may therefore happen with little or no warning. The Reservoir Flood Maps from the Environment Agency show potential flood extents in the event of reservoir failure.

The Environment Agency Reservoir Flood Maps for the study site are shown in Appendix H. There are two flooding scenarios shown in the mapping: the "dry day" and "wet day" flood extents. The "dry day" scenario predicts flood extents should reservoir failure occur at a time when river levels are normal. The "wet day" scenario is a reasonable worst case scenario depicting flood extents if reservoir failure were to occur when water levels are already high and extreme fluvial flooding occurs at the same time. This is a reasonable worst-case scenario because of the joint probability of reservoir failure or breach occurring due to heavy rainfall (which would also cause high river levels and increase the risk of fluvial flooding).

For context, the "fluvial contribution" layer is also shown in Appendix H. This layer shows an extreme fluvial flood extent (not the same as Flood Zone 2 or 3) and is used to show the fluvial flood extents used by the Environment Agency to develop the "wet day" reservoir flood extents.

To develop the Reservoir Flood Maps, it was calculated how much and how fast water would flow out of any reservoir in the UK in the event that it fails. This calculated flow was then added to a topographic ground model of the reservoir and allowed it to flow downstream and recorded the greatest predicted flood extent in the software.

Table 6-4: Reservoirs in the SFRA study area

Reservoir	Location (NGR)	Physical status	Local authority
Douster Pond	Cottesmore (TQ 24400 34400)	In Operation	Horsham District Council
Ifield Mill Pond	Ifield (TQ 24500 36400)	In Operation	Crawley Borough Council
Tilgate Lake	Tilgate Park (TQ 27800 34100)	In Operation	Crawley Borough Council
Fish Pond	Crabbett Park House, Worth (TQ 30800 37400)	In Operation	Mid Sussex District Council
Worth Farm	Worth (TQ 30425 35917)	In Operation	Mid Sussex District Council

Clays Lake	Cowdray Forest (TQ 28870 32685)	In Operation	Mid Sussex District Council
Gatwick Airport Long Term Storage Lagoon	North of Radford Road (TQ 29300 40300)	In Operation	Crawley Borough Council

Additional reservoirs that fall under the volume threshold of 25,000m^3 but pose a considerable flood risk downstream in the event of breach are Dragonsbill Dam and Rookfield Dam, both located in Horsham District, though outside of the SFRA study area. They are listed in West Sussex County Council's Flood Risk Asset Register and should continue to be actively monitored to reduce the risk of collapse and subsequent breach.

6.9 Summary of flood risk to key settlements

A high-level review of the flood risk to each neighbourhood / ward in the study area has been undertaken. Table 6-5 summarises the predicted flood risk to each settlement within the study area. The following flood risk data has been used to inform:

- Environment Agency Flood Zones
- Environment Agency Risk of Flooding from Surface Water dataset
- GeoSmart groundwater flood mapping
- Environment Agency reservoir flood risk dataset

Figure 6-7 shows the locations of these neighbourhoods/ wards within the study area.

Figure 6-7: Location of neighbourhoods/ wards within the study area

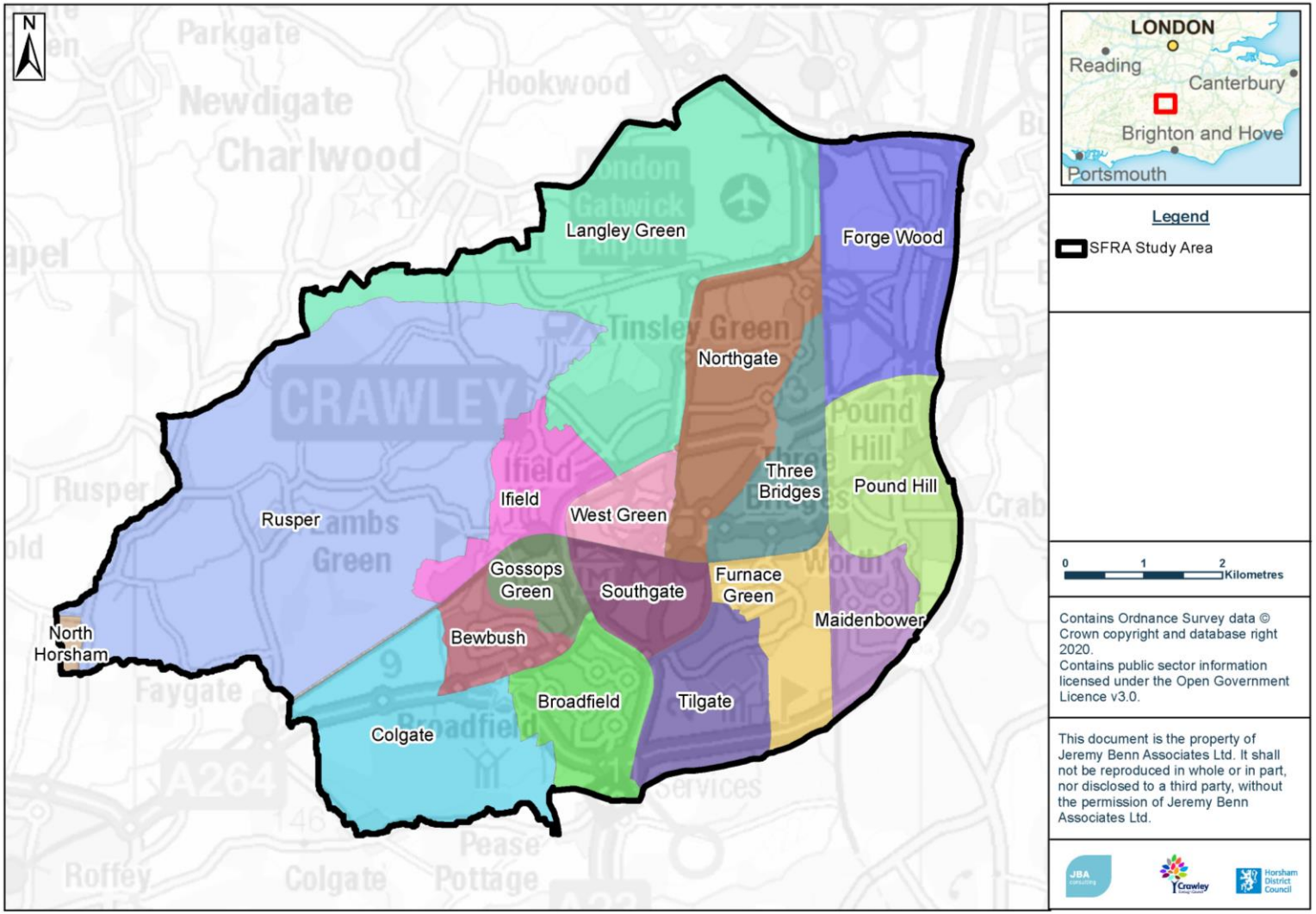


Table 6-5: Summary of predicted flood risk to the key settlements in the study area

Settlement		Fluvial flood risk	Formal flood defences	Surface water flood risk	Susceptibility to groundwater flooding, according to GeoSmart map				Reservoir inundation
					Negligible risk	Low risk	Moderate	High	
Crawley Borough	Forge Wood	Forge Wood is located on the eastern bank of Gatwick Stream. Flood zones 2 and 3 are generally restricted to open land surrounding the channel in the west of the ward, though a number of Gatwick Airport South Terminal Car Parks are also situated within these Flood Zones.	See Section 7	Mapping shows several surface water flow paths from south to north that follow surface topography. Main paths flow along Balcombe Road from Tinsley Green, as well as along the drainage network of Gatwick Stream. High surface water flood risk is identified around Gatwick Airport's South Terminal although the flood attenuation area to the south should have helped to reduce this risk.	✓	✓	✓		Inundation from Gatwick Airport's long-term storage reservoir, north west of Forge Wood, posed a risk of wet day flooding around Gatwick Airport South Terminal and Horley Land wood. Dry day reservoir flood risk is isolated around the A23 near Gatwick Airport.
	Pound Hill	Pound Hill is bounded to the west by Gatwick Stream and to the south by Stanford Brook. The neighbourhood is almost entirely situated within Flood Zone 1, with the exception of small areas in the north west and south which are located within Flood Zone 3b.	See Section 7	Mapping shows that there are many surface water flow paths from east to west in Pound Hill, that generally follow roads and surface topography. High risk areas are also identified parallel to Gatwick Stream and ponding is predicted to the east of the railway line.	✓				No flood risk from Large raised reservoirs has been identified. However, there are a number of smaller reservoirs which could pose an inundation risk, for example The Moat and Worth Park Lake.
	Maidenbower	There is fluvial flood risk from Gatwick Stream and Stanford Brook within Maidenbower. Areas around Billinton Drive, Haworth Drive, Westminster Road and Nelson Close are located within Flood Zone 2.	See Section 7	Areas of high surface water flood risk are identified around the Stanford Brook and Gatwick Stream drainage networks. Risk is greatest in the north of Maidenbower, in particular on the roads surrounding Billinton Drive Flood Attenuation Pond (also known as Maidenbower pond).	✓				Inundation from Stanford Brook and Gatwick stream pose a flood risk in the north eastern corner of Maidenbower area for the wet day scenario. This is likely due to Worth Farm and Clays Lake, to the South of Maidenboweraffecting watercourses through Maidenbower. Maidenbower pond poses a reservoir flood risk during the dry day scenario.

Settlement		Fluvial flood risk	Formal flood defences	Surface water flood risk	Susceptibility to groundwater flooding, according to GeoSmart map				Reservoir inundation
					Negligible risk	Low risk	Moderate	High	
	Langley Green	Langley Green is bounded by the River Mole to the north and south west, and Gatwick Stream to the east. A large proportion of Gatwick Airport is identified to be at risk of fluvial flooding, located within Flood Zones 2 and 3.	See Section 7	Mapping shows vast areas of high surface water flood risk across Gatwick Airport, which corresponds to the characteristic low topography of the area. A large area of ponding is predicted at the western end of the two runways where Crawter's Brook joins the River Mole – the mapped flood risk here may partially be caused by lack of representation of the culvert under the runways.	✓	✓	✓		Inundation from Gatwick Airport's long-term storage reservoir may affect areas around Gatwick Airport and the River Mole for both dry and wet day scenarios. The wet day flood extents are extensive, affecting nearly all of Gatwick Airport.
	Northgate	There is fluvial flood risk in Northgate from Crawter's Brook. Areas at risk include commercial buildings across Sussex Manor Business Park and Manor Royal Business District, and residential properties around Green Lane and Five Acres, located within Flood Zones 2 and 3. Further high-risk areas located in Flood Zone 3b include Woodfield Road and Dalewood Gardens.	See Section 7	Mapping identifies that there are several surface water flow paths from south to north, following surface topography. There is a large area of surface water risk where flows pond around the A2011. Additionally, there is a high surface water flood risk in the open areas surrounding Lowfield Heath and the Crawter's Brook in the North.	✓	✓	✓		Inundation from Gatwick Airport's long-term storage reservoir will affect a very small area in the north, around Gatwick Road roundabout in both the dry and wet day scenarios. There is a risk of inundation surround Crawters Brook in the wet day scenario.
	Three Bridges	Three Bridges is bounded to the east by Gatwick Stream and to the west by Crawter's Brook. The south west corner of the neighbourhood is situated within Flood Zone 3b, largely affecting the A2220 and Hazelwick Avenue.	See Section 7	Mapping shows that surface water flood risk within Three Bridges is relatively low within the study area. The areas predicted to have the highest risk of surface water flooding include Northgate Avenue, the junction of Three Bridges Road and Haslett Avenue East, Hazelwick Avenue and Hermits Road.	✓	✓	✓		The area surrounding Three Bridges Station is predicted to be at risk of flooding from both dry and wet day reservoir flooding. This is due to flood water flowing downslope from the Maidenbower area and exacerbated by Maidenbower pond.

Settlement		Fluvial flood risk	Formal flood defences	Surface water flood risk	Susceptibility to groundwater flooding, according to GeoSmart map				Reservoir inundation
					Negligible risk	Low risk	Moderate	High	
	Furnace Green	Fluvial flood risk in Furnace Green is a result of Tilgate Brook and Gatwick Stream. Waterlea Meadows, in the east of the neighbourhood, is a high-risk area located within Flood Zone 3b. Residential properties around Furnace Drive, Sylvan Road and Wychwood Road are also at risk, situated within Flood Zones 2 and 3a.	See Section 7	Mappings shows that there are several surface water flow paths from west to east that generally follow the route of Tilgate Brook and the surface topography. High surface water risk is identified upstream of Waterlea Meadows where flows pond around St. Andrew's CofE Primary School, Weald Drive and Theydon Close.	✓	✓			Large areas of Furnace green are at risk of both dry and wet day reservoir flooding due to Tilgate Lake upslope. Areas at risk include St Andrew's Primary School and large sections of residential areas.
	West Green	The neighbourhood of West Green is located entirely within Flood Zone 1.	No	Mapping shows two distinct flow pathways that flow south to north around either side of a topographic high point in the centre of West Green. Flows largely follow the routes of roads, with the roads at highest risk of surface water flooding including Buckmans Road, Sunnymead, Deerswood Road and Ifield Road. Crawley Leisure Park and the junction of Ifield Avenue and London Road are also at a high risk of surface water flooding.	✓				None
	Southgate	The neighbourhood of Southgate is located entirely within Flood Zone 1.	No	Mapping shows that the largest areas of high surface water flood risk are located in the north of Southgate, around Brighton Road and St Francis of Assisi Catholic Primary School. Flows also pond in Goffs Park, south of the railway line.	✓				None
	Tilgate	A relatively large number of roads across Tilgate are at risk of fluvial flooding from Tilgate Brook. High risk areas located within Flood Zone 2 and 3 include Shackleton Road, Chantrey Road and Desmond Anderson Primary Academy.	See Section 7	Mapping shows that there is a relatively wide surface water flow path following the route of the culverted watercourse from Titmus Lake through an area of residential properties in Tilgate, from Ashdown Drive to Loppets Road. Other high-risk areas include Tilgate Parade, Tilgate Way, Nash Road and the junction of Southgate Avenue and Ashdown Drive.	✓	✓	✓		Inundation from Tilgate Lake, may affect the immediate area of Tilgate to the north of the lake in the dry day scenario. The Wet day scenario also shows inundation in the residential area up to Canterbury Road adjacent to Desmond Anderson Primary School and Thomas Bennet Community College.

Settlement		Fluvial flood risk	Formal flood defences	Surface water flood risk	Susceptibility to groundwater flooding, according to GeoSmart map				Reservoir inundation
					Negligible risk	Low risk	Moderate	High	
	Broadfield	Broadfield is bounded to the east by Broadfield Brook. Creasy's Brook also flows through the west of the neighbourhood. Flood zones 2 and 3 are generally restricted to open land surrounding Broadfield Brook. However, small areas at risk include Broadfield Primary Academy and properties around Canvey Close and Plantain Crescent.	See Section 7	Mapping shows that there are several flow paths from south to north, following the routes of roads. The north of Broadfield contains the areas at highest risk, including Coachmans Drive, Broadfield Drive and Colonsay Road.	✓	✓	✓		None
	Ifield	Fluvial flood risk in Ifield is limited to open areas surrounding Ifield Brook, which flows along the western boundary. The majority of the ward is located in Flood Zone 1.	See Section 7	Mapping identifies high surface water flood risk in the open areas surrounding Ifield Brook, along the western boundary of the Ifield catchment. A relatively wide area of high surface water flood risk is also identified in the centre of Ifield, flowing along Ifield Drive and Warren Drive.	✓	✓			Inundation from Ifield Mill Pond, would affect areas surrounding Ifield Brook in both the dry day and wet day scenarios.
	Gossops Green	Gossops Green is located on the eastern bank of Broadfield Brook. Fluvial flood risk is low with most of the neighbourhood located within Flood Zone 1. A small area of risk is identified along Buckswood Drive, which is situated in Flood Zone 2.	See Section 7	Mapping shows surface water flood risk at the junction of Buckswood Road and Kinscote Hill (associated with flooding from Broadfield Brook). There is also a flow path showing high risk of flooding between Gossops Drive and The Hollow	✓				There is a risk of wet day inundation of the open areas surrounding Ifield Mill Pond on the western border of the Gossops Green ward.
	Bewbush	Fluvial flood risk to the neighbourhood is low, with areas situated in Flood Zones 2 and 3, limited to undeveloped corridors running alongside Creasy's Brook, Douster Brook and Spruce Hill Brook.	See Section 7	Mapping shows areas of high surface water flood risk across Bewbush. Flow pathways follow surface topography, generally flowing along roads, before pooling in open areas around Ifield Brook and Ifield Mill Pond.	✓				Inundation from Douster Pond and Fish Pond, south of Bewbush, may affects southern, central, and northern areas in both dry day and wet day scenarios. Spruce Hill Brook and Duster Brook exacerbate flood extents and risk during the wet day scenario.

Settlement		Fluvial flood risk	Formal flood defences	Surface water flood risk	Susceptibility to groundwater flooding, according to GeoSmart map				Reservoir inundation
					Negligible risk	Low risk	Moderate	High	
Horsham District	Rusper	Small areas of Rusper are at risk of fluvial flooding from the River Mole and Mans Brook. However, areas of Flood Zones 2 and 3 are generally restricted to open areas surrounding the watercourses. Limited sections of Prestwood Lane, Ifield Avenue, Ifield Green, Lambs Green Road and Rusper Road are at risk.	See Section 7	Rusper is characterised by expansive areas of high surface water risk. Risk is identified in the open areas surrounding all main rivers and ordinary watercourses in Rusper.	✓	✓	✓		Inundation from Ifield Mill Pond and Gatwick Airport's long-term storage reservoir may affect a limited area in the east that runs along the River Mole and Ifield Brook in both the dry day and wet day scenarios. The Ifield Brook and River Mole pose a risk of inundation in areas surrounding the watercourses in the wet day scenario, with additional inundation shown in the agricultural fields to the north of Rusper Road.
	Colgate	Colgate is bounded by Bewbush Brook to the north. The watercourse does not create a fluvial flood risk to the surrounding neighbourhood. Therefore, Colgate is almost entirely situated within Flood Zone 1.	No	Surface water flow paths run from south to north, following topographic lows. Predicted surface water flood areas are largely concentrated in the north of Colgate. Due to the small number of residential properties in the area, risk is limited to several farms, including Holmbush Farm and Hopper Farm.	✓	✓	✓		Inundation from Douster Pond and Fish Pond, may affect a very small area, immediately north of the ponds in both dry day and wet day scenarios.
	North Horsham	The small area of North Horsham that lies within the study area is located entirely within Flood Zone 1.	No	A small area of North Horsham that lies within the study area experiences a high surface water flood risk. A surface water flow path is directed south west to north east from Hilltop Farm to Prospect Cottage.	✓				None

7 Fluvial defences

This section provides a summary of the existing flood defence assets within the study area. Planners should note the areas that are protected by defences where further work to understand the actual and residual flood risk through a Level 2 SFRA may be beneficial. Developers should consider the benefit they provide over the lifetime of a development in a site-specific Flood Risk Assessment. Refer to the SFRA guide to using technical data in Appendix L for recommendations and details on how to apply the Sequential and Exception tests using the data set out in this section.

A high-level review of flood defences was carried out for this SFRA based on the Environment Agency's Spatial Flood Defences dataset, involving an interrogation of existing information on asset condition and standard of protection.

Defences are categorised as either raised flood defences (e.g. walls/embankments), Flood Storage Areas (FSAs) or channel maintenance. The assessment of the Environment Agency Spatial Flood Defence dataset has considered defences which potentially provide a standard of protection from a 20% AEP event or more. The dataset includes man-made and natural defences which are associated with naturally high ground adjacent to a watercourse. The defences and their locations are summarised in the following sections.

Mapping of the defences can be found in Appendix I.

7.1 Defence standard of protection

One of the principal aims of this SFRA is to outline the present risk of flooding across the study area including consideration of the effect of flood risk management measures (including flood banks and defences). The modelling that informs the understanding of flood risk within the study area is typically of a catchment wide nature, suitable for preparing evidence on possible site options for development. In cases where a specific site risk assessment is required, detailed studies should seek to refine the results used to provide a strategic understanding of flood risk from all sources. Developers should consider the standard of protection provided by defences when preparing detailed Flood Risk Assessments.

Standard of Protection

Flood defences are designed to give a specific standard of protection, reducing the risk of flooding to people and property in flood prone areas. For example, a flood defence with a 1% AEP standard of protection means that the flood risk in the defended area is reduced to a 1% chance of flooding in any given year.

Although flood defences are designed to a standard of protection it should be noted that, over time, the actual standard of protection provided by the defence may decrease, for example due to deterioration in condition or increases in flood risk due to the increased magnitude of the flood hazard caused by climate change effects (e.g., rise in frequency and intensity of extreme weather over time).

For raised flood defences (bunds or banks), a standard of protection can be straight forward to define. However, sometimes it is not possible to define the standard of protection for Flood Storage Areas as there are several factors that determine the protection that they can provide e.g., outflow rates, number of watercourses that flow into the Flood Storage Area.

7.2 Defence condition

Formal structural defences are given a rating by the Environment Agency based on a grading system for their condition[14]. A summary of the grading system used by the Environment Agency for condition is provided in Table 7-1.

Table 7-1:Defence asset condition rating

Grade	Rating	Description
1	Very Good	Cosmetic defects that will have no effect on performance.
2	Good	Minor defects that will not reduce the overall performance of the asset.
3	Fair	Defects that could reduce the performance of the asset.
4	Poor	Defects that would significantly reduce the performance of the asset. Further investigation required.
5	Very Poor	Severe defects resulting in complete performance failure.

The condition of existing flood defences and whether they are planned to be maintained and/or improved in the future must be considered with respect to the safety and sustainability of development over its intended life and also with respect to the financial and economic commitment to the long-term provision of appropriate standards of protection. In some cases, the relevant strategy may suggest that it is not appropriate to maintain the condition of the assets, which may prove influential for the development over its intended life. In addition, detailed FRAs undertaken by developers (if a defence is influential to the proposed development) will need to thoroughly explore the condition of defences, especially where these defences are informal and demonstrate a wide variation of condition grades. It is important that all of these assets are maintained to a good condition and their function remains unimpaired in accordance with the policy and strategy for Flood Risk Management – funding to support the maintenance of defences could be sought through the Community Infrastructure Levy (CIL).

7.3 Fluvial defences in the study area

The maps shown in Appendix I provide a summary of the defences with a standard of protection against a 20% AEP event or greater in the study area, including the defence type, condition and standard of protection, using the spatial defence data provided by the Environment Agency. All defences in the study area provide protection against fluvial flood events, with the majority of the main river sections having channel maintenance along their lengths, as well as various different fluvial defences. Most defences only provide a standard of protection of 20% AEP, however, there are also several areas with a standard of protection greater than 20% AEP, up to a protection of 0.5% AEP:

- Embankments with a standard of protection of 0.5% AEP are located at Tilgate Lake
- Embankments and two-stage channels with a standard of protection of 1% AEP are located along the River Mole diversion, north of Gatwick Stream
- Embankments and maintained banks with a standard of protection of 4% AEP are located along Gatwick Stream and Tilgate Brook

14 Condition Assessment Manual, Environment Agency (2012)

- Channel maintenance with a standard of protection of 5% AEP are located along Gatwick Stream and Stanford Brook.

The Environment Agency defence data shows that most defences within the study area are in 'Good' or 'Fair' condition.

7.4 Alleviation Schemes

There are a limited number of alleviation schemes within the study area, and there are no Flood Storage Areas recorded in the study area in the Environment Agency's 'Flood Map for Planning – Flood Storage Areas' dataset.

The Upper Mole Flood Alleviation Scheme was constructed by the Environment Agency to reduce the risk of flooding in Crawley and Horley following significant flooding in 1990, 2000, and the winter of 2013/14. The scheme involved the construction of three flood storage reservoirs, at Tilgate Lake, Worth Farm and Clay's Lake and were completed in 2011, 2014 and 2018 respectively. A fourth flood storage reservoir at Ifield was suspended due to the need for significant external funding proving difficult to source. The Upper Mole Flood Alleviation Scheme aims to reduce flood risk to over 1,000 homes in Crawley and Horley, and also to Gatwick Airport.

The Environment Agency is continuing to investigate the feasibility of a flood attenuation scheme within the Ifield area as part of the Upper Mole Flood Alleviation Scheme, and are working with local stakeholders and undertaking further works to understand the full benefits a scheme in this area could offer. A number of other options to reduce flood risk have been identified, including changes to road layouts, raising kerbs, adapting the road bridge and works to redirect flow from a field away from properties.

7.5 Residual flood risk

Residual flood risks are those remaining after applying the sequential approach and taking mitigating actions. The residual risk can be:

- the effects of a flood with a magnitude greater than that for which the defences or management measures have been designed to alleviate (the 'design flood'). This can result in overtopping of flood banks, failure of flood gates to cope with the level of flow or failure of pumping systems to cope with the incoming discharges; and/or
- failure of defences or flood risk management measures to perform their intended duty. This could be breach or failure of flood embankments, failure of flood gates to operate in the intended manner, or failure of pumping stations.

In circumstances where measures are put in place to manage flood risk, there remains a possibility of flooding being experienced, either as a consequence of the event exceeding the design capacity or the failure of the asset providing the appropriate standard of protection. It is the responsibility of the developer, as part of a Flood Risk Assessment, to fully assess flood risk, propose measures to mitigate it and demonstrate that any residual risks will be safely managed.

This SFRA does not assess the probability of failure other than noting that such events are very rare. However, in accordance with the NPPF, all sources of flooding need to be considered. If a breach or overtopping event were to occur, then the consequences to people and property could be high. Developers should therefore be aware that any site that is at or below defence level may be subject to flooding if an event occurs that exceeds the design capacity of the defences, or the defences fail, and this should be considered when building resilience into low level properties.

7.5.1 Defence breach

A breach of a defence occurs when there is a failure in the structure and a subsequent ingress of flood water.

Where defences are present, risk of breach events should be considered as part of the site-specific Flood Risk Assessment. Flood flows from breach events can be associated with significant depths and flow velocities in the immediate vicinity of the breach location and so FRAs must include assessment of the hazards that might be present so that the safety of people and structural stability of properties and infrastructure can be appropriately taken into account. Whilst the area in the immediate vicinity of a breach can be subject to high flows, the whole flood risk area associated with a breach must also be considered as there may be areas remote from the breach that might, due to topography, involve increased depth hazards.

8 FRA requirements and flood risk management guidance

This section provides guidance on site-specific Flood Risk Assessments (FRAs). These are carried out by (or on behalf of) developers to assess flood risk to and from a site. They are submitted with Planning Applications and should demonstrate how flood risk will be managed over the development's lifetime, considering climate change and vulnerability of users.

8.1 Over-arching principles

This SFRA focuses on delivering a strategic assessment of flood risk within the study area. Prior to any construction or development, site-specific FRAs will need to be undertaken as required by the NPPF (see 8.2.1) to assess all sources of flood risk.

Some sites may additionally require the application of the Exception Test following the Sequential Test if there are safety and sustainability issues to be addressed. If the Exception Test is applied, it must be informed by a detailed FRA to ensure that the development is safe and will not increase flooding elsewhere. Any site that does not pass the Exception Test should not normally be allocated or permitted for development. It is the responsibility of the developer to provide an FRA with an application.

It should be acknowledged that a detailed FRA may show that a site is not appropriate for development within a particular vulnerability classification, or even for development at all. Where the FRA shows that a site is not appropriate for a particular use, a lower vulnerability classification may be appropriate.

8.2 Requirements for site-specific flood risk assessments

8.2.1 What are site specific FRAs?

Site specific FRAs are carried out by (or on behalf of) developers to assess flood risk to and from a site. They are submitted with planning applications and should demonstrate how flood risk will be managed over the development's lifetime, taking into account climate change and vulnerability of users.

The Environment Agency's **Flood Risk Assessment For Planning Applications** sets out a checklist for developers to assist with site specific flood risk assessments.

Site specific FRAs are required in the following circumstances:

- Proposals for new development (including **minor development** and **change of use**) in Flood Zones 2 and 3
  - Proposals for new development (including minor development and change of use) in an area within Flood Zone 1 which has critical drainage problems (as notified to the LPA by the Environment Agency)
  - Proposals of one hectare or greater in Flood Zone 1
  - Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding
  - Proposals of less than one hectare in Flood Zone 1 where they could be affected by sources of flooding other than rivers and the sea (e.g. surface water).

  An FRA may also be required for some specific situations:
  - If the site may be at risk from the breach of a local defence (even if the site is actually in Flood Zone 1)
  - Where evidence of historical or recent flood events have been passed to the LPA

- On land in the vicinity of small watercourses or drainage features that might not have been demarcated as being in a Flood Zone on the national mapping – see Appendix B for further guidance.
- At locations where proposals could affect or be affected by substantial overland surface water flow routes – see Appendix E for further guidance.

8.2.2 Objectives of site specific FRAs

The aim of an FRA is to demonstrate that the development is protected to the 1% AEP fluvial flood scenario and is safe for its intended life span during the 'design' flood event, including an allowance for climate change. This includes assessment of mitigation measures required to safely manage flood risk. Development proposals requiring FRAs should establish:

- whether a proposed development is likely to be affected by current or future flooding from any source;
- whether a proposed development will increase flood risk elsewhere over the lifetime of the development;
- whether the measures proposed to deal with the effects and risks are appropriate;
- the potential cumulative impact of development on flood risk;
- how surface water runoff from the site will be managed (see section 9);
- the evidence, if necessary, for the Local Planning Authority to apply the Sequential Test; and
- whether, if applicable, the development will be safe and pass the Exception Test.

FRAs for sites located in the study area should follow the approach recommended by the 2022 NPPF (and associated guidance) and guidance provided by the Environment Agency and West Sussex County Council. This includes:

- **Site-specific Flood Risk Assessment: Paragraph 020** (NPPF PPG, Defra)**Standing Advice on Flood Risk** (Environment Agency)
- **Flood Risk Assessment for Planning Applications** (Environment Agency)
- **West Sussex County Council LLFA Policy for the Management of Surface Water** (West Sussex County Council)

When undertaking an FRA, developers should refer to the most up to date climate change allowances as provided by the Environment Agency. More information on the updated climate change allowances, based on the UKCP18 projections, is available in Section 4.3. Developers are encouraged to seek planning advice from the Environment Agency at pre-application stage. By making an allowance for climate change it will help reduce the vulnerability of the development and provide resilience to flooding in the future. See section 4 for further details.

Guidance for local planning authorities for reviewing flood risk assessments submitted as part of planning applications has been published by Defra in 2015 – **Flood Risk Assessment: Local Planning Authorities**.

8.3 Mitigation measures

Mitigation measures should be regarded as a last resort to address flood risk issues where the site has passed the Exception Test and therefore has strong planning/sustainability reasons for development. Consideration should first be given to minimising risk by planning sequentially, through careful design and layout, across a site. Once risk has been minimised as far as possible, only then should mitigation measures be considered.

Often the determining factors in deciding whether a particular development is appropriate are the practical feasibility, financial viability, and long-term maintenance implications of flood risk mitigation rather than technical limitations. Detailed technical assessments are required in the FRA to assess the practical feasibility, together with a commercial review by the developer of the cost of the mitigation works and how contributions will be made for their long-term maintenance. At the SFRA stage, broad assumptions must be made regarding the feasibility of flood risk mitigation to highlight sites with greater development potential and eliminate sites where mitigation may not be feasible. The formulation of measures that not only provides an appropriate standard of protection to new development, but also reduces the risk to existing communities will be an important consideration.

Attention must also be paid to the provision of safe access and egress during flood events (see 10.3.2), including the implications of climate change, and how this is linked to flood warning and emergency evacuation where necessary. The Emergency Services and local authority Emergency Planning team should be consulted on the evacuation and rescue capabilities and any advice or requirements included. Consideration should also be given to residual risk to understand the safety implications during events where the design capacity of flood defences is exceeded or there is a failure.

There should normally be no change to flood routing or loss of flood storage as a result of any proposed development. Flood storage compensation may be appropriate for sites on the edge of the existing floodplain or within a flood cell, however this would need to be provided level for level. Resilience rather than resistance measures should be used if flood plain compensation is not being provided.

Whilst it might be possible to identify appropriate flood mitigation measures for some sites, it is worth noting that in some instances the findings of individual FRAs may determine that the risk of flooding to a proposed development is too great and mitigation measures are not feasible or appropriate.

The minimum acceptable standard of protection against flooding for new residential property within flood risk areas is the 1% AEP event plus climate change for fluvial flooding and for surface water flooding. Sites susceptible to flood risk resulting from blockage or exceedance of structures should be protected beyond the 1% AEP plus climate change scenario. An allowance for climate change over the lifetime of the development must be made when assessing each of these scenarios and be conducted in line with latest guidance for climate change.

8.4 Reducing flood risk

8.4.1 Site layout and design

Flood risk from all sources should be considered at an early stage in deciding the layout and design of a site to provide an opportunity to reduce flood risk within the development.

Guidance on the best practice design is available in the **Construction Industry Research and Information Association (CIRIA) SuDS Manual C753 (2015).**

The NPPF states that a sequential, risk-based approach should be applied to try to locate more vulnerable land use away from flood zones, to higher ground, while more flood-compatible development (e.g., vehicular parking, recreational space) can be located in higher risk areas. However, vehicular parking in floodplains should consider the nature of parking, flood depths and hazard including evacuation procedures and flood warning. The nature of risk to water quality also needs to be considered and mitigated to ensure that accumulated hydrocarbons and other vehicle related pollutants are not released to the aquatic environment.

Waterside areas, or areas along known flow routes, can be incorporated into the masterplan as multi-functional green infrastructure, being used for recreation, amenity and environmental purposes, allowing the preservation of flow routes and flood storage, and at the same time providing valuable social and environmental benefits contributing to other sustainability objectives. Landscaping should ensure safe access to higher ground from these areas and avoid the creation of isolated islands as water levels rise.

8.4.2 Raised floor levels

The raising of internal floor levels within a development avoids damage occurring to the interior, furnishings and electrics in times of flood.

Minimum finished floor levels for development that does not include sleeping accommodation on the ground floor should normally be set to whichever is higher of the following:

- a minimum of 300mm above the design flood level
- if finished floor levels cannot be raised in this way, additional flood resistance and resilience measures should be added to the property to protect it to at least 300mm above the estimated flood level.

Please note that it is the design flood level should be estimated as part of a site specific Flood Risk Assessment.

Finished floor levels for vulnerable developments (e.g., dwellings and for sleeping accommodation) should be a minimum of whichever is higher of 300mm above the:

- average ground level of the site
- adjacent road level to the building
- design flood level (1% annual probability plus climate change allowance)

Allocating the ground floor of a building for less vulnerable development, such as for non-residential use, is an effective way of raising living space above flood levels. Single storey buildings such as ground floor flats or bungalows are especially vulnerable to rapid rise of water (such as that experienced during a breach). This risk can be reduced by use of multiple storey construction and raised areas that provide an escape route.

Ideally, sleeping accommodation should be at first floor level or above. However, if ground floor sleeping accommodation were to be provided, raised floor levels of 300mm may not be adequate. Therefore, it may be necessary to raise finished floor levels to 600mm.

Part H of building regulations recommends that finished floor levels (FFL) and openings (e.g. air bricks) of new developments are set to a minimum of 150mm above the surrounding ground levels. This is to prevent flooding from flowing or ponding storm water near doorways and other ingress routes such as vents and air bricks.

If it is not practical (for example where level for level flood plain compensation cannot be provided) to raise floor levels to those specified above, consultation with

the Environment Agency will be required to determine whether alternative approaches are appropriate.

Safe access and egress will need to be demonstrated at all development sites. Emergency vehicular access (no more than 300mm depth along access routes) should be possible during times of flood.

The additional height that the floor level is raised above the maximum water level is referred to as the "freeboard". Additional freeboard may be required because of risks relating to blockages to the channel, culverts or bridges. These should be considered as part of an FRA.

Allocating the ground floor of a building for less vulnerable, non-residential, use is an effective way of raising living space above flood levels.

Single storey buildings such as ground floor flats or bungalows are especially vulnerable to rapid rise of water (such as that experienced during a breach). This risk can be reduced by use of multiple storey construction and raised areas that provide an escape route. However, access and egress can still be an issue, particularly when flood duration covers many days.

Similarly, the use of basements should be avoided. Habitable uses of basements within Flood Zone 3 should not be permitted, whilst basement dwellings in Flood Zone 2 will be required to pass the Exception Test. Basements should not be used for sleeping arrangements and access should be situated 300mm above the design flood level and waterproof construction techniques used.

8.4.3 Development and raised defences

Construction of localised raised floodwalls or embankments to protect new development is not a preferred option, unless wider benefits can be provided (for example by mitigating risks downstream), as a residual risk of flooding will remain if they are overtopped or breached. Compensatory storage must be provided where raised defences remove storage from the floodplain and exceedance would need to be considered. It would be preferable for schemes to involve an integrated flood risk management solution.

Temporary or demountable defences are not acceptable forms of flood protection but might be appropriate to address circumstances where the consequences of residual risk are severe. In addition to the technical measures the proposals must include details of how the temporary measures will be erected and decommissioned, the associated temporary flood plain compensation, responsibility for maintenance and the cost of replacement when they deteriorate.

8.4.4 Modification of ground levels

Modifying ground levels to raise the land above the required flood level can be an effective way of reducing flood risk to a particular site in circumstances where the land does not act as conveyance for flood waters. However, care must be taken at locations where raising ground levels could adversely affect existing communities and property.

In most areas of fluvial flood risk, raising land above the floodplain would reduce conveyance or flood storage in the floodplain and could adversely impact flood risk downstream or on neighbouring land.

Compensatory flood storage should therefore be provided, and this would normally be required on a level for level, volume for volume basis, situated on land that does not currently flood but is adjacent to the floodplain (in order for it to fill and drain). Compensatory flood storage should be in the vicinity of the site and within the red line of the planning application boundary.

Raising levels can also create areas where surface water might pond during significant rainfall events. Any proposals to raise ground levels should be tested to ensure that it would not cause increased ponding or build-up of surface runoff on third party land.

Any proposal for modification of ground levels will need to be discussed at an early stage with the Environment Agency, in relation to the impact on flood risk and its impacts assessed as part of a detailed FRA.

8.4.5 Developer contributions

In some cases, and following the application of the Sequential Test, it may be necessary for the developer to contribute to the improvement of flood defence provision that would benefit both proposed new development and the existing local community. Developer contributions can also be made to maintenance and provision of flood risk management assets, flood warning and the reduction of surface water flooding (i.e. SuDS). These could be funded through the Community Infrastructure Levy (CIL) or Section 106 agreements. Such measures can ensure that development is safe for its users during its lifetime, whilst also ensuring that the development does not increase flood risk elsewhere.

DEFRA's Flood and Coastal Erosion Risk Management Grant in Aid (FCERM GiA)[15] can be obtained by operating authorities to contribute towards the cost of a range of activities including flood risk management schemes that help reduce the risk of flooding and coastal erosion. Some schemes are only partly funded by FCERM GiA and therefore any shortfall in funds will need to be found from elsewhere when using Resilience Partnership Funding, for example local levy funding, local businesses or other parties benefitting from the scheme.

For new development in locations without existing defences, or where the development is the only beneficiary, the full costs of appropriate risk management measures for the life of the assets proposed must be funded by the developer.

However, the provision of funding by a developer for the cost of the necessary standard of protection from flooding or coastal erosion does not of itself mean the development is appropriate in flood risk terms, as other policy aims must also be met. This will include application of the NPPF sequential, and as necessary, exception tests. Funding from developers should be explored prior to the granting of planning permission and in partnership with the council and the Environment Agency.

The most appropriate route for the consideration of strategic measures to address flood risk issues is the Local Flood Risk Management Strategy prepared by the Lead Local Flood Authority (Section 2.3.6). The LFRMS describes the priorities with respect to local flood risk management, the measures to be taken, the timing of these measures and how they will be funded. It will be preferable for the developer to demonstrate that strategic provisions are in accordance with the LFRMS, can be afforded and have an appropriate priority.

The Environment Agency is committed to working in partnership with developers to reduce flood risk. Where assets are in need of improvement or a scheme can be implemented to reduce flood risk, the Environment Agency request that developers contact them to discuss potential solutions.

8.5 Buffer strips

The provision of a buffer strip to 'make space for water', allows additional capacity to accommodate climate change and ensure that access to the watercourse, structures and defences is maintained for future maintenance purposes. It enables the

15 Principles for implementing flood and coastal resilience funding partnerships (Environment Agency, 2012)

avoidance of disturbing riverbanks, adversely impacting ecology and having to construct engineered riverbank protection. Building adjacent to riverbanks can also cause problems to the structural integrity of riverbanks and the building itself, making future maintenance of the river much more difficult.

Various buffer strip Byelaws are in place within the SFRA study area, to be consulted when allocating new development. Under the **Environmental Permitting Regulations 2018** (England and Wales), the Environment Agency specifies that no development is permitted within 8m of any Main River without previous consent from the Authority. This distance is measured horizontally from the foot of any bank of the river on the landward side, or where there is no such bank, measured horizontally from the top edge of the batter enclosing the river. Furthermore, no development should be permitted within 8m of any ordinary watercourse without previous consent from the Lead Local Flood Authority.

Additionally, Thames Water under the **Water Industry Act (1991)** which granted their ownership over all public sewers within their administrative area, have restricted easement within 3m of their sewer systems without prior consent[16].

8.6 Resistance and Resilience measures

There may be instances where flood risk to a development remains despite implementation of such planning measures as those outlined above. For example, where the use is water compatible, where the use of an existing building is being changed, where residual risk remains behind defences, or where floor levels have been raised but there is still a risk at the 0.1% AEP scenario. In these cases, (and for existing development in the floodplain), additional measures can be put in place to reduce damage should a flood event occur and increase the speed of recovery. These measures should not normally be relied on for new development as an appropriate mitigation method.

Resistance measures aim to reduce the amount of floodwater entering the building and resilience measures aim to reduce the damage caused by flood water which has entered the property.

Resistance and Resilience measures will be specific to the nature of flood risk, and as such will be informed and determined by the FRA. Further guidance relating to appropriate resistance and resilience measures can be found at:

- Environment Agency's **Flood risk assessment in flood zones 2 and 3** webpage.
- Sussex Resilience Forum provides information and advice for individuals on **Preparing for Emergencies**.
- West Sussex County Council's **Guide to Flooding** also provides advice on how to prepare for flood events, as well as on how to make properties more flood resilient.

8.6.1 Resistance measures

Most resistance measures should be regarded as reducing the rate at which flood water can enter a property during an event and represent an improvement on what could be achieved with sandbags. They are often deployed with small scale pumping equipment to control the volume of flood water that does seep through these systems. The effectiveness of these forms of measures is often dependant on the availability of a reliable forecasting and warning system, so the measures are

[16] Building over or close to a public sewer, Thames Water Available: http://secure.thameswater.co.uk/cps/rde/xbcr/corp/building-over-a-public-sewer.pdf

deployed in advance of an event. The following resistance measures are often deployed:

Permanent barriers

Permanent barriers can include built up doorsteps, rendered brick walls and toughened glass barriers.

Temporary barriers

Temporary barriers consist of moveable flood defences which can be fitted into doorways and/or windows. The permanent fixings required to install these temporary defences should be discrete and keep architectural impact to a minimum. On a smaller scale, covers for airbricks and air vents can also be fitted to resist the entrance of flood water.

As these measures will reduce the storage within the floodplain compensatory storage provision is likely to be required to prevent incremental detriment to the flood risk elsewhere.

8.6.2 Resilience measures

Resilience measures should be regarded as reducing the impact the flood water has once it has entered a property. These typically include:

Water resistant materials

Floors, walls and fixtures can be finished with water resistant materials to help reduce the damage and greatly shorten the recovery time after a flood. Materials can include waterproof plaster, solid concrete floors and tiled flood coverings.

Electrical installation

Electrical circuitry can be installed at a higher level with power cables being carried down from the ceiling rather than up from the floor level to reduce the likelihood of the circuitry being affected by flood water

8.6.3 Community resistance measures

Community resistance measures include demountable defences that can be deployed by local communities to reduce the risk of water ingress to a number of properties. The methods require the deployment of inflatable (usually with water) or temporary quick assembly barriers in conjunction with pumps to collect water that seeps through the systems during a flood.

West Sussex County Council's '**What if?**' community resilience programme has been working with communities at Parish Council level providing training and advice to enable communities to prepare, respond and recover in time of emergency. WSCC has also encouraged the preparation of community emergency plans to help support emergency response arrangements[17]. Where applicable, Local Parish Councils should be contacted by developers to see if a community has an Emergency Plan in place.

8.7 Natural Flood Management and Sustainable Urban Drainage

The **PPG** sets out a clear aim to make use of natural and sustainable flood risk management methods wherever they may be effective when opportunities are presented by new developments. The documentation encourages consideration of net gains and multiple benefits of applying such measures. Strategic Flood Risk Assessments are to identify opportunities for nature-based solutions. Developments subject to the exception test must reduce overall flood risk where possible.

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[17] Your essential Flood Guide: Information and forward planning. West Sussex County Council. Available at: https://www.westsussex.gov.uk/media/2184/guide_to_flooding.pdf

All new development should consider the opportunity presented to improve and enhance the river environment, seeking opportunities for river restoration and enhancement as part of the development. A sustainable drainage approach can alleviate flood risk as well as increase surface water infiltration, increasing vegetation (and improving biodiversity), providing additional flood storage, and reducing the surface water load of the existing sewerage network.

Natural flood Management (NFM) techniques work with natural processes to protect, restore, and emulate natural functions of catchment, floodplains, rivers, and coasts. Examples include land management to improve soil health and infiltration rates and soil moisture storage, river restoration, restoring or creating wetland areas, and woodland creation. When designed properly, such measures can have benefits such as reducing the costs of maintaining hard engineering structures, reducing flood risk, improving water quality and increasing biodiversity. Social benefits are also gained by increasing green space and access to the river.

8.7.1 Emergency planning

Safe access and egress from the site should be provided to reduce the residual risks to a development. The developer should seek to incorporate into the design an emergency plan and a safe refuge point if the development site has been identified to be at risk of flooding. Developers should consult the local authority and Emergency Services when designing an emergency plan. For further details on emergency planning, see Section 10.

8.8 Reducing flood risk from other sources

8.8.1 Groundwater

Groundwater flooding has a very different flood mechanism to any other and for this reason many conventional flood defence and mitigation methods are not suitable. The only way to fully reduce flood risk is through building design (development form), ensuring floor levels are raised above the water levels caused by a 1% AEP plus climate change event. Site design will need to preserve any flow routes followed by the groundwater overland to ensure flood risk is not increased downstream.

Infiltration SuDS can cause increased groundwater levels and subsequently may increase flood risk from groundwater sources on or off the site. Developers should provide appropriate evidence and ensure that this will not be a significant risk arising from development.

When redeveloping existing buildings, it may be acceptable to install pumps in basements as a resilience measure. However, for new development this is not considered an appropriate solution.

8.8.2 Surface water and sewer flooding

Developers should discuss public sewerage capacity with the water utility company (Thames Water) at the earliest possible stage. If a development increases flood risk on site or the wider area then the drainage infrastructure will need to be improved to prevent this. It is important that a drainage impact assessment demonstrates that this will not increase flood risk elsewhere, and that the drainage requirements regarding runoff rates and SuDS for new development are met.

During the redevelopment of brownfield sites, the Drainage Hierarchy should be used to direct surface water to natural outfall routes such as infiltration to the ground or into watercourses, before utilising sewers (surface water or combined), as supported by **the PPG**. Surface water should also not be permitted to connect to a foul sewer.

If residual surface water flood risk remains, the likely flow routes and depths across the site should be modelled. The site layout should be carefully considered and designed to ensure that these flow routes are preserved and building design should provide resilience against this residual risk.

When redeveloping existing buildings, the installation of permanent or temporary flood-proofing and resilience measures could protect against both surface water and sewer flooding (provided compensatory storage is also included if required). Non-return valves prevent water entering the property from drains and sewers. These can be installed within gravity sewers or drains in a property's private sewer upstream of the public sewerage system. They need to be carefully installed and must be regularly maintained. Consideration must also be given to attenuation and flow ensuring that flows during the 1%AEP plus climate change event are retained within the site if any flap valves shut. This must be demonstrated with suitable modelling techniques. Particular consideration should be given to designing drainage systems that reduce the risk of groundwater ingress, as this is a known existing problem.

8.8.3 Sustainable Drainage Systems

Sustainable Drainage Systems (SuDS) aim to mimic the natural processes of greenfield surface water drainage by encouraging water to flow along natural flow routes, thereby reducing runoff rates and volumes during storm events while providing some water treatment benefits. SuDS also have the advantage of providing effective blue and green infrastructure and ecological and public amenity benefits when designed and maintained properly.

The inclusion of SuDS within developments should therefore be seen as an opportunity to enhance ecological and amenity value, and promote green infrastructure, incorporating above ground facilities into the development landscape strategy. SuDS must be considered at the outset, during preparation of the initial site conceptual layout to ensure that enough land is given to design spaces that will be an asset to the development, rather than as an after-thought. Advice on best practice is available from the Environment Agency and the Construction Industry Research and Information Association (CIRIA).

Consideration must also be given to attenuation and flow ensuring that flows during the 1%AEP plus climate change event are retained within the site if the system were to fail.

More detailed guidance on the effective use of SuDS is providing in Section 9.3.

9 Surface water management and SuDS

This chapter provides guidance and advice on managing surface water runoff and flooding.

9.1 Introduction

Sustainable Drainage Systems (SuDS) are management practices which enable surface water to be drained in a more sustainable manner that mimics the local natural drainage. The inclusion of SuDS within developments is an opportunity to enhance ecological and amenity value, and promote Green Infrastructure, incorporating above ground facilities into the development landscape strategy.

9.2 Role of the LLFA and Local Planning Authority in surface water management

From April 2015 local planning policies and decisions on planning applications relating to major development, including major commercial development, should make provision for sustainable drainage systems to manage run-off. Major development is defined as:

- residential development: 10 dwellings or more, or residential development with a site area of 0.5 hectares or more where the number of dwellings is not yet known; and
- non-residential development: provision of a building or buildings where the total floor space to be created is 1,000 square metres or more or, where the floor area is not yet known, a site area of one hectare or more.

The government announced its intention to enact Schedule 3 of the Flood and Water Management Act 2010, in January 2023. If implemented, Sustainable Drainage Systems would be approved by a SuDS Approving Body (SAB) which is the unitary or upper-tier authority for the area (West Sussex County Council. The SAB would have the power to approve SuDS as part of a separate approvals process to the planning system and would also have powers to adopt SuDS.

The Local Planning Authority must satisfy themselves that clear arrangements are in place for future management of the maintenance arrangements and the LLFA (West Sussex County Council), as statutory consultee is required to review the drainage and Sustainable Drainage Systems (SuDS) proposals to confirm that they are appropriate.

When considering planning applications, Local Planning Authorities should seek advice from the relevant flood risk management bodies, principally the LLFA, in relation to the management of surface water (including what sort of SuDS they would consider to be reasonably practicable), satisfy themselves that the proposed minimum standards of operation are appropriate and ensure, through the use of planning conditions or planning obligations, that there are clear arrangements for on-going maintenance over the development's lifetime. Judgement on what SuDS system would be reasonably practicable should be reached through reference to Defra's **'Non-statutory technical standards for SuDS' document** and should take into account viability and design and construction costs.

In their respective roles as LLFA and LPA West Sussex County Council and Crawley Borough and Horsham District Councils should:

- promote the use of SuDS for the management of run off;
- ensure their policies and decisions on applications support and compliment the building regulations on sustainable rainwater drainage, giving priority to infiltration over watercourses and then sewer conveyance;
- incorporate favourable policies within development plans;
- adopt policies for incorporating SuDS requirements into Local Plans; and
- encourage developers to utilise SuDS whenever practical, if necessary, through the use of appropriate planning conditions.

9.3 Sustainable Drainage Systems (SuDS)

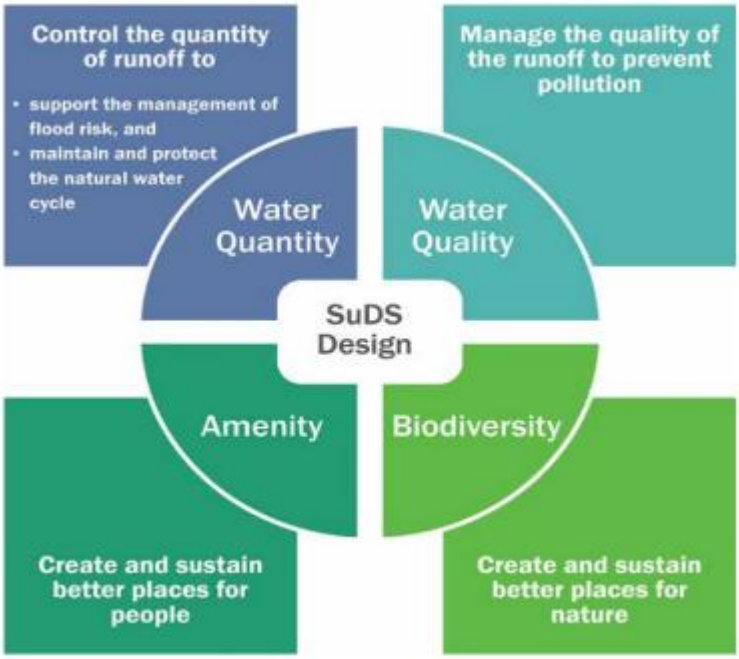
It is essential that developers consider sustainable drainage at an early stage of the development process – ideally at the design brief or master-planning stage. This will assist with the delivery of well designed, appropriate and effective SuDS. Proposals should also comply with the key SuDS principles (the four pillars of SuDS design - Figure 9-1) enabling solutions that deliver multiple long-term benefits. These principles are:

- **Quantity:** should be able to cope with the quantity of water generated by the development at the agreed greenfield rate and volume with due consideration for climate change via a micro-catchment based approach. Where frequency of flood risk, steepness of topography or permeability of geology has a significant impact on the volume or rate of surface water being discharged from a site, the LLFA should be contacted, as a review of the greenfield runoff rate to be achieved may be needed.
- **Quality:** should utilise SuDS features in a "treatment train" that will have the effect of treating the water before infiltration or passing it on to a subsequent water body
- **Amenity:** should integrate greenery or water features to improve the visual characteristics of the area. These can be incorporated within "open space" or "green corridors" within the site and designed with a view to performing a multifunctional purpose.
- **Biodiversity:** should include a range of natural features such as plants, trees and other vegetation which will provide additional filtration of surface water runoff. These can be designed to complement and improve the ecology of the area.

There are a number of ways in which SuDS can be designed to meet surface water quantity, climate change resilience, water quality, biodiversity and amenity goals. Given this flexibility, SuDS are generally capable of overcoming or working alongside various constraints affecting a site, such as restrictions on infiltration, without detriment to achieving these goals.

SuDS must be fully considered at the outset and during preparation of the initial conceptual site layout to ensure that enough land is given to design spaces that will be an asset to the development as opposed to an ineffective afterthought. For SuDS to work effectively, appropriate techniques should be selected based on the objectives for drainage and any site-specific constraints. It is recommended, that on all developments, source control (managing surface water run-off as close to its source as possible, to minimise its affect elsewhere) is implemented as the first stage of a management train allowing for improvements in water quality and reducing or eliminating runoff from smaller, more frequent, rainfall events.

Figure 9-1: Four pillars of SuDS design (from The SuDS Manual C753 (2015))



All new major development proposals should ensure that sustainable drainage systems for the management of run-off are put in place. The developer is responsible for ensuring that the design, construction and future/ongoing maintenance of such a scheme are carefully and clearly defined, and a clear and comprehensive understanding of the existing catchment hydrological processes and existing drainage arrangements is essential.

9.4 Types of SuDS System

There are many different SuDS techniques that can be implemented in attempts to mimic pre-development drainage (Table 9-1). Techniques can include soakaways, infiltration trenches, permeable pavements, grassed swales, green roofs, ponds and wetlands and these measures do not necessarily need to take up a lot of space. The suitability of the techniques that are utilised will be dictated in part by the development proposal and site specific conditions. Advice on best practice is available from the Environment Agency and the Construction Industry Research and Information Association (CIRIA) e.g. the **CIRIA SuDS Manual C753 (2015)** and the previous CIRIA SuDS Manual C697 (2007).

Table 9-1: Examples of SuDS techniques and potential benefits

SuDS Technique	Flood Reduction	Water Quality Treatment & Enhancement	Landscape and Wildlife Benefit
Living roofs	✓	✓	✓
Basins and ponds Constructed wetlands Balancing ponds Detention basins Retention ponds	✓ ✓ ✓ ✓ ✓	✓ ✓ ✓ ✓ ✓	✓ ✓ ✓ ✓ ✓
Filter strips and swales	✓	✓	✓
Infiltration devices Soakaways Infiltration trenches and basins	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ ✓
Permeable surfaces and filter drains Gravelled areas Solid paving blocks Porous pavements	✓ ✓ ✓ ✓	✓ ✓ ✓ ✓	
Tanked systems Over-sized pipes/tanks Storm cells	✓ ✓ ✓		

9.4.1 SuDS Management

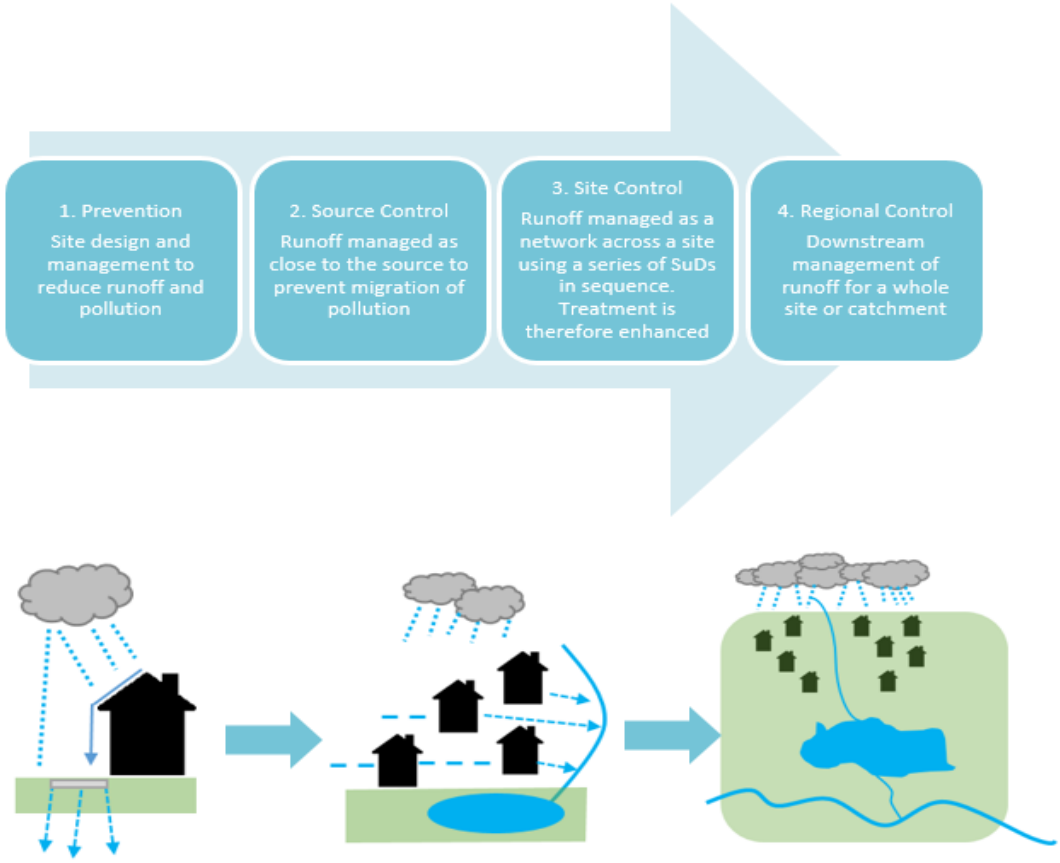
SuDS should not be used individually, but rather as a series of features in an interconnected system designed to capture water at the source and convey it to a discharge location. Collectively this concept is described as a SuDS Management Train (see

Figure 9-2). The number of treatment stages required within the Management Train depends primarily on the source of the runoff and the sensitivity of the receiving waterbody or groundwater. A Surface Water Drainage Strategy will need to demonstrate that an appropriate number of treatment stages are delivered to ensure that there is no negative impact on the receiving watercourse.

A Surface Water Drainage Strategy is also required to set out extent, position, function and future management arrangements for the sustainable drainage system for a proposed site. This information is required by the Local Planning Authority at the time that an application is made.

SuDS components should be selected based on design criteria, having regards to how surface water management is to be integrated within the development and landscaping setting. By using a number of SuDS features in series it is possible to reduce the flow and volume of runoff as it passes through the system as well as minimising pollutants which may be generated by a development.

Figure 9-2: SuDS Management Train



9.4.2 Treatment

A key objective of the four pillars of SuDS is to provide the maximum improvement to water quality through the use of the "SuDS Management Train". To maximise the scope for treatment of pollutants within SuDS, CIRIA recommends[18] the following good practice is implemented in the treatment process:

1. **Manage surface water runoff close to source:** This makes treatment easier due to the slower velocities and also helps isolate incidents rather than transport pollutants over a large area.
2. **Treat surface water runoff on the surface:** This allows treatment performance to be more easily inspected and managed, and enables sources of pollution and potential flood risk to be more easily identified. It also helps with future maintenance work and identifying damaged or failed components.
3. **Treat a range of contaminants:** SuDS should be chosen and designed to deal with the likely contaminants from a development and be able to reduce them to acceptably low levels.
4. **Minimise the risk of sediment remobilisation:** SuDS should be designed to prevent sediments being washed into receiving water bodies or systems during events greater than what the component may have been designed.

18 C753 CIRIA SuDS Manual (2015)

5. **Minimise the impact of spill:** Designing SuDS to be able to trap spills close to the source or provide robust treatment along several components in series.

The number of treatment stages required depends primarily on the source of the runoff. A Surface Water Drainage Strategy will need to demonstrate that an appropriate number of treatment stages are delivered. This involves determining a pollutant hazard score for each pollutant type. An index is then used to determine the treatment potential of different SuDS features for different pollutant types. This is known as the mitigation index. The Total SuDS mitigation index should be equal or greater than the pollution hazard score to deliver adequate treatment.

9.4.3 Overcoming SuDS constraints

The design of a SuDS system will be influenced by a number of physical and policy constraints. These should be taken into account during the conceptual, outline and detailed stages of SuDS design. Table 9-2 details some possible constraints and how they may be overcome.

Table 9-2: Example SuDS design constraints and possible solutions

Considerations	Solution
Land availability	SuDS can be designed to fit into small areas by utilising different systems. For example, features such as permeable paving and green roofs can be used in urban areas where space may be limited.
Contaminated soil or groundwater below site	SuDS can be placed and designed to overcome issues with contaminated groundwater or soil. Shallow surface SuDS can be used to minimise disturbance to the underlying soil. The use of infiltration should also be investigated as it may be possible in some locations within the site. If infiltration is not possible linings can be used with features to prevent infiltration.
High groundwater levels	Non-infiltrating features can be used. Features can be lined with an impermeable liner or clay to prevent the egress of water into the feature. Additional, shallow features can be utilised which are above the groundwater table.
Steep slopes	Check dams can be used to slow flows. Additionally, features can form a terraced system with additional SuDS components such as ponds used to slow flows.
Shallow slopes	Use of shallow surface features to allow a sufficient gradient. If the gradient is still too shallow pumped systems can be considered as a last resort.
Ground instability	Geotechnical site investigation should be done to determine the extent of unstable soil and dictate whether infiltration would be suitable or not.
Sites with deep backfill	Infiltration should be avoided unless the soil can be demonstrated to be sufficiently compacted. Some features such as swales are more adaptable to potential surface settlement.
Open space in floodplain zones	Design decisions should be done to take into consideration the likely high groundwater table and possible high flows and water levels. Features should also seek to not reduce the capacity of the floodplain and take into consideration the influence that a watercourse may have on a system. Facts such as siltation after a flood event should also be taken into account during the design phase.
Future adoption and maintenance	Local Planning Authority should ensure development proposals, through the use of planning conditions or planning obligations, have clear arrangements for on-going maintenance over the development's lifetime.

For SuDS techniques that are designed to encourage infiltration, it is imperative that the water table is low enough to receive surface run-off waters. A site-specific infiltration test will need to be conducted early on as part of the design of the development, in order to determine the impact of groundwater levels on the effectiveness of the drainage system. Groundwater monitoring is also encouraged. Infiltration should be considered with caution within areas of possible subsidence or sinkholes. Where sites lie within or close to groundwater source protection zones (GSPZs) or aquifers, further restrictions may be applicable, and guidance should be sought from the LLFA and the Environment Agency.

Where frequency of flood risk, steepness of topography or permeability of geology has a significant impact on the volume or rate of surface water being discharged from a site, developers should contact the LLFA, as a review of the greenfield runoff rates to be achieved may be needed.

9.5 Sources of SuDS guidance

C753 CIRIA SuDS Manual (2015)

The C753 CIRIA SuDS Manual (2015) provides up to date guidance on planning, design, construction and maintenance of SuDS. The document is designed to help the implementation of these features into new and existing developments, whilst maximising the key benefits regarding flood risk and water quality. The manual is divided into five sections ranging from a high-level overview of SuDS, progressing to more detailed guidance on specific SuDS approaches. It is recommended that developers and the LPA utilise the information within the manual to help design SuDS which are appropriate for a development.

Defra Non-Statutory Technical Guidance (2015)

The guidance was developed by Defra to sit alongside PPG to provide non-statutory standards as to the expected design and performance for SuDS.

In March 2015, the latest guidance was released, providing amendments as to what the LPA should expect from development in order to meet the National standards. The guidance provides a valuable resource for developers and designers, outlining peak flow control, volume control, structural integrity of the SuDS, and flood considerations both within and outside the development as well as maintenance and construction considerations.

The LPA will make reference to these standards when determining whether proposed SuDS are considered reasonably practicable.

DEFRA launched a consultation on a new set of standards intended to supersede this, although as of August 2023 there has been no confirmation of a publication date.

West Sussex County Council LLFA Policy for the Management of Surface Water

This policy outlines the specific requirements that WSCC has for drainage strategies and surface water provisions that development applications within the county should adhere to. The policy statement contains 10 SuDS policies and should be used by developers, professionals and local authorities involved in the development of new or brownfield sites; drainage schemes for major developments; and local planning and land-use policy.

Water, People, Places: A guide for master planning sustainable drainage into developments

West Sussex County Council and partner LLFAs produced a document on SuDS design and guidance, aimed at developers and planners involved in designing small and large developments in the South East of England.

More information and guidance on SuDS is available on the **Susdrain** website.

9.5.1 Groundwater Vulnerability Zones

The Environment Agency published new groundwater vulnerability maps in 2015. These maps provide a separate assessment of the vulnerability of groundwater in overlying superficial rocks and those that comprise the underlying bedrock. The maps show the vulnerability of groundwater at a location based on the hydrological, hydrogeological and soil properties within a one-kilometre grid square.

Two maps are available:

- **Basic groundwater vulnerability map:** this shows the likelihood of a pollutant discharged at ground level (above the soil zone) reaching groundwater for superficial and bedrock aquifers and is expressed as high, medium and low vulnerability.
- **Combined groundwater vulnerability map:** this map displays both the vulnerability and aquifer designation status (principal or secondary). The aquifer designation status is an indication of the importance of the aquifer for drinking water supply.

The groundwater vulnerability maps, which can be viewed on **Defra's MAGIC map**, should be considered when designing SuDS. Depending on the height of the water table at the location of the proposed development site, restrictions may be placed on the types of SuDS appropriate to certain areas. Particular consideration of these maps should be taken by developments in Maidenbower, Pound Hill, Forge Wood, Three Bridges and Northgate, which could all be, at least partially, located within an area of high groundwater vulnerability.

9.5.2 Groundwater Source Protection Zones (GSPZ)

The Environment Agency also defines Groundwater Source Protection Zones in the vicinity of groundwater abstraction points, as shown on **Defra's MAGIC map**. These areas 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, from any activity that may cause pollution. The Groundwater SPZ requires attenuated storage of runoff to prevent infiltration and contamination. The definition of each zone is shown below:

- **Zone 1 (Inner Protection Zone)** – Most sensitive zone: defined as the 50-day travel time of a pollutant to the source. This zone has a minimum radius of 50 metres.
- **Zone 1c (Inner Protection Zone – subsurface activity only)** – Extends Zone 1 where the aquifer is confined and may be impacted by deep drilling activities.
- **Zone 2 (Outer Protection Zone)** – Also sensitive to contamination: defined by a 400-day travel time of a pollutant to source. This has a 250 or 500 metres minimum radius around the source, depending on the size of the abstraction.
- **Zone 2c (Outer Protection Zone – subsurface activity only)** – Extends Zone 2 where the aquifer is confined and may be impacted by deep drilling activities.
- **Zone 3 (Total Catchment)** - Defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source. In confined aquifers, the source catchment may be displaced some distance from the source. For heavily exploited aquifers, the final Source Catchment Protection Zone can be defined as the whole aquifer recharge area where the ratio of groundwater abstraction to aquifer recharge (average recharge multiplied by outcrop area) is >0.75. Individual source protection areas will still be assigned to assist operators in catchment management.

- **Zone 4 (Zone of special** interest) – A fourth zone SPZ4 or 'Zone of Special Interest' usually represents a surface water catchment which drains into the aquifer feeding the groundwater supply (i.e. catchment draining to a disappearing stream). In the future this zone will be incorporated into one of the other zones, SPZ 1, 2 or 3, whichever is appropriate in the particular case, or become a safeguard zone.

There are presently no Groundwater SPZs in the study area.

9.5.3 Nitrate Vulnerable Zones

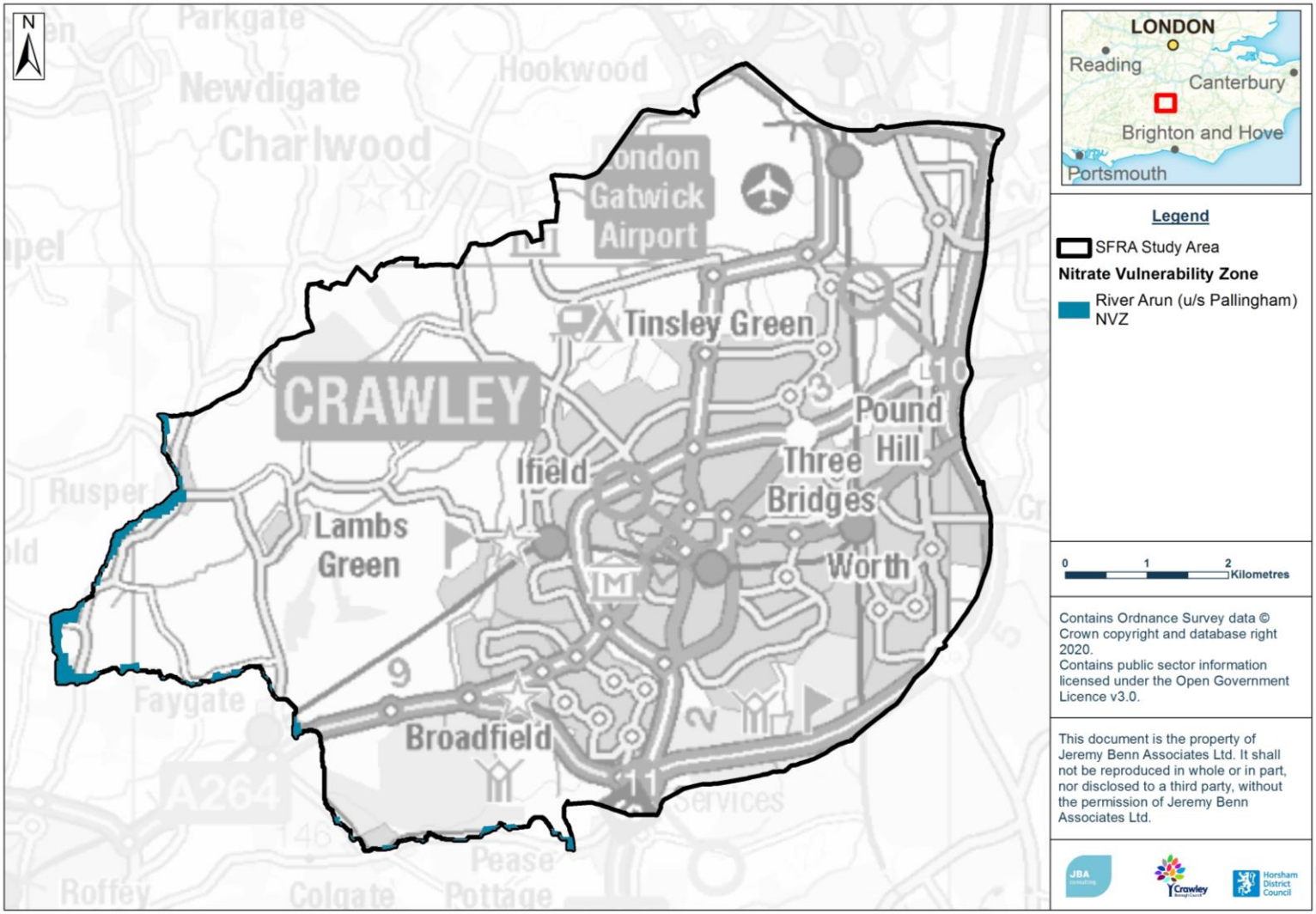
Nitrate Vulnerable Zones (NVZs) are areas designated as being at risk from agricultural nitrate pollution. Nitrate levels in waterbodies are affected by surface water runoff from surrounding agricultural land entering receiving waterbodies. The level of nitrate contamination will potentially influence the choice of SuDS and should be assessed as part of the design process.

The definition of each NVZ is as follows:

- **Groundwater NVZ** – an area of land where groundwater supplies are at risk from containing nitrate concentrations exceeding the 50mg/l level dictated by the EU's Surface Water Abstraction Directive (1975) and Nitrates Directive (1991).
- **Surface Water NVZ** – an area of land where surface waters (in particular those used or intended for the abstraction of drinking water) are at risk from containing nitrate concentrations exceeding the 50 mg/l dictated by the EU's Surface Water Abstraction Directive (1975) and Nitrate Directive (1991).
- **Eutrophic NVZ** – an area of land where nitrate concentrations are such that they could/will trigger the eutrophication of freshwater bodies, estuaries, coastal waters and marine waters.

The locations of the Nitrate Vulnerable Zones in the study area are shown in Figure 9-3.

Figure 9-3: Nitrate Vulnerability Zones in the SFRA study area



10 Flood warning and emergency planning

This chapter provides guidance and advice on managing flood related incidents before, during and after flooding occurs.

10.1 Emergency planning

Emergency planning is one option to help manage flood related incidents. From a flood risk perspective, emergency planning can be broadly split into three phases: before, during and after a flood. The measures involve developing and maintaining arrangements to reduce, control or mitigate the impact and consequences of flooding and to improve the ability of people and property to absorb, respond to and recover from flooding.

In development planning, a number of emergency planning activities are already integrated in national building control and planning policies e.g., the NPPF Flood Risk Vulnerability and Flood Zone 'Compatibility' table seeks to avoid inappropriate development in areas at risk from all sources of flooding. Flood warning and emergency planning is a last resort after using this SFRA to undertake the Sequential Test appropriately first.

However, safety is a key consideration for any new development and includes residual risk of flooding, the availability of adequate flood warning systems for the development, safe access and egress routes and evacuation procedures.

The Association of Directors of Environment, Economy, Planning and Transport (ADEPT) and the Environment Agency have published a **Flood Risk Emergency Plans for New Development** document which provides guidance for Local Planning Authorities regarding their decisions over planning applications.

The **NPPF Planning Practice Guidance** outlines how developers can ensure safe access and egress to and from development in order to demonstrate that development satisfies the second part of the Exception Test. As part of an FRA, the developer should review the acceptability of the proposed access in consultation with the LPA and the Environment Agency.

There are circumstances where a flood warning and evacuation plan[19] is required and / or advised:

- It is a **requirement under the 2019 NPPF** that safe access and escape routes are included in an FRA where appropriate, for example where escape routes are at risk of flooding, as part of an agreed emergency plan.
- The **Environment Agency and Defra's standing advice** for undertaking flood risk assessments for planning applications states that details of emergency escape plans will be required for any parts of the building that are below the estimated flood level.

It is recommended that Emergency Planners at Crawley Borough Council and Horsham District Council are consulted prior to the production of any emergency flood plan.

In addition to the **flood warning and evacuation plan considerations listed in the NPPF / PPG**, it is advisable that developers also have regard to the following:

19 Flood warning and evacuation plans may also be referred to as an emergency flood plan or flood response plan.

- How to manage the consequences of events that are un-foreseen or for which no warnings can be provided (e.g., managing the residual risk of a breach);
- Proposed new development that places additional burden on the existing response capacity of the relevant Council(s) will not normally be considered to be appropriate;
- Developers should encourage those owning or occupying developments, where flood warnings can be provided, to sign up to receive these warnings. This applies even if the development is defended to a high standard;
- The vulnerability of site occupants;
- Situations may arise where occupants cannot be evacuated (e.g. prisons) or where it is safer to remain "in-situ" and / or move to a higher floor or safe refuge area (e.g. at risk of a breach). Where applicable, a site-specific Flood Risk Assessment should be carried out by a developer to help develop emergency plans.

Further emergency planning information links:

- **2004 Civil Contingencies Act**
- **DEFRA (2014) National Flood Emergency Framework for England**
- **Sign up for Flood Warnings with the Environment Agency**
- **National Flood Forum**
- **GOV.UK Make a Flood Plan guidance and templates**
- **FloodRe**

10.2 Flood warning systems

Flood warnings can be derived and, along with evacuation plans, can inform emergency flood plans or flood response plans. The Environment Agency is the lead organisation for providing warnings of fluvial flooding (for watercourses classed as Main Rivers) and coastal flooding in England. Flood Warnings are supplied via the Flood Warning Service (FWS), to homes and business within Flood Zones 2 and 3. The different levels of warnings are shown in Table 10-1.

Table 10-1: Environment Agency Warnings

Flood Warning Symbol	What it means	What to do
	Flood Alerts are used to warn people of the possibility of flooding and encourage them to be alert, stay vigilant and make early preparations. It is issued earlier than a flood warning, to give customers advance notice of the possibility of flooding, but before there is full confidence that flooding in Flood Warning Areas is expected.	• Be prepared to act on your flood plan • Prepare a flood kit of essential items • Monitor local water levels and the flood forecast on the Environment Agency website • Stay tuned to local radio or TV • Alert your neighbours • Check pets and livestock • Reconsider travel plans
	Flood Warnings warn people of expected flooding and encourage them to take action to protect themselves and their property.	• Move family, pets and valuables to a safe place • Turn off gas, electricity and water supplies if safe to do so • Seal up ventilation system if safe to do so • Put flood protection equipment in place • Be ready should you need to evacuate from your home • 'Go In, Stay In, Tune In'
	Severe Flood Warnings warn people of expected severe flooding where there is a significant threat to life.	• Stay in a safe place with a means of escape • Co-operate with the emergency services and local authorities • Call 999 if you are in immediate danger
Warning no longer in force	Informs people that river or sea conditions begin to return to normal and no further flooding is expected in the area. People should remain careful as flood water may still be around for several days.	• Be careful. Flood water may still be around for several days • If you've been flooded, ring your insurance company as soon as possible

It is the responsibility of individuals to sign-up to the Flood Warning Service to receive the flood warnings via FWS. Registration and the service is free and publicly available through **https://www.gov.uk/sign-up-for-flood-warnings** or call 0345 988 1188.

It is recommended that any household considered at risk of flooding signs-up. Developers should also encourage those owning or occupying developments, where flood warnings can be provided, to sign up to receive them. This applies even if the development is defended to a high standard.

10.2.1 Flood Alert and Warning Areas in the Study area

There is currently one Flood Alert Area (FAA) and five Flood Warning Areas (FWAs) located within the study area. These are displayed in Appendix J. The FAA in the study area is shown in Table 10-2 and a list of FWAs are shown in Table 10-3

Table 10-2: Flood Alert Area within the study area

Flood Alert Code	Flood Alert Name	Source of flooding	Description
064WAF32UpprMole	Upper River Mole, Ifield Brook, Gatwick Stream, Burstow Stream and Salfords Stream	Ifield Brook, River Mole, Gatwick Stream, Burstow Stream	Ifield Brook, Upper River Mole, Burstow Stream and Salfords Stream including Ifield, Lowfield Heath, Charlwood, Hookwood, Bewbush, Furnace Green, Maidenbower, Crawley, Horley, Copthorne and Salfords

Table 10-3: Flood Warning Areas within the study area

Flood Warning Code	Flood Warning Name	Source of flooding	Description
064FWF32Ifield	Ifield Brook and the River Mole at Ifield and the River Mole at Lowfield Heath	Ifield Brook, River Mole	Ifield Brook and the River Mole at Ifield and the River Mole at Lowfield Heath including Gatwick Airport, West Sussex
064FWF32BrstStrm	Burstow Stream at East and North Horley	Burstow Stream, Haroldslea Stream, Silverlea Ditch, Weatherhill Stream	Burstow Stream, Haroldslea Stream, Silverlea Ditch and Weatherhill Stream at East and North Horley, Surrey
064FWF32Charlwd	River Mole at Charlwood and Hookwood	River Mole	River Mole at Charlwood and Hookwood including Povey Cross Road and Gatwick Airport, West Sussex and Surrey
064FWF32GtwkStrm	Gatwick Stream at South West Horley	Gatwick Stream	Gatwick Stream at South West Horley including Gatwick Airport, West Sussex and Surrey

Flood Warning Code	Flood Warning Name	Source of flooding	Description
064FWF32Maidnbwr	Gatwick Stream at Maidenbower and Crawley	Gatwick Stream	Gatwick Stream at Maidenbower and Crawley including Tinsley Green, West Sussex
064FWF32Tilgate	Tilgate Brook at Tilgate and Furnace Green	Tilgate Brook	Tilgate Brook including Tilgate and Furnace Green

10.2.2 Local arrangements for managing flood risk

The West Sussex County Council **Guide to Flooding** provides information on emergency planning, property flood protection and community resilience and advice for how to respond to flooding.

The **Sussex Resilience Forum website** contains information on how to prepare for and respond to emergencies in the local area. A site-specific Multi- Agency Flood Plan has been produced for Crawley Borough.

10.3 Emergency planning and development

10.3.1 NPPF

The NPPF Flood Risk Vulnerability and Flood Zone 'Compatibility' table seeks to avoid inappropriate development in areas at risk from all sources of flooding. It is essential that any development which will be required to remain operational during a flood event is located in the lowest flood risk zones to ensure that, in an emergency, operations are not impacted upon by flood water, or that such infrastructure is resistant to the effects of flooding such that it remains serviceable/operational during 'upper end' events, as defined in the Environment Agency's Climate Change allowances (May 2022). For example, the NPPF classifies police, ambulance and fire stations and command centres that are required to be operational during flooding as Highly Vulnerable development, which is not permitted in Flood Zones 3a and 3b and only permitted in Flood Zone 2 providing the Exception Test is passed. Essential infrastructure located in Flood Zone 3a or 3b must be operational during a flood event to assist in the emergency evacuation process. All flood sources such as fluvial, surface, groundwater, sewers and artificial sources (such as canals and reservoirs) should be considered.

The outputs of this SFRA should be compared and reviewed against any emergency plans and continuity arrangements. This includes the nominated emergency rest and reception centres (and prospective ones), so that evacuees are outside of the high-risk Flood Zones and will be safe during a flood event.

10.3.2 Safe access and egress

The NPPF Planning Practice Guidance outlines how developers can secure safe access and egress to and from development in order to demonstrate that development satisfies the second part of the Exception Test[20]. Access considerations should include the voluntary and free movement of people during a 'design flood' as well as for the potential of evacuation before a more extreme flood. A 'design flood' in this

20 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 039, Reference ID: 7-056-20140306) March 2014

context is defined as a fluvial 1% AEP plus climate change flood event. The access and egress must be functional for changing circumstances over the lifetime of the development. The NPPF Planning Practice Guidance sets out that:

- Access routes should allow occupants to safely access and exit their dwellings in design flood conditions. In addition, vehicular access (no more than 300mm depth along access routes or 1.5m/s velocity) for emergency services to safely reach development in design flood conditions is normally required; and
- Where possible, safe access routes should be located above design flood levels and avoid flow paths including those caused by exceedance and blockage. Where this is unavoidable, limited depths of flooding may be acceptable providing the proposed access is designed with appropriate signage etc. to make it safe. The acceptable flood depth for safe access will vary as this will be dependent on flood velocities and risk of debris in the flood water. Even low levels of flooding can pose a risk to people in situ (because of, for example, the presence of unseen hazards and contaminants in floodwater, or the risk that people remaining may require medical attention).

The depth, velocity, and hazard mapping from hydraulic modelling, which will form part of the Flood Risk Assessment, should help inform the provision of safe access and egress routes.

As part of an FRA, the developer should review the acceptability of the proposed access in consultation with Crawley Borough and Horsham District Councils and the Environment Agency. Site and plot specific velocity and depth of flows should be assessed against standard hazard criteria to ensure safe access and egress can be achieved.

10.3.3 Potential evacuations

During flood incidents, evacuation may be considered necessary. The NPPF Planning Guidance states practicality of safe evacuation from an area will depend on[21]:

1. the type of flood risk present, and the extent to which advance warning can be given in a flood event;
2. the number of people that would require evacuation from the area potentially at risk;
3. the adequacy of both evacuation routes and identified places that people could be evacuated to (and taking into account the length of time that the evacuation may need to last); and
4. sufficiently detailed and up to date evacuation plans being in place for the locality that address these and related issues.

The vulnerability of the occupants is also a key consideration. The NPPF, through application of the Sequential Test aims to avoid inappropriate development in flood risk areas. However, it is possible that developments may contain proposals for mixed use on the same site. In this instance, the NPPF Planning Practice Guidance states that layouts should be designed so that the most vulnerable uses are restricted to higher ground which is at a lower risk of flooding, with development which has a lower vulnerability (parking, open space etc.) directed to the highest risk areas, unless there are overriding reasons to prefer a different location[22]. Where the overriding reasons cannot be avoided, safe and practical evacuation routes must be identified.

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21 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 044, Reference ID: 7-044-20220825) March 2014

22 NPPF Planning Practice Guidance, Reducing the causes and impacts of flooding Paragraph: 023 Reference ID: 7-023-20220825

The Environment Agency and Defra provide standing advice for undertaking flood risk assessments for planning applications. Developers should refer to **the government website** for the criteria on when to follow the standing advice. Under these criteria, developers will need to provide details of emergency escape plans for any parts of the building that are below the estimated flood level. The plans should show that:

- single storey buildings or ground floors that do not have access to higher floors can access a space above the estimated flood level, e.g., higher ground nearby;
- basement rooms have clear internal access to an upper level, e.g., a staircase; and
- occupants can leave the building if there is a flood and there is enough time for them to leave after flood warnings[23].

Situations may arise where occupants cannot be evacuated (e.g., prisons) or where it is safer to remain "in-situ" and / or move to a higher floor or safe refuge area (e.g., developments located immediately behind a defence and at risk of a breach). These applications should be assessed against the outputs of the SFRA and where applicable, a site-specific Flood Risk Assessment to help develop appropriate emergency plans.

10.3.4 Flood warning and evacuation plans

Flood warning and evacuation plans are potential mitigation measures to manage the residual risk, as stated in the NPPF Planning Practice Guidance. It is a requirement under the NPPF that a flood warning and evacuation plan is prepared for sites at risk of flooding that are used for holiday or short-let caravans and camping and are important at any site that has transient occupants (e.g., hostels and hotels). While not specifically stated within the NPPF PPG, flood warning and evacuation plans should also be prepared for sites used by gypsies, travellers and travelling show people where these sites are at risk of flooding.

A flood warning and evacuation plan should detail arrangements for site occupants on what to do before, during and after a flood as this will help to lessen its impact, improve flood response and speed up the recovery process. The Environment Agency provides practical advice and templates on how to prepare flood plans for individuals, communities and businesses (see text box below for useful links).

It is recommended that developers liaise with emergency planners at Crawley Borough and Horsham District Councils to ensure they are consulted prior to the production of any emergency flood plan. **West Sussex County Council** and the **Environment Agency** provide guidance to help local communities to protect their home and valuables and understand what to do before, during and after a flood.

Once the emergency flood plan is prepared, it is recommended that it is distributed to emergency planners at Crawley Borough and Horsham District Councils and the emergency services. When developing a flood warning and evacuation plan, it is recommended that it links in with any existing parish / community level plan. Local Parish Councils should be contacted to establish if a community level plan exists for an area.

23 Environment Agency and DEFRA (2012) Flood Risk Assessment: Standing Advice: https://www.gov.uk/flood-risk-assessment-standing-advice

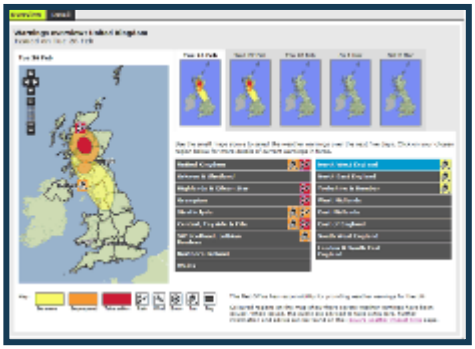
Guidance documents for preparation of flood response plans

- **Environment Agency (2012) Flooding – minimising the risk, flood plan guidance for communities and groups**
- **Environment Agency (2014) Community Flood Plan template**
- **Environment Agency Personal flood plans**
- **ADEPT and the Environment Agency (2019) - Flood Risk Emergency Plans for New Development**

10.3.5 Other sources of information

The joint guidance on **flood risk emergency plans for new development** which has been produced between the Environment Agency and the Association of Directors of Environment, Economy, Planning and Transport (ADEPT) aims to support robust consideration of whether proposed development will be safe. The guidance will help developers and their consultants produce suitable emergency plans.

As well as being a statutory consultee for new development at risk of flooding, the Environment Agency can offer independent technical advice. The Environment Agency website contains a breadth of information on flood risk and there are numerous publications and guidance available. For example, the **"flooding from groundwater"** guide has been produced by the Environment Agency and Local Government Association to offer practical advice to reduce the impact of flooding from groundwater.



The Met Office provides a National Severe Weather Warning Service about rain, snow, wind, fog and ice. The severity of warning is dependent upon the combination of the likelihood of the event happening and the impact the conditions may have. In simplistic terms, the warnings mean: Yellow: Be Aware, Amber: Be Prepared, Red: Take Action. This service does not provide flood warnings. The Met Office provide many other services and products. For further information, please visit their **website**.

The **National Flood Forum** (NFF) is a national charity, set up in 2002 to support those at risk and affected by flooding. The NFF helps people to prepare and recover from flooding as well as campaigning on behalf of flood risk communities, including providing advice on matters such as insurance.

Individual property flood resilience protection (PFR) measures are design to help protect homes and businesses from flooding. These include a combination of flood resistance measures - trying to prevent water ingress – and flood resilience measures - trying to limit the damage and reduce the impact of flooding, should water enter the building. It is important that any measures have the BSI Kitemark. This shows that the measure has been tested and ensures that it meets industry standards. Please visit the **Government website: "Prepare for flooding"** for more information.

11 Strategic flood risk solutions

This chapter provides information on strategic flood risk solutions (for example flood storage schemes and natural flood management) and how these could be implemented.

11.1 Introduction

Strategic flood risk solutions may offer a potential opportunity to reduce flood risk in the study area. The following section outlines different options which could be considered for strategic flood risk solutions. Any strategic solutions should ensure they are consistent with wider catchment policy and the local policies. It is important that the ability to deliver strategic solutions in the future is not compromised by the location of proposed development. When assessing the extent and location of proposed development consideration should be given to the requirement to secure land for flood risk management measures that provide wider benefits. Funding for these solutions could be sought via S106 agreements or the Community Infrastructure Levy (CIL).

11.2 Flood storage schemes

Flood storage schemes aim to reduce the flows passed downriver to mitigate downstream flooding. Development, particularly on greenfield land, increases the impermeable area within a catchment, creating additional and faster runoff into watercourses. Flood storage schemes aim to detain this additional runoff, releasing it downstream at a slower rate, to avoid any increase in flood depths and/or frequency downstream. Methods to provide these schemes include[24]

- enlarging the river channel;
- raising the riverbanks; and/or
- constructing flood banks set back from the river.

Flood storage schemes have the advantage that they generally benefit areas downstream, not just the local area.

11.2.1 Promotion of SuDS

By considering SuDS at an early stage in the development of a site, the risk from surface water can be mitigated to a certain extent within the site as well as reduce the risk that the site poses to third party land. Regionally, SuDS should be promoted as part of all new developments to ensure the quantity and quality of surface water is dealt with sustainably in order to reduce flood risk. The policies and guidance produced by WSCC as the LLFA (summarised in Section 9) should be used by developers to produce technically proficient and sustainable drainage solutions that conform with the non-statutory standards for SuDS (2015).

11.3 Natural Flood Management

Development can provide opportunities to work with natural processes to help reduce flood and erosion risk, benefit the natural environment and reduce costs of schemes. This is known as Natural flood management, a process whereby action is taken to mitigate flood risk by protecting, restoring and emulating natural processes. This approach aims to reduce flow volumes and delay the arrival of peak flood flow downstream.

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24 Environment Agency: Fluvial Design Guide – Chapter 10 (2010)

This requires integrated catchment management and the involvement of those who use and shape the land, as well as partnership working with neighbouring authorities, organisations and water management bodies. The Environment Agency has developed **Natural Flood Management (NFM) mapping** which displays opportunities for NFM.

The Thames Regional Flood and Coastal Committee has prepared NFM opportunity mapping within the Thames Region, highlighting potential locations for different types of NFM techniques.

Conventional flood prevention schemes may be preferred, but consideration of 're-wilding' rivers upstream could provide cost efficiencies as well as considering multiple sources of flood risk; for example, reducing peak flows upstream such as through felling trees into streams or building earth banks to capture runoff, could be cheaper and smaller-scale measures than implementing flood walls for example. With flood prevention schemes, consideration needs to be given to the impact that flood prevention has on the WFD status of watercourses. It is important that any potential schemes do not have a negative impact on the ecological and chemical status of waterbodies.

There are a number of approaches and techniques within NFM, which are summarised in the following sections.

11.3.1 Catchment and Floodplain restoration

Compared to flood defences and flood storage, floodplain restoration represents the most sustainable form of strategic flood risk solution, allowing watercourses to return to a more naturalised state, and by creating space for naturally functioning floodplains that work with natural processes.

Although the restoration of floodplain is difficult in previously developed areas where development cannot be rolled back, the following measures should be adopted:

- Promoting existing and future brownfield sites that are adjacent to watercourses to naturalise banks as much as possible. Buffer areas around watercourses provide an opportunity to restore parts of the floodplain;
- Removal of redundant structures to reconnect the river and the floodplain;
- Apply the Sequential Approach to avoid new development within the floodplain.

For those sites considered within the Local Plan Review and / or put forward by developers, that also have watercourses flowing through or past them, the sequential approach should be used to locate development away from these watercourses. This will ensure the watercourses retain their connectivity to the floodplain. Loss of floodplain connectivity could potentially increase flooding.

11.3.2 Re-naturalisation

There is potential to re-naturalise a watercourse by re-profiling the channel, removing hard defences, re-connecting the channel with its floodplain and introducing a more natural morphology (particularly in instances where a watercourse has historically been modified through hard bed modification). Detailed assessments and planning would need to be undertaken to gain a greater understanding of the response to any proposed channel modification.

In 2011, the Environment Agency proposed the restoration of the reach of Gatwick Stream that flows through Grattons Park. The restoration formed part of the mitigation and enhancement measures associated with the Upper Mole Flood Alleviation Scheme. The works were subsequently completed by Crawley Borough Council as part of its contribution to the scheme and involved the replacement of the

existing straight concrete channel with a meandering earth channel to reconnect the river to the floodplain.

11.4 Structure Removal and / or modification (e.g., Weirs)

Structures, both within watercourses and adjacent to them can have significant impacts upon rivers. This can occur through alterations to the geomorphology and hydraulics of the channel through water impoundment, and through altering the sediment transfer regime, which over time can significantly impact the channel profile including bed and bank levels, alterations to flow regime and interruption of biological connectivity, such as the passage of fish and invertebrates.

Many artificial in-channel structures (examples include weirs and culverts) are often redundant and / or serve little purpose, meaning that opportunities exist to remove them where feasible. The need to do this is heightened by climate change, for which restoring natural river processes, habitats and connectivity are vital adaptation measures. However, it also must be recognised that some artificial structures may have important functions or historical/cultural associations, which need to be considered carefully when planning and designing restoration work.

In the case of weirs, whilst removal should be investigated in the first instance, in some cases it may be necessary to modify a weir rather than remove it. For example, by lowering the weir crest level or adding a fish pass. Whilst enabling the weir to continue functioning, this will allow more natural water level variations upstream of the weir and remove a barrier to fish migration.

11.5 Flood defences

There are a number of formal flood defences present within the study area (see Section 7 for further information). The flood risk at several potential sites identified within Crawley Borough and Horsham District could be influenced by the presence of these defences. At these locations it will be important to understand the benefit that defences can have on reducing flooding, and consequences if their design standard is exceeded or they fail. Residual risk of these defences should be understood and managed.

For new development, flood mitigation measures should only be considered if, after application of the Sequential Approach, development sites cannot be located away from higher risk areas. If defences are specifically constructed to protect a development site, it will need to be demonstrated that the defences will not have a resulting negative impact on flood risk elsewhere, and that there is no net loss in floodplain storage. Maintenance arrangements, including funding mechanisms, for the defences will need to be evidenced for the lifetime of development.

11.6 Bank Stabilisation

Bank erosion should be avoided, and landowners are strongly encouraged to avoid using machinery and vehicles close to or within the watercourse.

There are several techniques that can be employed to restrict the erosion of the banks of a watercourse. In an area where bankside erosion is particularly bad and/or vegetation is unable to properly establish, ecologically sensitive bank stabilisation techniques, such as willow spiling, can be particularly effective. Live willow stakes thrive in the moist environment and protect the soils from further erosion allowing other vegetation to establish and protect the soils. Other approaches include the planting of brash or small trees, large wood, large trees and roots wads.

11.7 Green Infrastructure

Green infrastructure (GI) is a planned and managed network of natural environmental components and green spaces that intersperse and connect the urban centres, suburbs and rural fringe. Green Infrastructure consist of:

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

The identification and planning of Green Infrastructure is critical to achieving sustainable growth, and merits forward planning and investment as much as other socio-economic priorities such as health, transport, education and economic development. GI is also central to climate change action and is a recurring theme in planning policy. With regards to flood risk, green spaces can be used to manage storm flows and free up water storage capacity in existing infrastructure in order to reduce risk of damage to urban property, particularly in city centres and vulnerable urban regeneration areas. Green infrastructure can also improve accessibility to waterways and improve water quality, supporting regeneration and improving opportunities for leisure, economic activity and biodiversity.

The adopted **Crawley Borough Council Local Plan** (2015) and **Horsham District Council Local Plan** (2015) both contain a policy on GI (Policy ENV1 and Policy 31 respectively) encouraging the creation of a Green Infrastructure network in and around the area. Crawley Borough Council has produced a **Green Infrastructure Supplementary Planning Document** and Horsham District Council, a **Green Infrastructure Strategy Document**, to aid developers in contributing to the implementation of GI.

11.8 Engaging with key stakeholders

Flood risk to an area or development can often be attributed to a number of sources including fluvial, surface water and/or groundwater. In rural areas the definition between each type of flood risk is more distinguished. However, within urban areas flooding from multiple sources can become intertwined. Where complex flood risk issues are identified it is important that all stakeholders are actively encouraged to work together to identify issues and provide suitable solutions.

Engagement with riparian owners is also important to ensure they understand their rights and responsibilities including:

- maintaining riverbed and banks;
- allowing the flow of water to pass without obstruction; and
- controlling invasive alien species e.g. Japanese knotweed.

More information about riparian owner responsibilities can be found in the Environment Agency's guidance on **Owning a Watercourse** (2018).

12 Level 1 summary assessment of potential development locations

12.1 Introduction

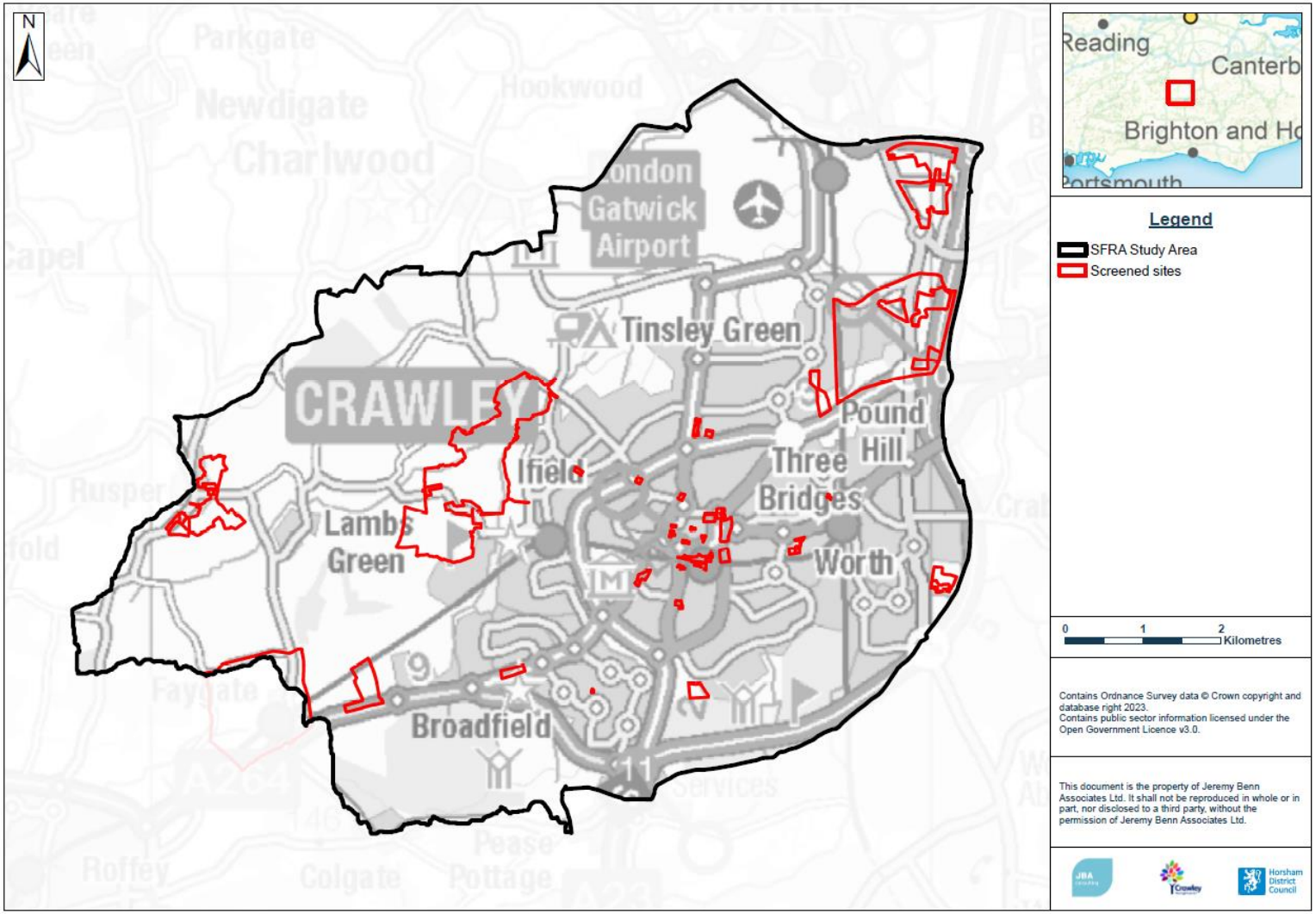
A total of 40 sites were provided by Crawley Borough and Horsham District Councils as shown in Figure 12-1.. The sites that were screened include potential development locations, existing committed development locations, and development allocations and regeneration areas that were adopted in the most recent Local Plans. These sites were screened against a suite of available flood risk information and spatial data to provide a summary of risk to each site (see Appendix K).

The information considered includes the flood risk datasets listed below:

- Environment Agency Flood Zones 2 and 3
- Flood Zone 3b
- Fluvial climate change allowances
- Environment Agency Risk of Flooding from Surface Water (3.33% AEP, 1% AEP, 0.1% AEP)
- Risk of Flooding from surface water uplifted for climate change (1% AEP +20% and +40% rainfall intensity)
- Environment Agency Reservoir Flood Maps GeoSmart Groundwater Flood Map
- Environment Agency Historic Flood Map
- West Sussex County Council's recorded incidents of flooding dataset

A summary has been prepared on the proportion of each site that is affected by the different sources of flooding. The information provided is intended to enable a more informed consideration of the sites when applying the sequential approach, which will be used to determine whether more detailed assessment of sites is needed to further identify those that should be taken forward as potential development allocations.

Figure 12-1: Mapping of Level 1 sites to be screened



12.2 Overview of risk at identified sites

A summary of flood risk at each of the sites in light of the screening is provided below:

- Flood Zone composition is varied across the sites. However, the majority of the sites are located mostly within Flood Zone 1, with 36 sites completely located within Flood Zone 1
- 4 sites are partially located within Flood Zone 2
- 2 sites are partially located within Flood Zone 3a
- 4 sites are at least partially located within Flood Zone 3b
- 17 sites are predicted to be at risk of fluvial flooding in the future due to climate change
- 43 sites are predicted to be at risk of surface water flooding during the 3.3%, 1% or 0.1% AEP events
- 3 sites intersect the Environment Agency's historic flood outlines
- No sites are predicted to be at a moderate risk of groundwater flooding
- 3 sites are predicted to be at risk of both Wet Day and Dry Day reservoir flooding
- No sites are located within 50m of an incident recorded by WSCC during the 2012 flood event

12.3 Sequential Testing

The SFRA does not include the Sequential Test of the development sites that were screened, as this is described under separate cover. However, Appendix K summarises the flood risk to the potential and confirmed development sites and provides evidence for use in the completion of the Sequential Test.

Inclusion of the SHLAA and Main Employment Areas sites in the SFRA does not imply that development can be permitted without further consideration of the Sequential Test. The required evidence should be prepared as part of a Local Plan Review Sustainability Appraisal or alternatively, it can be demonstrated through a free-standing document, or as part of strategic housing land or employment land availability assessments. NPPF Planning Practice Guidance for Flood Risk and Coastal Change describes how the Sequential Test should be applied in the preparation of a Local Plan Review. The assessments undertaken for this SFRA will assist Crawley Borough and Horsham District Councils in the preparation of the Sequential Test.

12.4 Cumulative impacts of development on flood risk

Cumulative impacts are defined as the effects of past, current and future activities on the environment. Under the 2021 NPPF, strategic policies and their supporting Strategic Flood Risk Assessments, are required to 'consider cumulative impacts in, or affecting, local areas susceptible to flooding' (para 160).

When allocating land for development, consideration should be given to the potential cumulative impact on flood risk within a catchment. Development increases the impermeable area within a catchment, which if not properly managed, can cause loss of floodplain storage, increased volumes and velocities of surface water runoff, and result in heightened downstream flood risk. Whilst individual development with appropriate site mitigation measures should not result in measurable local effects with respect to hydrology and flood risk, the cumulative effect of multiple development may be more severe at downstream locations in the catchment. Locations where there are existing flood risk issues with people, property or infrastructure will be particularly sensitive to cumulative effects.

The cumulative impact should be considered throughout the planning process, from the allocation of sites within the study area, to the planning application and development design stages. Once preferred options are identified, their cumulative impact can be considered in more detail within a Level 2 SFRA, where necessary. In addition, site-specific FRAs must consider the cumulative impact of the proposed development on flood risk within the wider catchment area if there are potentially material effects.

Crawley Borough and Horsham District Councils have boundaries with the following Local Authorities, which can be seen in Figure 1-1:

- Mole Valley District Council
- Reigate and Banstead District Council
- Tandridge District Council
- Mid Sussex District Council

Development management should ensure that the impact on receiving watercourses from development in the study area has been sufficiently considered during the planning stages and appropriate mitigation measures put in place to ensure there is no adverse impact on flood risk or water quality within the design standards.

12.4.1 Approach and methodology

The approach is based on providing an assessment of catchments where multiple development sites could result in effects that increase the flood risk to third parties. At a strategic level this involves consideration of catchments, as used in the Water Framework Directive and an outline evaluation of the quantum of proposed development and the sensitivity of the catchment to changes in flood risk. Historic flooding incidents are also included in the assessment, as these are an indicator of the actual sensitivity of locations within a catchment to flood events.

The methodology deploys a range of metrics to assess the potential cumulative impacts (detailed in sections 12.4.2 and 12.4.3), which provide a balance between predicted and observed flooding data recorded by West Sussex County Council and the Environment Agency. In addition, it was considered important to identify those catchments where an increase in flows (as a result of development) would potentially have the greatest impact upon downstream flood risk.

The WFD river catchments defined in the River Basin Management Plans were used to divide the study area into manageable areas on which to base a cumulative impact assessment. The National Receptor Dataset (NRD), a GIS layer containing information on property type, building area and floor levels, was used to provide a quantitative estimate of risk based on the number of affected receptors.

12.4.2 Development pressure

So that the strategic policies of the Local Plan Review considers the potential effects of any future development on areas susceptible to flooding, potential development pressures during the Local Plan period has been considered. To understand areas of the Local Plans that are likely to experience the greatest pressure for future growth, all potential future development sites received for consideration within the study area are analysed. This will allow calculation of the overall area of suggested sites within each catchment, illustrating the relative pressures on the catchments. This can be used with existing development extent, to identify catchments likely to be under the greatest pressure for development. The context for this being that in circumstances where the proportion of proposed new development is greater, the more likely it is to give rise to cumulative effects.

The proposed level of growth was assessed using development sites provided by Crawley Borough Council. This was then compared to the existing area of development, as indicated through the OS Open Zoomstack Dataset. The OS Open Zoomstack dataset is an OS basemap of the UK which contains various receptor layers, of which the buildings layer was used to identify the current level of development.

A development pressure score was derived for each catchment within the study area.

The risk metrics calculated for development pressure were:

- Calculation of total development currently within the catchment (%)
- Indicator of potential change in developed area within a catchment (%)

12.4.3 Historic and predicted flood risk

A composite flood risk score was derived for each catchment within the study area by taking an average ranking of both recorded (historic incidents) and modelled (predicted) flood risk.

The risk metrics calculated for predicted (modelled) flood risk were:

- Percentage of catchment within the combined 1 in 100-year fluvial and pluvial flood risk extent
- Sensitivity of catchment to an increase in flood flows (to a 1 in 1000-year fluvial and pluvial flood risk event)
- Percentage of properties within the combined 1 in 100-year fluvial and pluvial flood risk extent
- Sensitivity of properties to an increase in fluvial and pluvial flood flows (to a 1 in 1000-year fluvial and pluvial flood risk event)

To do this, the Risk of Flooding from Surface Water 1 in 100-year extent was merged with Flood Zone 3a and the 1 in 1000-year extent was merged with Flood Zone 2, to create combined layers showing predicted flood risk. The sensitivity is a measure of the increase in the percentage of catchment / properties at risk of flooding from a 1 in 100-year event to a 1 in 1000-year event.

The risk metrics calculated for historic flood risk were:

- Number of recorded flood incidents, recorded by West Sussex County Council
- Percentage of NRD points within the Environment Agency's historic flood map

12.4.4 Scoring

A relative risk score of 1 to 3 (low to high) was applied to each flood risk (Table 12-1) and development pressure metric (Table 12-2) and summed to give an overall relative flood risk score for each WFD catchment (Table 12-3).

A summary of the Cumulative Impacts Assessment results is shown in Table 12-4, with the highest risk in the Burstow Stream catchment. Mapping to display the results of this assessment is shown in Figure 12-2.

It should be noted that scoring is based on the use of national datasets that may not account for localised differences in flood risk. Datasets may be periodically updated and there is a potential for information to not be fully represented (i.e., historic flood events may be under reported). However, the results are deemed suitable for use as a broad-scale assessment of WFD catchments.

Table 12-1: Individual components of the relative cumulative impacts score for historic and predicted flood risk (per WFD catchment)

Point Score	% of catchment within the combined 100-year fluvial and pluvial flood risk extent	% increase in percentage of catchment at risk during the combined 1000-year pluvial and fluvial flood risk extent	% of properties within the combined 100-year fluvial and pluvial flood risk extent	% increase in percentage of properties at risk during the combined 1000-year pluvial and fluvial flood risk extent	Recorded flood incidents (WSCC)	% of NRD points within the EA historic flood map
1 – Low risk	< 1%	< 50%	< 0.1%	< 0.3%	< 10	< 1%
2 – Medium risk	1 - 3%	50 - 200%	0.1 - 0.25%	0.3 - 1%	10 – 100	1 – 5%
3 – High risk	> 3%	> 200%	> 0.25%	> 1%	> 100	> 5%

Table 12-2: Individual components of the relative cumulative impacts score for development pressure (per WFD catchment)

Point Score	% of total current development in catchment	% of potential future change in development
1 – Low risk	< 2%	< 50%
2 – Medium risk	2 to 5%	50% – 500%
3 – High risk	> 5%	> 500%

Table 12-3: Matrix of flood risk and future development pressure

	Historic and predicted flood risk		
Development pressure	**Low**	**Medium**	**High**
Low	1	3	4
Medium	3	4	5
High	4	5	6

Table 12-4: Summary of Cumulative Impacts Assessment results

Catchment	Flood Risk		Development pressure		Overall Score
Stanford Brook	LOW	1	LOW	1	LOW
Ifield Brook	LOW	1	MEDIUM	2	LOW
Baldhorns Brook	LOW	1	LOW	1	LOW
Mole upstream of Horley	LOW	1	MEDIUM	2	LOW
Tilgate Brook and Gatwick Stream at Crawley	LOW	1	HIGH	3	MEDIUM
Burstow Stream	HIGH	3	MEDIUM	2	HIGH
Deanoak Brook	LOW	1	LOW	1	LOW
Mole (Horley to Hersham)	HIGH	3	MEDIUM	2	MEDIUM

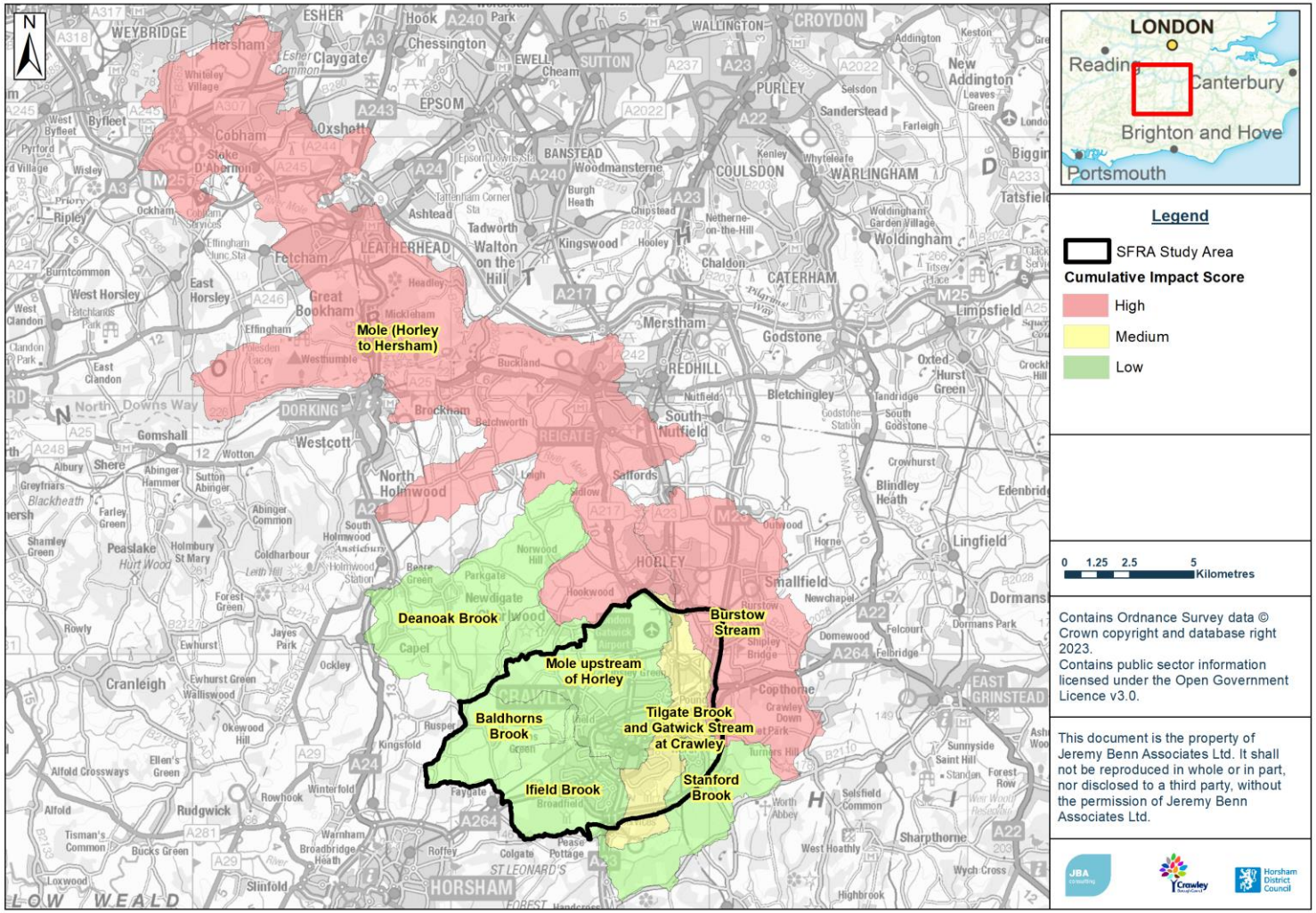


Figure 12-2 Mapping of the Cumulative Impact Assessment results

12.4.5 Implications

In circumstances where there is a high chance of encountering cumulative effects from planned development, this should be specifically addressed within FRAs for proposed development. Including consideration of cumulative effects, FRAs should assess:

- The location and sensitivity of receptors to cumulative effects and the mechanisms that potentially result in flooding (e.g., locations that are reliant on the performance of pumped drainage systems to manage flood risk, locations where existing flooding is experienced and can be exacerbated by relatively small changes in flood flow magnitude, volume or flood duration, etc.)
- The potential quantum of proposed cumulative development within a river catchment and assessment of the effect on sensitive receptors of the cumulative benefit afforded by piecemeal mitigation at the respective allocation sites
- The requirement for measures to address potential cumulative effects (these can be both 'on-site' measures and contributions to strategic 'off-site' measures
- The opportunity to integrate site mitigation measures with strategic flood risk management measures planned in the river catchment
- The long-term commitments to management and maintenance.

13 Summary

13.1 Overview

This Level 1 SFRA delivers a strategic assessment of all sources of flooding in the Study Area. It also provides an overview of policy and provides guidance for planners and developers.

The study area comprises of the administration area of Crawley Borough Council and the section of the Upper Mole Catchment which is situated within Horsham District Council's administrative area.

13.2 Sources of flood risk

The sources of flood risk in the study area have been assessed, further information on the data sources used can be found in Section 5 and the findings can be found in Section 6. A summary is outlined below.

13.2.1 Historic flooding

There have been several recorded flood incidents across the study area, with fluvial flooding and surface water flooding the most frequent causes. The most significant flood incidents occurred in 1968, when a fluvial flood event affected the Gatwick Airport runway, resulting in the closure of the airport for several days, and in 2000 when a heavy rainfall event surcharged an undersized temporary culvert resulting in widespread flooding of the A23 and 70 properties across Maidenbower, Furnace Green and Ifield Green, and 2012, when widespread surface water flooding impacted a small number of properties across Southgate, West Green, Rusper and Broadfield. More recently, flooding in the winter of 2019/2020 caused major disruption in West Sussex, resulting in road closures in the Crawley study area.

13.2.2 Fluvial flood risk

The River Mole and its tributary, Gatwick Stream are the main watercourses in the study area identified to contribute to fluvial flood risk. The key settlements identified to be at risk from fluvial flooding include Forge Wood, Three Bridges, Furnace Green, Langley Green, Maidenbower, Northgate and Tilgate. Flooding from ordinary watercourses are also identified to impact the Buckswood Drive and Horsham Road areas of Crawley.

Flood Zone mapping and climate change mapping of the fluvial flood risk in the study area has been prepared as part of the Level 1 SFRA and can be found in Appendix C and D.

13.2.3 Surface water flood risk

The Risk of Flooding from Surface Water dataset shows that surface water predominantly follows topographical flow paths of existing watercourses, dry valleys or roads, with some areas of pooling in lakes and ponds e.g. Tilgate Lake and Titmus Lake, often upslope of railway lines or roads. Surface water systems are often affected by back up from fluvial systems due to inadequate outfalls. Crawley is the area of greatest risk within the study area, with WSCC classifying it as a 'wet spot' within the Local Flood Risk Management Strategy (2013).

No Surface Water Management Plans (SMWPs) have currently been developed for the study area.

13.2.4 Groundwater flood risk

The GeoSmart Groundwater Flood Map identifies that the majority of the study area is at a 'negligible' risk of groundwater flooding. Some 'low' and 'moderate' risk areas are identified around Gatwick Airport, Three Bridges, Forge Wood, North Gate and Langley Green. It should be noted that as this information is based on a national dataset there may be localised differences in groundwater flood risk. Planners and developers should consult the LLFA to find out if they hold any local information.

13.2.5 Sewer flood risk

Historical incidents of sewer flooding are detailed by the Thames Water SFHD. This database records incidents of flooding related to public foul, combined or surface water sewers and identifies which postcode areas have been impacted by flooding. A total of 104 incidents have been recorded. Most frequently flooded postcodes cover areas of Pound Hill, Forge Wood, Maidenbower, Worth and Copthorne, with the majority of recorded instances occurring externally during 1 in 10 and 1 in 20-year events.

The Thames Water Drainage and Wastewater Management Plan identified that all forms of sewer flooding are regarded to be 'at or below the industry acceptability thresholds', meaning there is no significant risk of sewer flooding. The main areas of concern highlighted by the Thames Water analysis are the present-day pollution risk and storm overflow performance for the present day and in the future (linked directly with pollution risks).

13.2.6 Flooding from reservoirs

The Reservoir Flood Maps describe two reservoir flooding scenarios. A "dry day" scenario and a "wet day" scenario. The "dry day" scenario shows the predicted flood extents if a reservoir failure were to occur when river levels are at normal levels. The "wet day" scenario shows the predicted flood extents if reservoir failure were to occur when river levels are already high and extreme fluvial flooding is already occurring. The "wet day" scenario is used to demonstrate the combined effect of fluvial and reservoir flooding due to the potential probability of reservoir failure occurring due to extreme rainfall.

There are seven reservoirs which impact the study area. Three Bridges, Northgate, Langley Green (especially Gatwick Airport), Forge Wood, and Maidenbower are all areas at risk of both Wet Day and Dry Day reservoir flooding.

13.3 Flood defences

A high-level review of formal flood defences was carried out using existing information to provide an indication of their condition and standard of protection. Details of the flood defence locations and condition were provided by the Environment Agency for the purpose of preparing this assessment and can be found in Appendix I.

All defences in the study area provide protection against fluvial flood events, with the majority of the main river sections having channel maintenance along their lengths, as well as various different fluvial defences. Most provide a standard protection of 20% AEP, with a small number of the defences located along Tilgate Brook, Tilgate Lake, Gatwick Stream and the River Mole diversion (around Gatwick Airport) providing a standard of protection up to 0.5% AEP. The Environment Agency defence dataset shows that most defences within the study area are in 'Good' or 'Fair' condition.

13.4 Key policies

There are many relevant regional and local key policies which have been considered within the SFRA, such as the Thames Catchment Flood Management Plan, the Thames River Basin Management Plan, West Sussex Local Flood Risk Management Strategy and Preliminary Flood Risk Assessment. Other policy considerations have also been incorporated, such as sustainable development principles, climate change and flood risk management.

13.5 Development and flood risk

The Sequential and Exception Test procedures for both Local Plans and Flood Risk Assessments have been documented, along with guidance for planners and developers. Links have been provided for various guidance documents and policies published by other Risk Management Authorities, such as the LLFA and the Environment Agency.

14 Recommendations

A review of national and local policies has been conducted against the information collected on flood risk in this SFRA. Following this, several recommendations have been made for Crawley Borough and Horsham District Councils to consider as part of Flood Risk Management in the study area.

14.1 Recommendations for development and flood risk within the study area

14.1.1 Reduction of flood risk through site allocations and appropriate site design

- Locate new development in areas of lowest risk, in line with the Sequential Test, by steering sites to Flood Zone 1. If a Sequential Test is undertaken and a site at risk of flooding is identified as the only appropriate site for the development, the Exception Test shall be undertaken.
- After application of Exception Test, a sequential approach to site design must be used to reduce risk. Any re-development within areas of flood risk which provide other wider sustainability benefits should provide flood risk betterment and be made resilient to flooding.
- Identify long-term opportunities to remove development from the floodplain and to make space for water.
- Ordinary watercourses not currently afforded flood maps should be modelled to an appropriate level of detail to enable a sequential approach to the layout of the development.
- Ensure development is 'safe', dry pedestrian egress from the floodplain and emergency vehicular access should be possible for all residential development. If at risk, then an assessment should be made to detail the flood duration, depth, velocity and flood hazard rating in the 1% AEP plus climate change fluvial flood event, in line with FD2320.
- Raise residential and commercial finished floor levels above whichever is higher of either 300mm above the estimated flood level or 300mm above the general ground level of the site or 300mm above the adjacent road level to the building. If ground floor sleeping accommodation is provided, floor levels should be raised by a minimum of 600mm above the design flood level.
- Protect and Promote Areas for Future Flood Alleviation Schemes.
- Safeguard functional floodplain from future development.
- Identify opportunities for brownfield sites in functional floodplain to reduce risk and provide flood risk betterment.
- Identify opportunities to help fund future flood risk management through developer contributions to reduce risk for surrounding areas.
- Seek opportunities to make space for water to accommodate climate change.

14.1.2 Promote SuDS to mimic natural drainage routes to improve water quality

- SuDS design should demonstrate how constraints have been considered and how the design provides multiple benefits e.g., landscape enhancement, biodiversity, recreation, amenity, leisure and the enhancement of historical features.
- Planning applications for phased developments should be accompanied by a Surface Water Drainage Strategy, which takes a strategic approach to drainage provision across the entire site and incorporates adequate provision for SuDS within each phase.
- Use of the SuDS management train to prevent and control pollutants to prevent the 'first flush' polluting the receiving waterbody.

- SuDS are to be designed so that they are easy to maintain, and it should be set out who will maintain the system, how the maintenance will be funded and should be supported by an appropriately detailed maintenance and operation manual.
- Early consideration of SuDS within master planning will typically allow a more effective scheme to be designed.
- West Sussex County Council should be consulted at an early stage of development to ensure that SuDS are implemented and designed in response to site characteristics and policy factors.

14.1.3 Reduce surface water runoff from new developments and agricultural land

- SuDS should be considered and implemented as part of all new development, in line with the **West Sussex LLFA Policy for the Management of Surface Water.**
- Space should be provided for the inclusion of SuDS on all allocated sites and outline proposals.
- Promote biodiversity, habitat improvements and **Countryside Stewardship schemes** to help prevent soil loss and to reduce runoff from agricultural land.

14.1.4 Enhance and restore river corridors and habitat

- Assess condition of existing assets and upgrade, if required, to ensure that the infrastructure can accommodate pressures / flows for the lifetime of the development.
- Natural drainage features should be maintained and enhanced.
- Identify opportunities for river restoration / enhancement to make space for water.
- A presumption against culverting of open watercourses except where essential to allow highways and / or other infrastructure to cross, in line with CIRIA's Culvert screen and outfall manual, (C786 PR) and to restrict development over culverts.
- There should be no built development within 8m from the top of any Main River or 12m from any Ordinary Watercourse within the study area and 3m from any Thames Water sewer system without prior consent from the relevant party (Environment Agency, the LPA and Thames Water respectively), for the preservation of the watercourse corridor, wildlife habitat, flood flow conveyance and future watercourse maintenance or improvement.
- It should be noted that any proposed alterations to watercourses may require a Flood Risk Activities Permit (FRAP) from the Environment Agency or Ordinary Watercourse Land Drainage Consent from West Sussex County Council.

14.1.5 Mitigate against risk, improved emergency planning and flood awareness

- Work with emergency planning colleagues and stakeholders to identify areas at highest risk and locate most vulnerable receptors away from these areas.
- Exceedance flows, both within and outside of the site, should be appropriately designed to minimise risks to both people and property.
- For a partial or completely pumped drainage system, an assessment should be undertaken to assess the risk of flooding due to any failure of the pumps. The design flood level should be determined if the pumps were to fail; if the attenuation storage was full, and if a design storm occurred.
- An emergency overflow should be provided for piped and storage features above the predicted water level arising from a 100-year rainfall event, inclusive of climate change and urban creep allowances.
- Consideration and incorporation of flood resilience measures up to the 1 in 1,000-year event.

- Ensure robust emergency (evacuation) plans are produced and implemented for major developments.
- Increase awareness and promote sign-up to the Environment Agency Flood Warnings Direct (FWD) within the study area.

14.2 Local Plan Policies

The current **Draft Crawley Borough Local Plan** contains policies relating to flood risk management and development. These include the Strategic Policy EP1: Development and Flood Risk, which covers the need to account for flood risk at all stages in the planning process and to build in resilience to anticipated climatic changes, including the use of sustainable drainage systems (SuDS). In addition, the Non-Strategic Policy EP2: Flood Risk Guidance for Household Development and Minor Non-Residential Extensions, details the requirements for Flood Risk and Resilience statements for any householder development, minor non-residential extension or minor alterations to a property within Flood Zone 2 and 3a.

The current **Draft Horsham District Local Plan** includes Strategic Policy 40: Flooding, which covers similar topics regarding the need to account for flood risk at all stages in the planning process, in accordance with the NPPF, and the use and suitability of SuDS.

A review of these policies has been carried out against the findings of this SFRA. The following additional policies and updates to existing policies are recommended for the Local Plans:

14.2.1 Buffer Strips Policy

The provision of buffer strips is important in preserving watercourse corridors, flood flow conveyance and future watercourse maintenance and improvement. It also enables the avoidance of disturbing ecology and the structural integrity of riverbanks.

Developers should:

- Not build within 8m from the edge of bank of any Ordinary Watercourse within the District
- Not build within 8m from the edge of bank of any Main River within the District in accordance with the Environment Permitting Regulations (2016)
- Seek opportunities on a site by site basis to increase these buffer distances to 'make space for water', allowing additional capacity to accommodate climate change.

14.2.2 Sustainable Drainage Policy

- Space should be provided for the inclusion of SuDS on all allocated sites and outline proposals, including non-major development.
- Planning applications for phased developments should be accompanied by a Drainage Strategy, which takes a strategic approach to drainage provision across the entire site and incorporates adequate provision for SuDS within each phase.
- Opportunities should be considered to integrate SuDS into green infrastructure and open spaces.

14.3 Recommendations from the cumulative impact analysis

Policy Recommendation 1: High risk less urbanised catchments with localised flood risk issues

This policy relates to high risk catchments e.g.

- Burstow Stream

This policy is targeted towards a less urbanised catchment with localised flood risk issues. Mapping of this catchment can be found in 12-2.

To minimise cross boundary issues, the recommended policy is to:

- Work closely with neighbouring Local Authorities and the Lead Local Flood Authority to develop complementary Local Planning Policies for the Burstow Stream catchment
- Undertake more detailed drainage strategy work as part of a Level 2 SFRA or detailed local area Strategic Drainage Study to consider further how the cumulative effects of potential peak rates and volumes of water from development sites would impact on peak flows, duration of flooding and timing of flood peaks on receiving watercourses. Such studies could be used to justify greater restrictions / enforce through Local Planning Policy development site runoff rates and volumes specific to each catchment that are over and above those required by National and Local SuDS Standards. They could also identify where there are opportunities with allocated sites to provide off-site betterment e.g. online / offline flood storage and where land should be safeguarded within proposed site allocations to fulfil this purpose.
- Incorporate SuDS and provide details of adoption, ongoing maintenance and management on all development sites. Proposals will be required to provide reasoned justification for not using SuDS techniques, where ground conditions and other key factors show them to be technically feasible. Preference will be given to systems that contribute to the conservation and enhancement of biodiversity and green infrastructure in the study area where practicable.
- Seek to provide wider betterment by demonstrating in site specific Flood Risk Assessments and Surface Water Drainage Strategies what measures can be put in place to contribute to a reduction in flood risk downstream. This may either be by provision of additional storage on site e.g. through oversized SuDS, natural flood management techniques, green infrastructure and green-blue corridors and / or by providing a Partnership Funding contribution towards a wider community scheme. Consultation on the site-specific requirements should be undertaken with the LPA at the earliest opportunity.
- Promote environmental land management practices to attenuate surface water runoff, through methods such as cover crops, riparian borders and infiltration techniques, to alleviate potential issues downstream.
- Promote community resilience in rural areas where immediate assistance following serious flood events might not be possible.
- The LPA should work closely with the Environment Agency and West Sussex County Council as LLFA to identify areas of land that should be safeguarded for the future use of natural flood management features.

Policy Recommendation 2: Medium risk urban catchments

This policy related to medium risk catchments e.g.

- Tilgate Brook and Gatwick Stream at Crawley
- Mole (Horley to Hersham)

This policy is targeted towards catchments where a medium score has been identified based on a high amount of development. Mapping of these catchments can be found in 12-2.

All new development (other than minor extensions) should:

- Incorporate SuDS and provide details of adoption, ongoing maintenance and management on all development sites. Proposals will be required to provide reasoned justification for not using SuDS techniques, where ground conditions and other key factors show them to be technically feasible. Preference will be given to systems that contribute to the conservation and enhancement of biodiversity and green infrastructure in the study area where practicable.
- Seek to provide wider betterment by demonstrating in site specific Flood Risk Assessments and Surface Water Drainage Strategies what measures can be put in place to contribute to a reduction in flood risk downstream. This may either be by provision of additional storage on site e.g. through oversized SuDS, natural flood management techniques, green infrastructure and green-blue corridors and / or by providing a Partnership Funding contribution towards a wider community scheme. Consultation on the site-specific requirements should be undertaken with the LPA at the earliest opportunity.
- West Sussex County Council as LLFA will review Surface Water Drainage Strategies in accordance with their local requirements for major developments. These should take into account all sources of flooding to ensure that future development is resilient to flood risk and does not increase flood risk elsewhere.
- Crawley Borough and Horsham District Councils as LPAs will review Surface Water Drainage Strategies for non-major developments.

APPENDICES

Offices at

Coleshill
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Dublin
Edinburgh
Exeter
Glasgow
Haywards Heath
Isle of Man
Limerick
Newcastle upon Tyne
Newport
Peterborough
Saltaire
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Tadcaster
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