Dartford Borough Level 1 and 2 Strategic Flood Risk Assessment

Final Report

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Dartford Borough Council

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Revision history

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Version 1 / July 2020	Draft Level 1 SFRA Report	Andrea Wright (Dartford Borough Council)
Version 2 / August 2020	Final Level 1 SFRA Report	Andrea Wright (Dartford Borough Council)
Version 3 / October 2020	Final Level 1 and Level 2 SFRA Report	Andrea Wright (Dartford Borough Council)
Version 4 / February 2021	Final Level 1 and Level 2 SFRA Report following comments from Dartford Borough Council	Andrea Wright (Dartford Borough Council)

This report describes work commissioned by Andrea Wright of Dartford Borough Council, by an email dated 14 April 2020. Ffion Wilson, James Axton, Kate Fairfield and Alastair Dale of JBA Consulting carried out this work.

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Purpose

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Acknowledgements

We would like to acknowledge the assistance of:

- Dartford Borough Council
- Kent County Council
- The Environment Agency
- Southern Water
- Thames Water
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Carbon footprint

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Executive summary

Introduction

The study area for this Strategic Flood Risk Assessment (SFRA) is the Dartford Borough Council's authority area. This SFRA 2020 document supersedes the previous 2005 Kent Thameside SFRA and 2008 Dartford Town Centre SFRA.

The main purpose of the SFRA update was to prepare a document that provides comprehensive and supporting evidence for the emerging Dartford Local Plan as well as to inform future updates to the existing plan. At the time of the SFRA preparation the Local Plan is in the consultation stage.

The SFRA update must also be compliant with the latest guidance described in the 2019 update to the National Planning Policy Framework (NPPF), support the selection of site allocations in the emerging Local Plan and provide information and guidance to be used in the preparation of Flood Risk Assessments (FRAs) in support of site specific planning applications.

SFRA objectives

The key objectives of the 2020 SFRA are:

- To provide a robust evidence base to support the Council's emerging Local Plan and inform the assessment of sites in the final Strategic Housing Land Availability Assessment.
- To provide the basis for the application of the Sequential, and if necessary, Exception Tests for developers and planners.
- To provide up to date information and guidance on flood risk in Dartford Borough, taking into account the latest flood risk information (including the probable impacts of climate change), the current state of national planning policy and legislation and relevant studies.
- To identify requirements for site specific flood risk assessments and be suitable to inform the preparation of site specific FRAs.

SFRA outputs

The Planning Practice Guidance advocates a tiered approach to risk assessment and identifies the following two levels of SFRA, of which Level 1 should be completed first:

1. Level 1: 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 2: 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 and Level Two SFRA requirements.

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

- A review and update of new and amended data sources.
- Assessment of all potential sources of flooding
- Assessment of the potential impact of climate on flood risk.
- Mapping areas at risk from other sources including surface water, sewer, ground water, reservoir inundation.
- Mapping of location and extent of functional floodplain.

- 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.
- High-level screening of proposed development sites against flood risk information.
- Guidance for developers including requirements for site-specific flood risk assessments.
- Mapping areas covered by an existing flood alert / warning.
- Identification of opportunities to reduce flood risk which can be included in the Local Plan policies.
- An assessment of surface water management issues and the application of Sustainable Drainage Systems (SuDS).
- Identification of flood defence infrastructure.

Summary of assessment

Flood risk

- Flood risk within Dartford Borough is primarily from fluvial and tidal sources, with surface water, groundwater, sewer and reservoir flooding also a potential risk.
- The study area is bounded by the River Thames to the north and has several watercourses within the Borough, including the River Darent, River Cray and Ebbsfleet River. The River Thames and the lower reaches of the watercourses in the borough are tidally influenced.
- There have been several recorded flood incidents across the study area, with notable fluvial events recorded in 1968, 1993 and 2002/03, as well as notable tidal events recorded in 1953 and 1978.
- The Environment Agency's 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 ponding in low lying areas.
- The Areas Susceptible to Groundwater Flooding indicates that the susceptibility to groundwater flooding is generally greatest along the routes of the River Darent and River Cray.
- There are 59 historic incidents of sewer flooding in the study area that have been identified from the Southern Water and Thames Water records.
- There are no records of flooding from reservoirs in the study area, with the Risk of Flooding from Reservoirs dataset showing only the area of Dartford Borough around the confluence of the River Darent and River Cray predicted to be at risk.
- There are currently four Flood Alert Areas and six Flood Warning Areas in the Local Plan area.

Flood defences

There are tidal, fluvial and tidal / fluvial flood defences located along the majority of the watercourses in the study area. The standard of protection provided by these assets varies, as does their condition. The Dartford Barrier protects the areas adjacent to the lower reaches of the River Darent and River Cray from tidal flooding.

Climate change

Climate change will not only cause changes in trends and mean values in temperature, rainfall and sea levels but also increase the chance of occurrence and severity of more extreme wet, dry and storm events. It is important that development is planned with consideration of these

extreme events as exemplified by the significant consequences of storm surge events in the sea leading to high tide levels and potentially severe flooding.

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 key policies which have been considered within the SFRA, such as the North Kent Rivers Catchment Flood Management Plan, Thames River Basin Management Plan, the Preliminary Flood Risk Assessment, the TE2100 and Kent Local Flood Risk Management Strategy. Other policy considerations have also been incorporated, such as sustainable development principles, climate change and flood risk management.

Potential modelling improvements

The Environment Agency regularly reviews its flood risk mapping, and it is important to make contact to determine whether updated (more accurate) information is available prior to commencing a site-specific Flood Risk Assessment. Due to the publication of the UKCP18 the Environment Agency is continuing to update their climate change guidance. The Environment Agency should be contacted for the latest guidance on climate change modelling outputs for Flood Risk Assessments.

When using the SFRA to prepare FRAs it is important to check that the most up to date information is used, as is described in amendments to the flood mapping prepared and issued by the Environment Agency at regular intervals.

Use of Strategic Flood Risk Assessment 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.

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 O - Guide to using technical data.

Policy Recommendations

Dartford Borough Council will take account of the following recommendations with respect to flood risk management when preparing appropriate policy.

A. Development and the Local Plan

Sequential approach to development

It is recommended that the sequential approach, which considers all sources of flooding, is adopted for all future developments within 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 the areas of Dartford Borough at high risk of flooding from tidal, surface water (pluvial) and fluvial 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. Dartford Borough Council will use the information in this SFRA when deciding which development sites to take forward in the emerging Local Plan.

B. Site-specific Flood Risk Assessments

The following paragraphs are a summary of the requirements that should be addressed in a Flood Risk Assessment, with more detail provided in Section 9 of the Level One SFRA report.

Site specific Flood Risk Assessments (FRAs) 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.

Where required, developers should undertake more detailed hydrological and hydraulic assessments of the watercourses and tidal areas to verify flood extents (including latest climate change allowances). The modelling will inform floodplain and development zoning within the site and provide evidence that the Exception Test is satisfied if required. Where a site-specific Flood Risk Assessment (FRA) has produced modelling outlines which differ from the Environment Agency's Flood Map for Planning a full evidence-based review would be required. Where the watercourses are embanked, the effect of overtopping and breach must be considered and appropriately assessed.

All new development within the 1% AEP (Annual Exceedance Probability) fluvial flood extent including an allowance for climate change (for the lifetime of the development) must not normally result in a net loss of flood storage capacity to avoid cumulative effects. Where possible, opportunities should be sought to achieve an increase in the provision of floodplain storage. Where proposed development results in a change in building footprint, the developer should normally ensure that it does not impact upon the ability of the floodplain to store or convey water and seek opportunities to provide floodplain betterment. Similarly, where ground levels are elevated to raise the development out of the floodplain, compensatory floodplain storage within areas that currently lie outside the floodplain should normally be provided so the total volume of the floodplain storage is not reduced. Existing buildings should not normally be assumed to exclude floodwater. Any flood risk management measures 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.

A **revised NPPF** was published on 24 July 2018 (and last updated on 19 June 2019) setting out the Government's planning policies for England and how these are expected to be

applied. This revised framework replaces the previous NPPF published in March 2012.

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 (NPPG, Defra)**

It should be noted that the UK Climate Change Projections 2018 (**UKCP18**) was published on 26 November 2018. The UKCP18 projections replace the UKCP09 projections and is the official source of information on how the climate of the UK may change over the rest of this century. This resulted in the Environment Agency climate change allowances being updated in late December 2019. When undertaking an FRA, reference should be made to the most up to date climate change allowances provided by the Environment Agency.

Developers should consult with Dartford Borough Council, Kent County Council, the Environment Agency, and Thames Water / Southern Water at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling, and drainage assessment and design. Additionally, developments within the area potentially affected by TE2100 should seek further pre-application advice from the Environment Agency.

C. Surface water management and SuDS

Planners should be aware of the conditions and requirements set by Kent County Council as the Lead Local Flood Authority for surface water management and ensure development proposals and applications are compliant with the **Kent County Council Drainage and Planning Policy**.

Large parts of Dartford Borough are located within Groundwater Source Protection Zones (GZPZs). Kent County Council and the Environment Agency have confirmed that infiltration is possible within GSPZs 1, 2 and 3. However, this will be constrained within SPZ1 and only clean roof drainage will be permitted. In GSPZ 2 and 3, infiltration is possible for surface run-off from roads, car parking and public or amenity provided the SUDS management train is used to treat the drainage. Further guidance regarding infiltration within GSPZs can be found in the **C753 CIRIA SuDS Manual** (2015) and **the Environment Agency's approach to groundwater protection.**

D. Review of planning applications

The Council should consult the Environment Agency's **'Flood Risk Assessment: Local Planning Authorities'**, (last updated 1 March 2019) and any subsequent updates 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 process and they may, in some cases, also contact non-statutory consultees (e.g. Southern Water, Thames Water) that have an interest in the planning application.

E. 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 1% AEP fluvial event plus an allowance for climate change
- a minimum of 300mm above the 0.5% AEP tidal event plus an allowance for climate change
- 300mm above the general ground level of the site.

Finished Floor Levels for sleeping accommodation should normally be set to whichever is

higher of the following:

- a minimum of 600mm above the 1% AEP fluvial event plus an allowance for climate change
- a minimum of 600mm above the 0.5% AEP tidal event plus an allowance for climate change
- 300mm above the general ground level of the site.

If it is not practical to raise floor levels to those specified above, consultation with the Environment Agency will be required to determine alternative approaches.

Safe access and egress will need to be demonstrated at all development sites. Emergency vehicular access should be possible during times of flood.

Where development is located behind, or in an area benefitting from defences, consideration should be given to the potential safety of the development, finished floor levels and for safe access and egress in the event of rapid inundation of water due to a defence breach with little warning.

Resilience measures will be required if buildings are situated in the flood risk area, and opportunities to enhance green infrastructure and reduce flood risk by making space for water should be sought.

F. Residual risk

Residual risk is the risk that remains after mitigation measures are considered. 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.

Further, any developments located within an area protected by flood risk management measures, where the condition of those defences is 'fair' or 'poor', where the standard of protection is not of the required standard or where the failure of the intended level of service gives rise to unsafe conditions should be identified and appropriate responses identified.

The risk to development from reservoirs is residual but developers should consider reservoir flooding during the planning stage. They should seek to contact the reservoir owner to obtain information and should apply the sequential approach to locating development within the site. Developers should also consult with relevant authorities regarding emergency plans in case of reservoir breach. The long term commitment to management and maintenance of appropriate standards of safety should be established as being appropriate.

G. 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 an amenity and recreational purposes. Development that may adversely affect green infrastructure assets should not normally be permitted. Development should not compromise the ability of future generations to manage flood risk in the way they consider most appropriate.

The information provided in the SFRA should be used as a basis for investigating potential strategic flood risk solutions within the study area. Opportunities could consist of the following:

- Catchment and floodplain restoration;
- Flood storage areas;
- Opening up culverts, weir removal, and river restoration;
- The Regional Habitat Creation Programme;
- Green infrastructure; and

- Preserving the function of surface water flood routes where appropriate.

For successful future flood risk management, it is recommended that the Council adopts a catchment partnership working approach in tackling flood risk and environmental management.

H. Provision of buffer strips

The provision of a buffer strip to 'make space for water', allows additional capacity to accommodate climate change and ensure access to the watercourse, structures and defences is maintained for future maintenance purposes. It also enables the 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 the riverbanks and the building itself, making future maintenance of the river much more difficult. Development should therefore seek to leave an undeveloped margin of 8m next to fluvial watercourses and 16m margin next to tidal watercourses.

Any development within 8m either side of a Main River or within 16m from the foot of any sea defence may require the separate consent of the Environment Agency under local land drainage byelaws.

Additionally, the following points should be noted:

- For development which falls partly or wholly within the tidal flood defence raising zone alongside the River Thames or Dartford Creek careful consideration should be given to proposals in proximity to soft or hard defences as these might be constrained by the space needed to raise those defences in future (the Environment Agency and the Council should be consulted in these circumstances).
- Where appropriate, developments may be expected to incorporate a raised defence in line with TE2100 recommendations. Any new defence should also seek to deliver biodiversity net gain on the frontage.
- Where defences are not being raised to the full TE2100 height, developers will be expected to demonstrate that their proposals do not constrain options for future raising or other flood risk management works. This may involve geotechnical investigations and calculations by a specialist consultant.
- Usually, future maintenance of the defence will be the responsibility of the landowner.

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Abbreviations and glossary of terms

	Definition
ADEPT	Association of Directors of Environment, Economy, Planning and Transport
AEP	Annual Exceedance Probability - the chance of an event with a particular magnitude occurring in each and every year
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
DBC	Dartford Borough Council
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
FZ	Flood Zone
GI	Green Infrastructure
GIS	Geographic Information Service
GSPZ	Groundwater Source Protection Zone
ISIS	Hydrology and hydraulic modelling software
JBA	Jeremy Benn Associates
KCC	Kent County Council
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

	Definition
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.
OS	Ordnance Survey
PFRA	Preliminary Flood Risk Assessment
PFR	Property Flood Resilience
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.
RMA	Risk Management Authority
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 borough which is suitable and deliverable.
SFHD	Sewer Flood History Database
SIRF	Sewage Incident Reporting Form
SMP	Shoreline Management Plan
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

1 Introduction

1.1 Dartford Borough

This Strategic Flood Risk Assessment (SFRA) covers the study area of Dartford Borough. Dartford Borough covers an area of approximately 76km^2 and has an estimated population of over 110,000.

The location of Dartford Borough is shown within Figure 1-1. Dartford Borough consists of two distinct areas; the largely urbanised region north of the A2, and an area of Metropolitan Green Belt south of the A2 containing open countryside and small settlements[1]. The main settlement in the borough is Dartford Town Centre, with other urban settlements including Stone, Swanscombe, Knockhall and Greenhithe.

1.2 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 June 2019), Section 14 paragraph 156)

This Strategic Flood Risk Assessment 2020 document supersedes the previous 2005 Kent Thameside SFRA and 2008 Dartford Town Centre SFRA.

The main purpose of the SFRA update was to prepare a document that provides comprehensive and supporting evidence for the emerging Dartford Local Plan, which is currently in the consultation stage, as well as to inform future updates to the existing plan.

The SFRA update was also required to be compliant with the latest guidance described in the 2019 update to the National Planning Policy Framework (NPPF), support the selection of site allocations in the emerging Local Plan 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 February 2019 (and subsequently amended in June 2019) 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 July 2018 and March 2012.

The key objectives of the 2020 SFRA are:

- To provide a robust evidence base to support the Council's emerging Local Plan and inform the assessment of sites in the final Strategic Housing Land Availability Assessment.
- To provide the basis for the application of the Sequential, and if necessary, Exception Tests for developers and planners.
- To provide up to date information and guidance on flood risk in Dartford Borough, taking into account the latest flood risk information (including the probable impacts of climate change), the current state of national planning policy and legislation and relevant studies.

[1] Dartford Borough Council, Dartford Core Strategy, 2011.

- To identify requirements for site specific flood risk assessments and be suitable to inform the preparation of site specific FRAs.

1.3 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 flood characteristics within a Flood Zone and assessment of other sources of flooding.

This report fulfils the Level One and Level Two SFRA requirements.

1.4 SFRA outputs

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

- A review and update of new and amended data sources.
- Assessment of all potential sources of flooding
- Assessment of the potential impact of climate on flood risk.
- Mapping areas at risk from other sources including surface water, sewer, ground water, reservoir inundation.
- Mapping of location and extent of functional floodplain.
- 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.
- High-level screening of proposed development sites against flood risk information.
- Guidance for developers including requirements for site-specific flood risk assessments.
- Mapping areas covered by an existing flood alert / warning.
- Identification of opportunities to reduce flood risk which can be included in the Local Plan policies.
- An assessment of surface water management issues and the application of Sustainable Drainage Systems (SuDS).
- Identification of flood defence infrastructure.

1.5 SFRA user guide

Table 1-1 outlines the layout and location of information that is included in the 2020 SFRA.

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.

Section	Contents
2. Flood risk policy and strategy	Provides an overview of flood risk policy, legislation and strategy.
3. Roles and Responsibilities of Risk Management Authorities	The roles and responsibilities of Risk Management Authorities (RMAs) in Dartford Borough.
4. Planning policy for local flood risk management	Describes the Sequential Approach and application of Sequential and Exception Tests. Outlines cross boundary issues and considerations.
5. Climate change	Outlines climate change guidance and the implications for Dartford Borough.
6. Sources of information used in preparing the SFRA	Outlines what information has been used in the preparation of the SFRA.
7. Understanding flood risk in the Local Plan area	Introduces the assessment of flood risk and provides an overview of the characteristics of flooding affecting the borough. Provides a summary of responses that can be made to flood risk, together with policy and institutional issues that should be considered.
8. Fluvial and coastal defences	Assessment of existing flood defences and flood risk management measures.
9. 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 Lead Local Flood Authority (LLFA) and the Environment Agency that should be followed.
10. Surface water management and SuDS	Advice on managing surface water run-off and flooding and the application of SuDS.
11. Flood warning and emergency planning	Outlines the flood warning service in the SFRA area and provides advice for emergency planning, evacuation plans and safe access and egress.
12. Strategic flood risk solutions	Overview of possible strategies to reduce flood risk.
13. Level 1 assessment	A summary of the information presented in the site screening table, an overview of areas where flood defences may need improvements to reduce flood risk to the development sites, and an overview of the cumulative impacts of development in the study area.
14. Level 2 assessment	A summary of the sites included in the Level 2 assessment and the information used to assess the flood risk to each site in greater detail to produce site summary
15. Summary	Review of the Level 1 SFRA.
16. Recommendations	Identifies recommendations for the council to consider as part of Flood Risk Management policy.

Section	Contents
Appendix A-K: Flood risk mapping	Maps showing flood risk information from all sources.
Appendix L: Level 1 Site Screening table	Screening table showing the flood risk from all sources to the Level 1 development sites.
Appendix M: Level 2 site summary tables	Summary tables detailing flood risk to sites assessed in the Level 2 SFRA.
Appendix N: Level 2 site mapping	Mapping used to support the Level 2 SFRA.
Appendix O: SFRA user guide	Guidance for using the SFRA to support the planning process.

1.6 Consultation

The following parties have been consulted during the preparation of the Level 1 and Level 2 SFRA:

- Dartford Borough Council
- Kent County Council
- Environment Agency
- Ebbsfleet Development Corporation
- Southern Water and Thames Water
- Natural England
- Neighbouring authorities (Gravesham Borough Council, Sevenoaks District Council, Thurrock Council, Bromley Council, Bexley Council)

1.7 Use of SFRA data

Level 1 SFRAs are high-level strategic documents and do not go into detail on an individual site-specific basis. The primary purpose is to provide an evidence base to inform the Local Plan and any future flood risk policies.

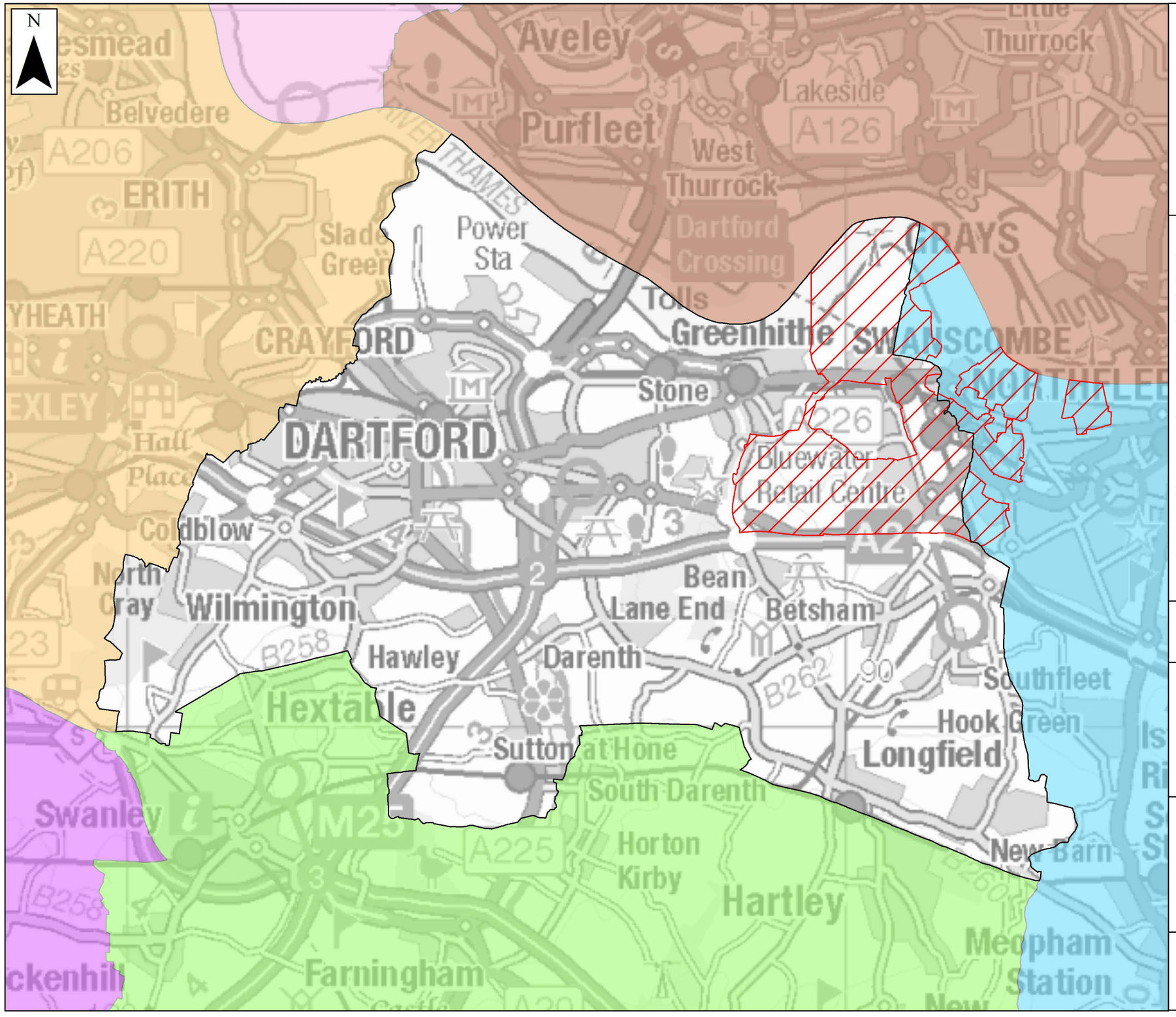
Developers will still be required to undertake site-specific Flood Risk Assessments to support Planning Applications. Developers will be able to use the information in the SFRA to scope out the sources of flood risk that will need to be explored in more detail at site level.

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

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

On the date of publication, the SFRA contains the latest flood risk information. Over time, new information will become available to inform planning decisions, such as updated hydraulic models (which then update the Flood Map for Planning), flood event information, new defence schemes and updates to policy and legislation. Developers should check the online Flood Map for Planning in the first instance to identify any major changes to the Flood Zones.

Figure 1-1: Local Plan area and neighbouring authorities



2 The Planning Framework and Flood Risk Policy

This section sets out the relevant legislation, policy and strategy for Flood Risk Management in Dartford Borough.

2.1 Key legislation for flood and water management

2.1.1 Floods Directive (2007) and Flood Risk Regulations (2009)

The **Flood Risk Regulations** translate the **EU Floods Directive** into UK law. The EU requires 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.

Under the Flood Risk Regulations LLFAs and the Environment Agency have the task of preparing a Preliminary Flood Risk Assessment (PFRA) report every 6 years. As the LLFA, Kent County Council must review the flood risk from local flood sources which includes surface water, groundwater and ordinary watercourses. The Environment Agency must review the flood risk from fluvial and coastal flood risks.

The LLFA **PFRA document** that covers the study area was first published by Kent County Council (KCC) as the LLFA in 2011. In 2011, ten indicative Flood Risk Areas were identified nationally by Defra / the Environment Agency, and as a result of KCC's assessment, none encroached on Dartford Borough Council's Local Plan area.

Under the Regulations, the Environment Agency exercised an 'Exception' in 2011 and did not prepare a PFRA for risk from rivers, reservoirs and the sea. This then made it a requirement for the EA to prepare and publish a Flood Risk Management Plan (FRMP).

In 2017, KCC prepared an **addendum** to the PFRA which updated the 2011 report. The exercise was also carried out in 2018 by the Environment Agency and a further **national study** was prepared to identify potential areas of significant flood risk ("Flood Risk Areas"). The north of Dartford Borough is located within the London and Thames Estuary Flood Risk Area.

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

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

The FWMA created clearer roles and responsibilities and helped to define a more risk-based approach to managing flooding. This included creating a lead role for some LAs, as LLFAs, to have a strategic overview of local flood risk (from surface water, groundwater and ordinary watercourses) and provide a national overview role of all flood risk for the EA.

The content and implications of the FWMA provide 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.

2.1.3 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 2.2.3), which were last published in 2015 and are currently being updated.

Dartford Borough lies within the Thames River Basin District.

2.1.4 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 Dartford Local Plan area is covered by the **Southern Region Land Drainage and Sea Defence Byelaws** and the **Thames Region Land Drainage Byelaws** enforced by the Environment Agency. These Byelaws have effect on functions relating to land drainage in the Southern Water and Thames Water Authority areas for any Main River or sea and tidal defences.

Byelaws relating to Main Rivers within the Southern and Thames Regions cover river control works, the flow of water in rivers, the duties of riparian owners, operations in rivers/ on banks and the placing of vessels in rivers. Byelaws relating to sea and tidal defences within the region cover the prevention of interference with defences, the maintenance and alteration of defences and the control of animals, vessels or acts affecting sea defences (e.g. erections and excavations).

Compliance to the relevant standards must be demonstrated by any developer planning works within proximity of a water body within the Local Plan area.

2.1.5 Additional Legislation

Further legislation related to development and flood risk in Dartford Borough 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).
- The **Environmental Permitting Regulations (2018)**. This sets 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.
- 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.

2.2 Key national, regional and local policy documents and strategies

Table 2-1 summarises key national, regional and local flood risk policy and strategy documents and how these apply to development and flood risk. Figure 2-1 shows how these documents are linked. Hyperlinks are provided to external documents. These documents may:

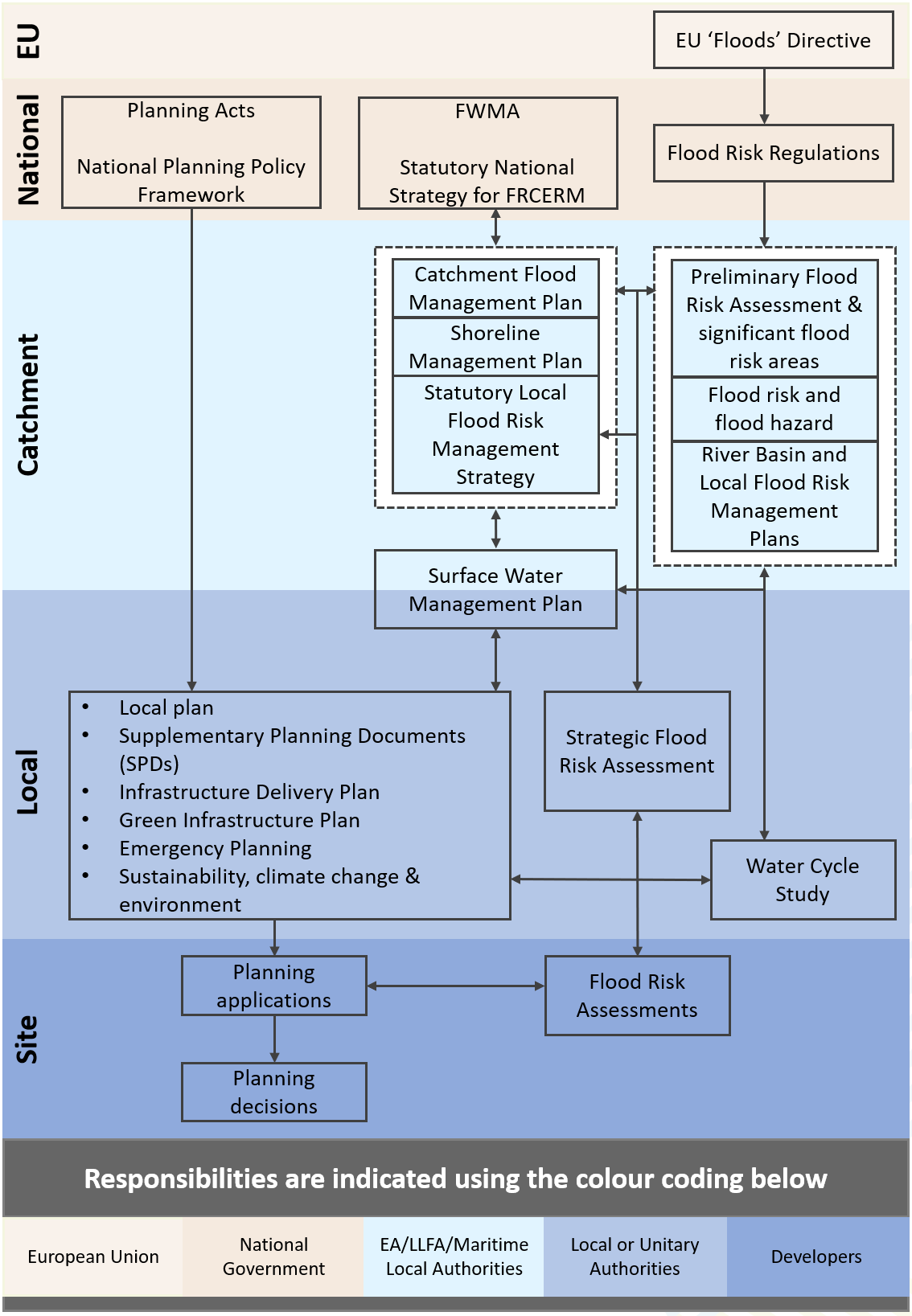
- Provide useful and specific local information to inform Flood Risk Assessments.
- Set the strategic policy and direction for Flood Risk Management (FRM) and drainage – they may contain policies and action plans that set out what future flood mitigation and climate change adaptation plans may affect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

- Provide guidance and/or standards that informs how a developer should assess flood risk and/or design flood mitigation and SuDS.

Table 2-1: 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	**Flood and Coastal Erosion Management Strategy** (Environment Agency) 2020	FWMA (Section 2.1.2)	No	Yes	No	2026
	Natural Flood Management Plans (Environment Agency)	N/A	Yes	No	No	-
	National Planning Policy Framework/Guidance (MHCLG) 2019/2014	Planning and Compulsory Purchase Act 2004 as amended & The Town and Country Planning (Local Planning) (England) Regulations 2012 as amended	No	Yes	Yes	-
Regional	**Thames River Basin District River Basin Management Plan** (Environment Agency) 2016	WFD (Section 2.1.3)	No	Yes	No	2021
	Thames River Basin District Flood Risk Management Plan (Environment Agency) 2016	Flood Risk Regulations (Section 2.1.1)	No	Yes	No	2021
	North Kent Rivers Catchment Flood Management Plan (Environment Agency) 2009	N/A	Yes	Yes	No	-
	TE2100 (Environment Agency) 2011	N/A	Yes	Yes	No	2022
	Climate Change guidance for development and flood risk (Environment Agency) 2019	N/A	No	No	Yes	2020
Local	**Kent Local Flood Risk Management Strategy 2017-2023** (KCC) 2017	FWMA (Section 2.1.2)	Yes	No	No	-
	Kent County Council Drainage and Planning Policy (KCC) 2019	FWMA (Section 2.1.2)	Yes	Yes	No	-
	Kent Thameside Water Cycle Study: Phase 1 2009	N/A	Yes	No	No	-
	Thameside Stage 1 Surface Water Management Plan / Dartford Stage 2 Surface Water Management Plan (KCC) 2013 / 2016	N/A	No	Yes	No	-
	Dartford Core Strategy / Dartford Development Policies Plan (DBC) 2011 / 2017	Planning and Compulsory Purchase Act 2004 as amended & The Town and Country Planning (Local Planning) (England) Regulations 2012 as amended	No	Yes	No	2020
	Drainage and Wastewater Management Plans (Southern Water / Thames Water) due 2023	N/A	Yes	Yes	Yes	2023

Figure 2-1: Strategic planning links and key documents for flood risk



2.2.1 The National Flood and Coastal Erosion Risk Management Strategy for England

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 new Strategy has been in preparation since 2018. The Environment Agency brought together a wide range of stakeholders to develop the strategy collaboratively. The Strategy is more ambitious than the previous one from 2011 and looks ahead to 2100 and the action needed to address the challenge of climate change.

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:

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

2.2.2 Natural Flood Management 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 Dartford Local Plan area and other neighbouring authorities. Discussions about NFM should be had with catchment stakeholders in combination with local knowledge.

2.2.3 River Basin Management Plans

River Basin Management Plans (RBMPs) are prepared under the WFD (Section 2.1.3) and assess the pressure facing the water environment in River Basin Districts. The Local Plan area falls within the **Thames River Basin District River Basin Management Plan** (2016).

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. An assessment of whether deterioration has occurred from the 2015 classification baseline will be carried out in 2021.

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

- Physical modifications
- Managing pollution from waste water
- 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

2.2.4 Flood Risk Management Plans

Under the Flood Risk Regulations (Section 2.1.1), Flood Risk Management Plans (FRMPs) are required. FRMPs set out how organisations, stakeholders and communities will work together to manage flood risk within a catchment.

The FRMP process adopts the same catchments as used in the preparation of River Basin Management Plans (as prepared to meet the requirements of the Water Framework Directive). The Local Plan Area lies within the Thames River Basin District, with most of the borough located within the Darent and Cray management catchment area and the east of borough within the Medway management catchment area.

More detailed strategic information on proposed strategic measures and approaches can be found in the **Thames River Basin District Flood Risk Management Plan** (2016) – Parts A, B and C. The FRMP draws on previous policies and actions identified in the Catchment Flood Management Plans and incorporates information from Local Flood Risk Management Strategies.

2.2.5 Catchment Flood Management Plans

Catchment Flood Management Plans (CFMPs) are a high-level strategic plan 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 Local Plan area is covered by the **North Kent Rivers Catchment Flood Management Plan** (2009). The primary policy units for the Local Plan area are:

- **Policy 1 – North Kent Downs.** Areas of low to moderate fluvial flood risk that will continue to be monitored and advised.
- **Policy 4 – Dartford and Ebbsfleet.** Areas of low, moderate or high flood risk where flood risk is currently managed effectively but further action may be needed to keep pace with climate change.
- **Policy 5 – Shuttle and Upper Cray.** Areas of moderate to high flood risk where further action can be taken to reduce flood risk.
- **Policy 6 – Upper Darent and tributaries.** Areas of low to moderate flood risk where action will be taken to store water or manage runoff to provide overall flood risk reduction or environmental benefits.

2.2.6 Thames Estuary 2100

The Thames Estuary 2100 (**TE2100**) was first published in 2011 outlining the Environment Agency's plans for managing tidal flood risk in the Thames Estuary until 2100. The Local Plan area lies within the Dartford & Erith, and the Swanscombe & Northfleet policy units. These areas are within Policy Zone 4 of the TE2100 plan, where the Environment Agency aim to take further action to keep up with climate and land use change so the flood risk does not increase. The plan outlines recommendations for flood risk management for different action zones across the estuary, with different recommendations for the short, medium, and long term. The action zones of greatest relevance to the Local Plan area are Action Zone 0, which includes strategic estuary wide policy recommendations, and Action Zone 5, which covers the policy units within Dartford Borough.

A five-year review TE2100 plan was published in 2016, concluding a review of the policies and recommendations of the original plan was not necessary at the time. A further review of the full plan is currently being undertaken and it is anticipated that the updated plan will be finalised by 2022.

A further consideration with respect to the TE2100 proposals is the land identified as being required in the future for Flood risk Management. The provisions for these measures should be aligned with the local plan proposals.

2.2.7 Kent Local Flood Risk Management Strategy 2017-2023

Under the Flood and Water Management Act (Section 2.1.2), LLFA's are required to develop, maintain, apply and monitor a Local Flood Risk Management Strategy (LFRMS). Kent County Council as the LLFA are responsible for the LFRMS for Kent, which includes the Local Plan area. The **Kent Local Flood Risk Management Strategy 2017-2023** (2017) sets out the strategic vision for local flood risk management in Kent.

The 2017 LFRMS builds upon the previous version, the **Kent County Council Local Flood Risk Management Strategy**, published in 2013.

2.2.8 LLFAs, surface water and SuDS

On 18 December 2014 a **Written Ministerial Statement** from the Secretary of State for Communities and Local Government set out changes to the planning process that would apply for major development from 6 April 2015. These were implemented in the **Town and Country Planning (Development Management Procedure) (England) Order 2015**.

Major developments are 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 1 hectare or more.

When considering planning applications, Local Planning Authorities should consult the LLFA on the management of surface water so that:

- the proposed minimum standards of operation are appropriate
- there are clear arrangements for on-going maintenance over the development's lifetime, through the use of planning conditions or planning obligations.

As LLFA, KCC has a strategic overview role for local flood risk, which involves flooding from surface water, groundwater and ordinary watercourses. The **Kent County Council Drainage and Planning Policy** sets out the requirements that KCC has for drainage strategies and surface water management provisions relating to development applications.

2.2.9 Water quality

The **Kent Thameside Water Cycle Study: Phase 1** (2009) was published to aid the sustainable development of the Thameside area, covering Dartford Borough and Gravesham. The study assesses the capacity for new development in the Thameside area in regard to water resources / supply, and water quality, stating that there are no ultimate environmental or water infrastructure constraints to planned development for the period up to 2026. The report also provides recommendations for the implementation of Sustainable Drainage Systems (SuDS) to manage attenuation volumes.

2.2.10 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.

The SWMPs applicable to the Local Plan area are summarised below. The outcomes and actions from these SWMPs should be considered in the context of proposed developments within their study areas.

Thameside Stage 1 Surface Water Management Plan

The **Thameside SWMP** (2013) was undertaken by Kent County Council to investigate the local flood risks in Dartford and Gravesham as part of their role in understanding local flood risk management in Kent.

In the SWMP Dartford Borough is split into two Drainage Areas, Dartford Town in the north of the borough and Dartford Rural in the south. The SWMP uses historic records of flooding and flood risk mapping to identify high risk areas that have experience flooding from local sources.

The plan outlines recommendations for actions for the reduction of flood risk, including generic actions applicable to the whole Thameside SWMP area and location specific actions targeted to locations identified as having experienced previous flooding from local sources. The action plan details the partners or stakeholders involved for each

action, as well as the indicative costs and associated timescales. The Stage 1 SWMP also recommended a detailed SWMP be completed for the Dartford Town Drainage Area.

Dartford Stage 2 Surface Water Management Plan

The **Dartford Stage 2 SWMP** (2016) was undertaken following the recommendation of the Stage 1 SWMP with the objective of providing a detailed understanding of the causes and consequences of surface water flooding and to assess potential mitigation measures.

Flood hotspots were identified using historic flood records and surface water flood mapping. Potential options to mitigate flood risk in Dartford were identified with the costs and benefits of each measure assessed. This assessment was used to recommend actions for reducing flood risk across Dartford, again with generic action for the whole of Dartford and with location specific actions targeted at the hotspots.

2.2.11 Drainage and Wastewater Management Plans

Southern Water and Thames Water are currently preparing Drainage and Wastewater Management Plans (DWMP) that will include the Local Plan area. The DWMPs are intended to provide the basis for long-term planning involving all organisations with interests and / or responsibilities relating to drainage, flooding, and protection of the environment. It is anticipated these will be published in 2023 and should be referred to once available.

2.3 Local Plan policies

Adopted Local Plan

The **Dartford Core Strategy (2011)** and **Dartford Development Policies Plan (2017)** provide the policy framework and long-term strategy to manage development, promotes sustainable growth, deliver infrastructure, and maintain and enhance Dartford's heritage, open space and existing or emerging residential neighbourhoods. The key policies relating to flood risk and drainage are:

- **Policy CS 24** - Flood Risk
- **Policy CS 25** - Water Management
- **Policy DP11** - Sustainable Technology and Construction

Additional relevant policies include:

- **Policy CS 2** - Dartford Town Centre
- **Policy CS 3** - Northern Gateway Strategic Site
- **Policy CS 5** - Ebbsfleet Valley Strategic
- **Policy CS 6** - Thames Waterfront
- **Policy CS 12** - Network of Shopping Centres
- **Policy CS 14** - Green Space
- **Policy CS 20** - Gypsies and travellers
- **Policy DP2** - Good Design in Dartford
- **Policy DP10** – Gypsy, Traveller and Travelling Showpeople Accommodation

Emerging Local Plan

Dartford Borough Council are currently preparing an updated Local Plan to inform planning and infrastructures within the borough up to 2037. The emerging document should be referred to for the latest requirements for development applications once available.

3 Roles and responsibilities of Risk Management Authorities

The roles and responsibilities of Risk Management Authorities (RMAs) in Dartford Borough, as described in the Flood Risk Regulations (2009) and Flood and Water Management Act (2010) are outlined in this section.

3.1 Dartford Borough Council

As a Local Planning Authority, Dartford Borough Council assess, consult on and determine whether development proposals are acceptable, so that flooding and other similar risks are effectively managed.

The council will consult relevant statutory consultees as part of planning application assessments and may, in some cases, also contact non-statutory consultees, such as Southern Water, that have an interest in the planning application.

3.2 Environment Agency

The Environment Agency is responsible for protecting and enhancing the environment and contributing to the government's aim of achieving sustainable development in England and Wales. In terms of flood risk, the Environment Agency has a strategic overview of all sources of flooding and coastal erosion. Examples of this strategic overview role include:

- Setting the direction for managing the risks through strategic plans;
- Providing evidence and advice to inform Government policy and support others;
- Working collaboratively to support the development of risk management skills and capacity; and
- Providing a framework to support local delivery.

The Agency also has operational responsibility for managing the risk of flooding from main rivers, reservoirs, estuaries and the sea. The Agency also provides coastal erosion management where this is provided in conjunction with the implementation of coastal flood defences, such as in the Thames Estuary. The Environment Agency has powers to carry out flood and coastal risk management work and to regulate the actions of other flood risk management authorities on the coast. These powers are permissive, which means they are not a duty.

The Environment Agency also has powers to regulate and consent works. You must follow the environmental permitting rules if you want to do work:

- on or near a main river
- on or near a flood defence structure
- in a flood plain
- on or near a sea defence

Further details on Environment Agency permits can be found on the **Environment Agency's Flood risk activities: environmental permits** website.

3.3 Kent County Council

As the Lead Local Flood Authority (LLFA) for the area, Kent County Council's duties and powers include:

- Local Flood Risk Management Strategy (LFRMS): LLFAs must develop, maintain, apply and monitor a LFRMS to outline how they will manage flood risk, identify areas vulnerable to flooding and target resources where they are needed most.

- Flood Investigations: When appropriate and necessary LLFAs must investigate and report on flooding incidents (Section 19 investigations).
- Register of Flood Risk Features: LLFAs must establish and maintain a register of structures or features which, in their opinion, are likely to have a significant effect on flood risk in the LLFA area.
- Designation of Features: LLFAs may exercise powers, as all RMAs can, to designate structures and features that affect flood risk, requiring the owner to seek consent from the authority to alter, remove or replace it.
- Consenting: When appropriate, LLFAs will perform consenting of works on ordinary watercourses. Further details can be found on the **KCC land drainage website**.
- Regulation: The LLFA has enforcement powers under the Land Drainage Act 1991 and FWMA 2010.

KCC is also the Local Highway Authority and manages highway drainage, carrying out maintenance and improvement works on an on-going basis, as necessary, to maintain highway assets, making appropriate allowances for flood risk and climate change. It also has the responsibility to ensure road projects cause no increased flood risk. KCC are statutory consultees with respect to surface water management in proposed new development. **KCC's sustainable drainage in planning website** provides further information and advice.

3.4 Water and wastewater providers

Southern Water and Thames Water both operate as sewerage undertakers within the Local Plan area. Southern Water covers Gravesham and Swanscombe while Thames Water is responsible for the sewers in Dartford. The sewerage undertakers have the responsibility to maintain surface, foul and combined public sewers to ensure the area is drained effectively. When flows (foul or surface water) are proposed to enter public sewers, Southern Water and Thames Water will assess whether the public system has the capacity to accept these flows as part of their pre-application service. If there is not available capacity, they will provide a solution that identifies the necessary mitigation. The water authorities can also comment on the available capacity of foul and surface water sewers as part of the planning application process although this is not a statutory role.

Early discussions with Southern Water or Thames Water are recommended so they can plan upgrades to infrastructure and sewer capacity in line with Developer's phasing plans.

For further details about developer services and relevant application forms please see **Southern Waters Developer Services website** and **Thames Waters Developer Services Website**.

3.5 Ebbsfleet Development Corporation

Ebbsfleet Development Corporation is the planning authority, set up by central government, which is responsible for development control in Ebbsfleet Garden City. Ebbsfleet Garden City will include the delivery of up to 15,000 homes and create 30,000 jobs in north Kent. The location of Ebbsfleet Development Corporation's authority area is shown in Figure 1-1

Dartford Borough Council maintain responsibility for strategic planning in the area and is the main point of contact for the Local Plan and SFRA.

4 Planning policy for flood risk management

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

4.1 National Planning Policy Framework and Guidance

The **revised National Planning Policy Framework** (NPPF) was published in February 2019 (and subsequently amended in June 2019), 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"

National **Planning Practice Guidance (PPG)** on flood risk was published in March 2014 (and has since been revised / updated) and sets out how the policy should be implemented. **Diagram 1 in the PPG** sets out how flood risk should be considered in the preparation of Local Plans.

4.2 The sequential, risk-based approach

This approach is designed to ensure areas with little or no risk of flooding (from any source) are developed in preference to areas at higher risk, with the aim of keeping development outside of medium and high flood risk areas (Flood Zones 2 and 3) and other sources of flooding, where possible. In the long term this will strategically reduce the reliance on flood risk management measures and avoid commitment to the long term investment required so the measures maintain appropriate standards of safety under climate change conditions.

When drawing up a Local Plan, it is often the case that it is not possible for all new development to be allocated on land that is not at risk from flooding. In these circumstances the Flood Zone maps, which show the extent of inundation without the presence of defences, are too simplistic. Thus, a greater understanding of the scale and nature of the actual flood risks is required as the Flood Zones do not take account of the effect of flood risk management measures.

4.2.1 Flood Zones

The NPPF Flood Risk and Coastal Change Guidance identifies four main Flood Zones, which apply to both Main River and Ordinary Watercourses. The four main Flood Zones are summarised in Table 4-1.

Table 4-1: Flood Zone descriptions

Zone	Probability	Description
Zone 1	Low	This zone comprises land assessed as having a less than 0.1% AEP (1 in 1000 annual probability of river or sea flooding in any year) for the present day.
		All land uses are appropriate in this zone.
		For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a flood risk assessment.
Zone 2	Medium	This zone comprises land assessed as having between a 0.1% - 1% AEP (1 in 100 and 1 in 1,000 annual probability of river flooding) or between a 0.1% – 0.5% AEP (1 in 200 and 1 in 1,000 annual probability of sea flooding) for the present day.
		Essential infrastructure, water compatible infrastructure, less vulnerable and more vulnerable land uses (as set out by NPPF) are appropriate in this zone. Highly vulnerable land uses are allowed as long as they pass the Exception Test.
		All developments in this zone require an FRA.
Zone 3a	High	This zone comprises land assessed as having a greater than a 1.0% AEP (1 in 100 annual probability of river flooding) or a greater than a 0.5% AEP (1 in 200 annual probability of flooding from the sea) in any year for the present day. Developers and the local authorities should seek to reduce the overall level of flood risk, relocating development sequentially to areas of lower flood risk and attempting to restore the floodplain and make open space available for flood storage.
		Water compatible and less vulnerable land uses are permitted in this zone. Highly vulnerable land uses are not permitted. More vulnerable and essential infrastructure are only permitted if they pass the Exception Test.
		All developments in this zone require an FRA.
Zone 3b	Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood for the present day. Local planning authorities should identify, in their SFRA, areas of functional floodplain, in agreement with the Environment Agency. The identification of functional floodplain should take account of local circumstances.
		Only water compatible 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. They must also be safe for users and not increase flood risk elsewhere. Essential Infrastructure will only be permitted if it passes the Exception Test.
		All developments in this zone require an FRA.

4.3 Applying the Sequential Test and Exception Test in the preparation of the Local Plan

When preparing a Local Plan, the Local Planning Authority should demonstrate it has considered a range of site allocations, using the SFRA when applying the Sequential and Exception Tests as appropriate.

The Sequential Test should be applied to the whole Local Planning Authority area to increase the likelihood of allocating development in areas not at risk of flooding.

It is recommended that the Council considers the climate change maps to understand how the Flood Zones are predicted to change over the lifetime of the development. These maps can give an indication of the future Flood Zones.

In accordance with the NPPF guidance the Sequential Test should use the present-day flood zones (Flood Zones 1, 2, 3a and 3b) for the consideration of site allocations and windfall sites. Within each flood zone, the sequential approach should be applied to the location of development within a site in areas known to be at risk now or in the future from any form of flooding.

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. NPPF Planning Practice Guidance for Flood Risk and Coastal Change describes how the **Sequential Test should be applied in the preparation of the Local Plan** (see Figure 4-1).

The Exception Test should only be applied following the application of the Sequential Test and as set out in Table 3 of the 2014 NPPF Planning Practice Guidance: Flood Risk and Coastal Change. The NPPF Guidance describes **how the Exception Test should be applied in the preparation of a Local Plan** (Figure 4-2).

Figure 4-1: Applying the Sequential Test in the preparation of a Local Plan

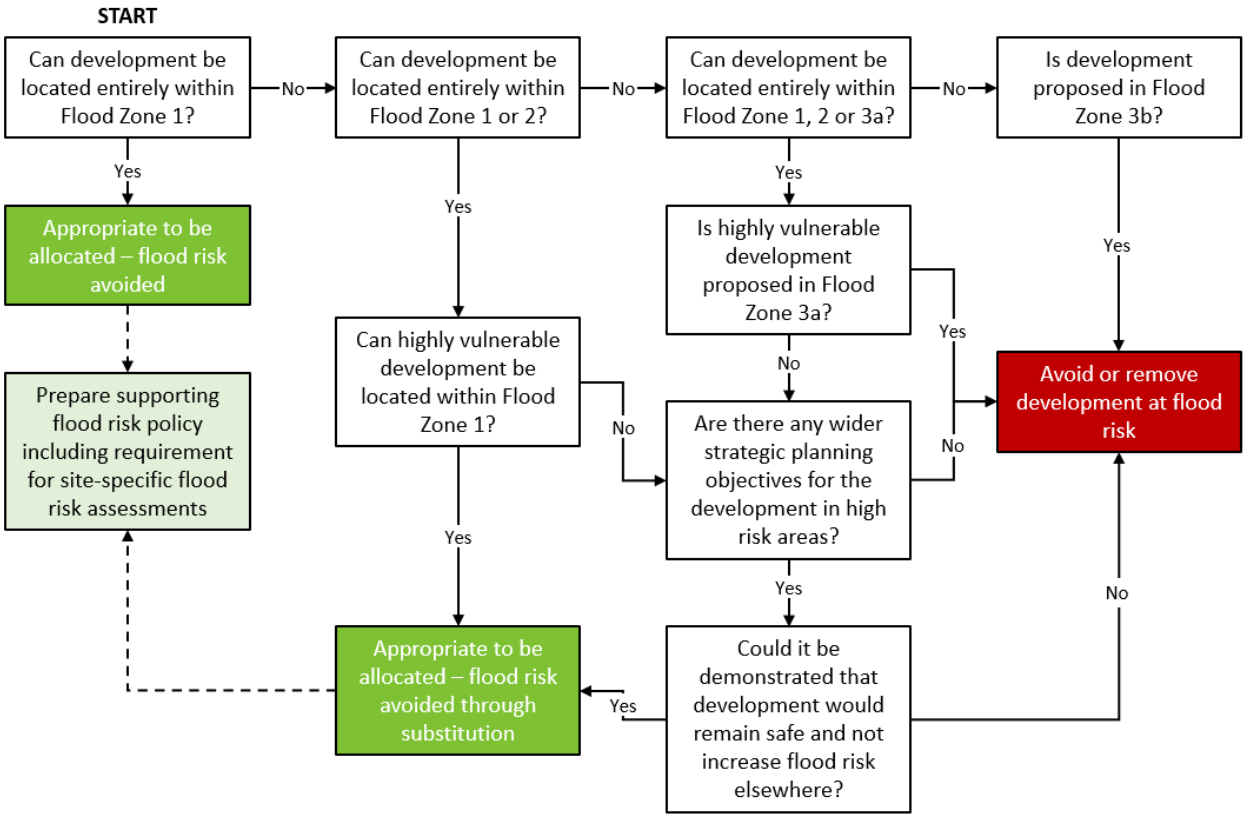
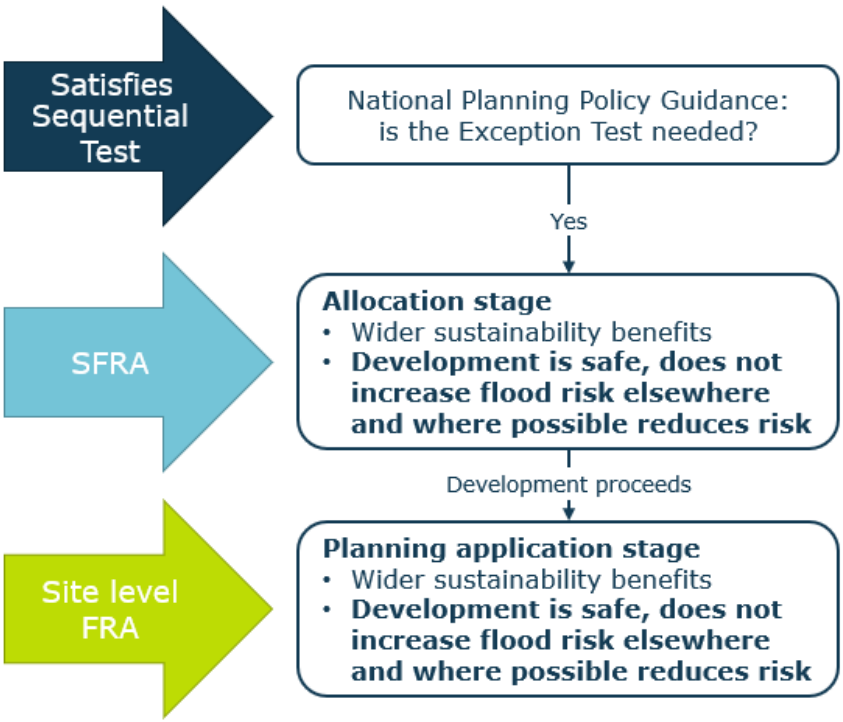


Figure 4-2: Applying the Exception Test in the preparation of a local plan



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

The NPPF Planning Practice Guidance sets out how developers and planners need to consider flood risk to, and from, the development site, following the broad approach of assessing, avoiding, managing and mitigating flood risk. A checklist for site-specific Flood Risk Assessments is provided in Paragraph 68 of the Guidance.

A site-specific Flood Risk Assessment should be carried out to assess all sources of flood risk to, and from, a development. The assessment should demonstrate how flood risk will be managed over a development's lifetime, taking climate change and the user vulnerability into account. The latest Environment Agency guidance for climate change allowances should be referred to. A Flood Risk Assessment should also consider the cumulative impact of the development, so flood risk is not exacerbated.

The NPPF Planning Practice Guidance sets out the following objectives for a site-specific Flood Risk Assessment which can be found in Section 9.2.3.

Sequential Test

The Sequential Test must be performed when considering the placement of future development and for planning application proposals. The sequential approach to locating development should be followed for all sources of flooding. The Flooding and Coastal Change Planning Practice Guidance to the NPPF gives detailed instructions on how to perform the test.

The Sequential Test does not need to be applied for individual developments under the following circumstances:

- The site has been identified in development plans through the Sequential Test
- Applications for minor development (as described in Paragraph 46 of the NPPG) or change of use (except for a change of use to a caravan, camping or chalet site, or to a mobile home or park home site)

It is normally reasonable to presume and state that individual sites that lie in Zone 1 satisfy the requirements of the Sequential Test. Consideration should be given to risks from all sources, areas with critical drainage problems and critical drainage areas. Also, in some circumstances the zone mapping might not have been prepared for small local watercourses making it appear as if land is in Zone 1, when in fact the presence of such features introduces the risk of flooding. At such locations an FRA should be prepared to establish the extent of the Zones, based on site specific local modelling and included in the FRA. The outputs can then be used, as necessary to perform the sequential and exception tests.

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. Whilst for some sites this may be clear, in other cases it may be identified by other local plan policies. A pragmatic approach should be taken when applying the Sequential Test and should be agreed with the Council.

Dartford Borough Council, with advice from the Environment Agency, are responsible for considering the extent to which Sequential Test considerations have been satisfied and will need to be satisfied that the proposed development would be safe and not lead to increased flood risk elsewhere.

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 deemed appropriate. The aim of the Exception Test is to ensure that more vulnerable uses, such as residential development can be implemented safely and are not located in areas where the hazards and consequences of flooding are inappropriate. For the test to be satisfied, the following two elements have to be accepted for development to be allocated or permitted:

1. It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared.

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].

2. A site-specific Flood Risk Assessment must demonstrate 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 people will not be exposed to hazardous flooding from any source. The details of what is expected to be included in a Flood Risk Assessment are outlined in Section 9.

The **NPPF** provides detailed information on how the Test can be applied.

4.5 Actual flood risk

If it has not been possible for all future development to be situated in Zone 1 then a more detailed assessment is needed to understand the implications of locating proposed development in Flood Zones 2 or 3. This is accomplished by considering information on the "actual risk" of flooding. The assessment of actual risk takes account of the presence of flood defences or flood risk management measures and provides a picture of the safety of existing and proposed development. It should be understood that the standard of protection afforded by flood defences and flood risk management measures is not constant and it is presumed that the required minimum standards for new development are:

- residential development should be protected against flooding with an annual probability of river flooding of 1% AEP (1 in 100-year chance of flooding); and
- residential development should be protected against flooding with an annual probability of tidal (sea) flooding of 0.5% AEP (1 in 200-year chance of flooding) in any year.

The assessment of the actual risk should take the following issues into account:

- The level of protection afforded by existing defences might be less than the appropriate standards and hence may need to be improved if further growth is contemplated.
- The flood risk management policy for the defences will provide information on the level of future commitment to maintain existing standards of protection. If there is a conflict between the proposed level of commitment and the future needs to support growth, then it will be a priority for the Flood Risk Management Strategy to be reviewed.

2 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 037, Reference ID: 7-056-20140306) March 2014

- The standard of safety must be maintained for the intended lifetime of the development. FRAs should clearly state the intended lifetime of the development so that planning decisions can be made on long term sustainability. Over time the effects of climate change may reduce the standard of protection afforded by defences, due to increased river flows and levels, and so commitment is needed to invest in the maintenance and upgrade of defences if the present-day levels of protection are to be maintained and where necessary land secured that is required for affordable future flood risk management measures.
- The assessment of actual risk can include consideration of the magnitude of the hazard posed by flooding. By understanding the depth, velocity, speed of onset, rate of rise and duration of floodwater it is possible to assess the level of hazard posed by flood events from the respective sources. This assessment will be needed in circumstances where a) the consequences of flooding need to be mitigated or b) where it is proposed to place lower vulnerability development in areas of flood risk.

4.6 Residual flood risk

Residual risk refers to the risks that remain after measures have been taken to alleviate flooding (such as flood defences). It is important that these risks are quantified to confirm that the consequences can be safely managed. 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 the defences or flood risk management measures to perform their intended duty. This could be breach failure of flood embankments, failure of flood gates to operate in the intended manner, failure of pumping stations or blockage of structures and assets by debris.

4.7 Cumulative impacts

When allocating land for development, consideration must be given to the potential cumulative impact of development on flood risk. The increase in impermeable surfaces and resulting rise in runoff increases the chances of surface water flooding if suitable mitigation measures, such as SuDS, are not put in place. Additionally, the increase in runoff may result in more flow entering watercourses, increasing the risk of fluvial flooding downstream at locations already vulnerable to the magnitude and volume of flood flows. At locations that are tidally influenced such as Dartford the effect on the performance of drainage systems affected by tide locking (or pumped drainage systems) might result in circumstances where cumulative effects are material.

Consideration must also be given to the potential cumulative impact of the loss of floodplain as a result of development. The effect of the loss of floodplain storage should be assessed, at both the development and elsewhere within the catchment and, if required, the scale and scope of appropriate mitigation should be identified.

Whilst the increase in runoff, or loss in floodplain storage, from individual developments may only have a minimal impact on flood risk, the cumulative effect of multiple developments may be more severe without appropriate mitigation measures.

For windfall sites which have not yet been allocated, the NPPF requires that the cumulative impact of development should be considered at the application stage and the appropriate mitigation measures undertaken to ensure flood risk is not

exacerbated, and in many cases the development should be used to improve the flood risk.

To address cumulative effects it will often be a requirement to consider the effects of development across the wider catchment and not just at the locations where development is planned.

4.8 Cross boundary considerations

The topography and location of the borough means that there are several watercourses and overland flow routes that cross the Dartford Borough boundary. As such, future development, both within and outside the borough, can have the potential to affect flood risk to existing development and surrounding areas, depending on the effectiveness of SuDS and drainage implementation. Dartford Borough has boundaries with various Local Authorities, displayed in Figure 1-1.

5 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.

5.1 Climate change, the NPPF and NPPG

The updated NPPF sets out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change. The NPPF states that new development should be planned for in ways that avoids vulnerability to the range of effects that result from climate change.

NPPF and NPPG describe how FRAs should demonstrate how flood risk will be managed over the lifetime of the development, taking climate change into account.

The NPPF 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 158).

5.2 Revised climate change guidance

The Environment Agency published **updated climate change guidance** on 19 February 2016 (further updated in February 2020 and March 2020) , 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.

5.3 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. 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 is the official source of information on how the climate of the UK may change over the rest of this century. The Environment Agency have already updated the climate change allowances for sea level rise to take account of the UKCP18 projections and further updates for peak river levels rainfall intensity are expected by the end of 2020.

For the purposes of the 2020 Level 1 SFRA the 2016 allowances have been considered. Any changes which impact on this SFRA will be added as an addendum after the release of the updated peak river level predictions, which are expected by the end of 2020.

5.4 Peak river flows

Climate change is expected to increase the frequency, extent and impact of flooding, reflected in peak river flows. 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. Also influential for Dartford is the predicted increase in mean sea level, as predicted flood levels along extensive lengths of the estuary reaches of rivers are greatly affected by tide levels.

For the purposes of this SFRA, the peak river flow allowances provided in the **2016 Environment Agency guidance** (updated in March 2020) have been used where readily available.

These allowances show the anticipated changes in peak flow in the Environment Agency river basin districts. The borough is located within the Thames River Basin District. Maps showing the extent of River Basins are **published by the Environment Agency**.

The guidance provides uplift in peak flows based on percentiles. A percentile is a measure used in statistics indicating the value below which a given proportion (percentage) of all observations in a set of results falls. For flood risk it is a way of taking account of the uncertainty in the methods and data used to define predicted flood water level results as generated for climate change conditions. The higher the percentile the more likely it is that the range of statistically generated results will lie within the specified threshold. Whereas a lower percentile will not encompass such a wide range of statistically generated values and thus the predicted flood water level would be lower.

The percentiles are based on the following:

- Central allowance is based on the 50th percentile (so only contains half of the total number of results generated)
- Higher central is based on the 70th percentile
- Upper end is based on the 90th percentile

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 2115)

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 paragraph 26 of the **NPPG**.

At the time of preparing the SFRA this guidance was being revised in line with the **UKCP18**. The Environment Agency should be contacted for the latest guidance if you are preparing a flood risk assessment for a development.

5.5 Peak rainfall intensity allowance

Climate change is predicted to result in wetter winters and increased summer storm intensity in the future. This increased rainfall intensity will affect land and urban drainage systems, resulting in surface water flooding, due to the increased volume of water entering the systems.

At the time of the preparation of this SFRA the peak rainfall intensity allowances were reviewed by the Environment Agency due to the publication of the **UKCP18**. The

Environment Agency should be contacted for the latest guidance for Flood Risk Assessments.

5.6 Tidal/coastal change

The **Environment Agency's sea level allowances** have been used to update the North Kent Coast model in the preparation of this report as confirmed by the Environment Agency. Updated modelling has been prepared for the 0.5% AEP tidal event for 2070 and 2120 for both the higher central and upper end allowances.

5.7 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.

5.8 The impact of climate change in the Local Plan area

5.8.1 Previous studies

The **UKCP18** provides a number of future projections for different variables across the UK. Climate change will cause changes in trends and mean values in temperature and rainfall.

However, 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, dry, and storm events. It is important that development is planned with consideration of these extreme events.

5.8.2 Adapting to climate change

NPPG Climate Change contains information and guidance for how to identify suitable mitigation and adaptation measure 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 the county level, KCC adopted the **Kent Environment Strategy** in 2016. The strategy's priorities include integrating strategy and policy, changing behaviours, conserving and enhancing natural resources, improving resource efficiency, improving resilience to environmental change, and encouraging sustainable growth. Supporting the strategy, the **Kent State of the Environment Report: Evidence Base Supporting the Strategy** provides statistics and information about Kent, including greenhouse gas emissions, energy consumption, waste and flood risk.

6 Sources of information used in preparing the SFRA

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

6.1 Historic flood risk

The historic flood risk in the Local Plan area has been assessed using information provided by the Environment Agency's recorded flood outline dataset, and Southern Water's and Thames Water's records of reported flood incidents. This has been supplemented with other information collected during the preparation of the SFRA. The key considerations from these sources are outlined in Section 7.1, the Environment Agency's recorded flood outlines are presented in Appendix B.

6.2 Flood Zones

The Flood Zones described in Section 4.2.1 should be used for the basis for decision making in the emerging Local Plan.

6.2.1 Delineation of Flood Zone 3b

Where available, detailed modelling results have been used to delineate Flood Zone 3b, showing flood risk that accounts for the presence of existing flood risk management features and flood defences, unlike the Zones 3a and 2 (which do not take account of defences). The mapping in the SFRA identifies Flood Zone 3b as land which would flood with a 5% AEP, where detailed modelling exists.

Modelling of some small watercourses and drains located in Dartford Borough has not previously been prepared by the Environment Agency. Therefore, flood risk from these watercourses is not included in the delineation of Flood Zone 3b, and the area surrounding the watercourses is not shown on the mapping as 'functional floodplain' (If development is proposed at such locations an FRA should identify the area of the site that is within 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.

Flood Zone mapping for the Local Plan area can be found in Appendix D.

Care should be taken when interpreting how Flood Zone 3b is predicted to change as a consequence of climate change effects, particularly at locations where the risk of flooding is affected by a change to the mean sea level. At such locations it is possible that the assessment performed to estimate the frequency of inundation (1 in 20 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.

6.3 Flood risk models used in this SFRA

Table 6-1 lists the flood risk modelling used to inform the SFRA. A list of the watercourses located within Dartford Borough are found in Section 7.3 and are shown in Appendix C.

Table 6-1: Flood risk models used in the SFRA

Model name	Model Type	Year	Software (type)
Dartford and Crayford	Fluvial / Tidal	2020	Flood Modeller / TUFLOW
Darent and Cray	Fluvial / Tidal	2019	Flood Modeller / TUFLOW
Ebbsfleet	Fluvial	2015	ISIS-TUFLOW
North Kent Coast	Tidal	2019	Flood Modeller / TUFLOW

Additionally, the 2018 Thames Estuary Breach Assessment study has been used to understand the residual flood risk to the Local Plan area from a breach of tidal flood defences along the River Thames. Breach modelling carried out as part of the 2020 Dartford and Crayford modelling study has also been used to assess the residual flood risk from a breach of the fluvial / tidal defences along the lower reaches of the River Darent and River Cray.

6.4 Climate change

The **Environment Agency 2016 climate change guidance** shows that for watercourses in the Thames River Basin District the 25%, 35% and 70% allowances should be considered. For further information on climate change allowances please refer to Section 5.3.

As part of this SFRA, the North Kent Coast model was updated with the latest climate change allowances for the 2070 and 2120 epochs.

Tidal climate change mapping from the 2020 Dartford and Crayford modelling study was also used in the assessment on the impact of climate change on flood risk. However, the modelled extents were not included in the mapping shown in Appendix E as they were less extensive than the results from the other modelling studies.

Table 6-2: Climate change allowances used for each model

Model	Allowances
Darent and Cray	25%, 35% and 70%
Ebbsfleet	25%, 35% and 70%
North Kent Coast (2019)	2070 and 2120 epochs

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.

2018 Thames Estuary Breach Assessment includes breach scenarios for the 0.5% and 0.1% AEP events for the 2115 epochs. According to the NPPF, developers should consider the lifetime of development for residential property to be 100 years. The Environment Agency have confirmed that for the purposes of the SFRA the 2115 epoch should be used for the purposes of this SFRA.

6.5 Surface Water

Mapping of surface water flood risk in Dartford Borough Council's Local Plan 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 6-3.

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 6-3: Surface water risk categories used in the RoFSW mapping

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

Although the RoFSW offers an 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 Local Plan area can be found in Appendix F.

6.5.1 Surface water flood risk with climate change uplifts

Additional 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 2016 climate 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 central and upper end allowances are 20% and 40% respectively.

Therefore, 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 Dartford Borough.

Mapping showing the extents of the 1% AEP plus 20% and 40% climate change scenarios can be found in Appendix G.

6.6 Groundwater

The risk of groundwater flooding has been analysed using the Areas Susceptible to Groundwater Flooding (AStGWF). This information is provided in Appendix H. The AStGWF is a strategic-scale map showing groundwater flood areas on a 1km square grid. The data was produced to annotate indicative Flood Risk Areas for PFRA studies and allow the LLFAs to determine whether they may be at risk of flooding from groundwater. This data shows the proportion of each 1km grid square, where

geological and hydrogeological conditions indicate that groundwater might emerge. It does not show the likelihood of groundwater flooding occurring, nor does it take account of the chance of flooding from groundwater rebound. This dataset covers a large area of land and only isolated locations within the overall susceptible area are actually likely to suffer the consequences of groundwater flooding.

The AStGWF data should be used only in combination with other information, for example local data or historical data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist.

6.7 Sewers

Historical incidents of sewer flooding are detailed by Southern Water through their Sewer Incident Report Form (SIRF) Data and by Thames Water through their Sewer Flood History Database (SFHD). These databases record incidents of flooding related to public foul, combined or surface water sewers, and detail the number of properties impacted by internal and external flooding.

The records of sewer flooding within Dartford Borough can be found in Table 7-3.

6.8 Reservoirs

The risk of inundation due to reservoir breach or failure of reservoirs within the area has been assessed using the Risk of Flooding from Reservoirs dataset made available by the Environment Agency.

The Environment Agency data has not been mapped as part of this SFRA as only a small area near the confluence of the River Darent and River Cray is predicted to be at risk. The areas predicted to be at risk of flooding from reservoir breach or failure are described in more detail in Section 7.9. Mapping showing the Risk of Flooding from Reservoirs dataset is available from the **Flood Warning Information Service**.

6.9 Suite of maps

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

- Appendix A: SFRA Appendix Mapping Grids flooding
- Appendix B: Historic Flood Risk
- Appendix C: Watercourses
- Appendix D: Fluvial and tidal Flood Zones
- Appendix E: Fluvial and tidal climate change flood risk map
- Appendix F: Surface water flood risk map
- Appendix G: Surface water climate change mapping
- Appendix H: Areas Susceptible to Groundwater Flooding
- Appendix I: Flood Defences
- Appendix J: Flood Alert and Flood Warning Areas
- Appendix K: Breach modelling extents

6.10 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 includes:

- **Thames River Basin District River Basin Management Plan** (Environment Agency, 2016). Further information can be found in Section 2.2.3.
- **Kent Local Flood Risk Management Strategy 2017-2023** (Kent County Council, 2017). Further information can be found in Section 2.2.4.
- **North Kent Rivers Catchment Flood Management Plan** (Environment Agency, 2009). Further information can be found in Section 2.2.5
- **Kent County Council Drainage and Planning Policy** (Kent County Council, adopted November 2019). Further information can be found in Section 2.2.8.
- **Kent County Council Flood Response Plan** (Kent County Council, 2017)

Provides information on the principles determining the response of KCC to a flooding event within their local authority administrative area. This document details the actions, roles and responsibilities in response to a flood event.

7 Understanding flood risk in the Local Plan area

This chapter explores the key sources of flooding in the borough and the factors that affect flooding including topography, soils and geology. The main sources of flooding are from watercourses, tidal surges, surface water, sewers and culvert blockages.

Refer to Appendix O for recommendations and details and details on how to apply the Sequential and Exception tests using the data set out in this section.

7.1 Historical flooding

The Local Plan 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, and Southern Water's and Thames Water's datasets of reported sewer flooding incidents.

Fluvial flood risk within the Local Plan area is largely associated with the River Darent, with several recorded incidents of flooding from the watercourse. Fluvial flooding has also been recorded along the River Cray and from small watercourses / drainage channels in the north of the borough.

Tidal flooding has also been recorded in the north of the borough from the tidal River Thames, as well as along the tidal lower reaches of the River Darent, River Cray, and Ebbsfleet River.

Surface water flooding in Dartford Borough has largely been recorded to impact highways, where heavy rainfall overloads the carriageways, drains and gullies, with some instances of flooding caused by blocked drains or gullies[3].

Groundwater flooding has been recorded several times in a southern part of Sutton at Hone after housing was built on watercress beds in the floodplain of the River Darent, with groundwater believed to have contributed to property flooding in 2003 and 2014.

Additionally, sewer flooding has been recorded in settlements across the Local Plan area, most frequently in Dartford Town Centre, Joydens Wood, Longfield and Swanscombe

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

- **January 1953** – A large storm surge coincided with spring high tides, with extensive flooding recorded in the north of the borough across the Dartford and Crayford Marshes, the Swanscombe Peninsula, Crossways, and Greenhithe. Approximately 1,300 properties in Dartford and Swanscombe were affected, with tidal defences in the borough breached[3].
- **September 1968** – The Environment Agency's recorded flood outlines show the channel capacity of the River Darent and River Cray was exceeded, resulting in fluvial flooding through Dartford and in Sutton at Hone. Flooding from the smaller watercourses in the north of the borough around the Swanscombe Peninsula, Dartford and Crayford Marshes, and Crossways is also recorded to have occurred.
- **January 1978** - A tidal storm surge of a similar magnitude to the 1953 event, though the construction of defences along the North Kent Coast meant the impact was reduced[3].

[3] JBA Consulting, Thameside Stage 1 SWMP: Appendix C, 2013. Available: https://www.kent.gov.uk/__data/assets/pdf_file/0008/50021/Thameside-Stage-1-SWMP-Appendix-C.pdf

- **December 1993** – The Environment Agency's recorded flood outlines show a operational failure or breach of defence resulted in fluvial flooding from the River Darent, impacting the Dartford Trade Park to the south of Dartford.
- **Winter 2002 / 2003** – Fluvial flooding was recorded along the River Darent in December 2002 to January 2003, with the Environment Agency reporting a total of 126 properties experienced flooding within Kent[3].

Appendix B shows the historic flood extents provided by the Environment Agency, though does not include reported incidents from Southern Water's or Thames Water's records of sewer flooding.

Kent County Council's historic flood database indicates that there have been 33 incidents of flooding throughout the borough, although the source of flooding for these events has not been provided.

7.2 Topography and geology

7.2.1 Topography

As shown in Figure 7-1, the topography of the local plan area comprises of low-lying land in the north of the borough, along the valley of the River Darent, and around the Bluewater Shopping Centre. The topography is generally higher in the south of the borough, with the highest elevations in of around 100mAOD in the southeast around Longfield. North of the A2, in the eastern part of the Borough, the presence of former quarries results in some steep changes in topography, with exposed chalk cliffs and topographic depressions.

7.2.2 Geology

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 7-2 and Figure 7-3 show the bedrock (solid permeable) formations and the superficial deposits (permeable, unconsolidated) in the Local Plan area respectively.

The bedrock layers and superficial deposits are identified as being aquifers that are classified as follows and are shown in Figure 7-4 and Figure 7-5 respectively:

- **Principal**: layers of rock or drift deposits with high permeability and, 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 Local Plan area is classified as a mixture of Principal and Secondary A aquifers and unproductive strata.

The superficial deposits in Dartford Borough are classified as Secondary A and Secondary (undifferentiated) aquifers, which are associated with areas of alluvium and river terrace deposits, with small pockets of Unproductive deposits.

Figure 7-1: Topography of the Local Plan area

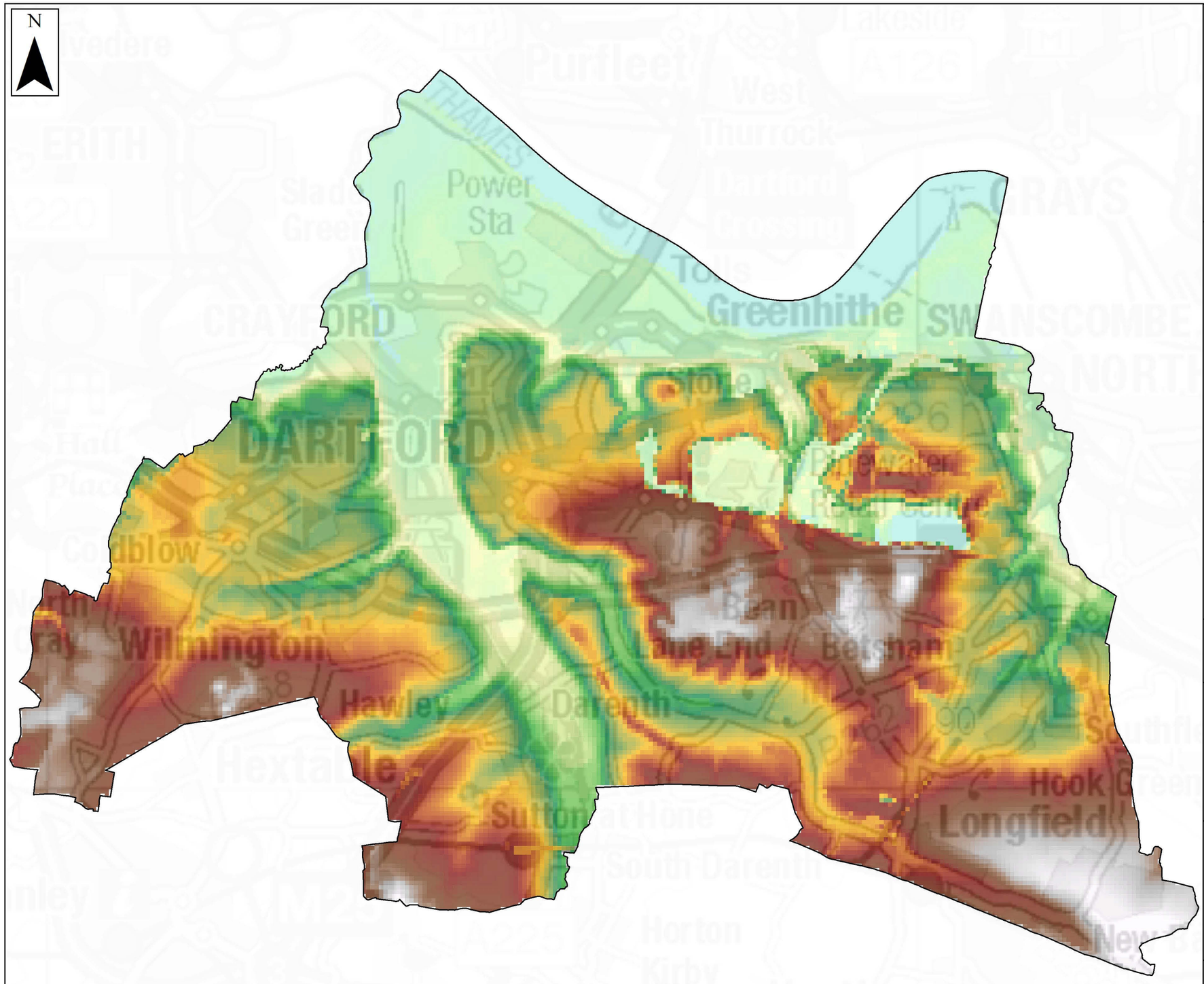
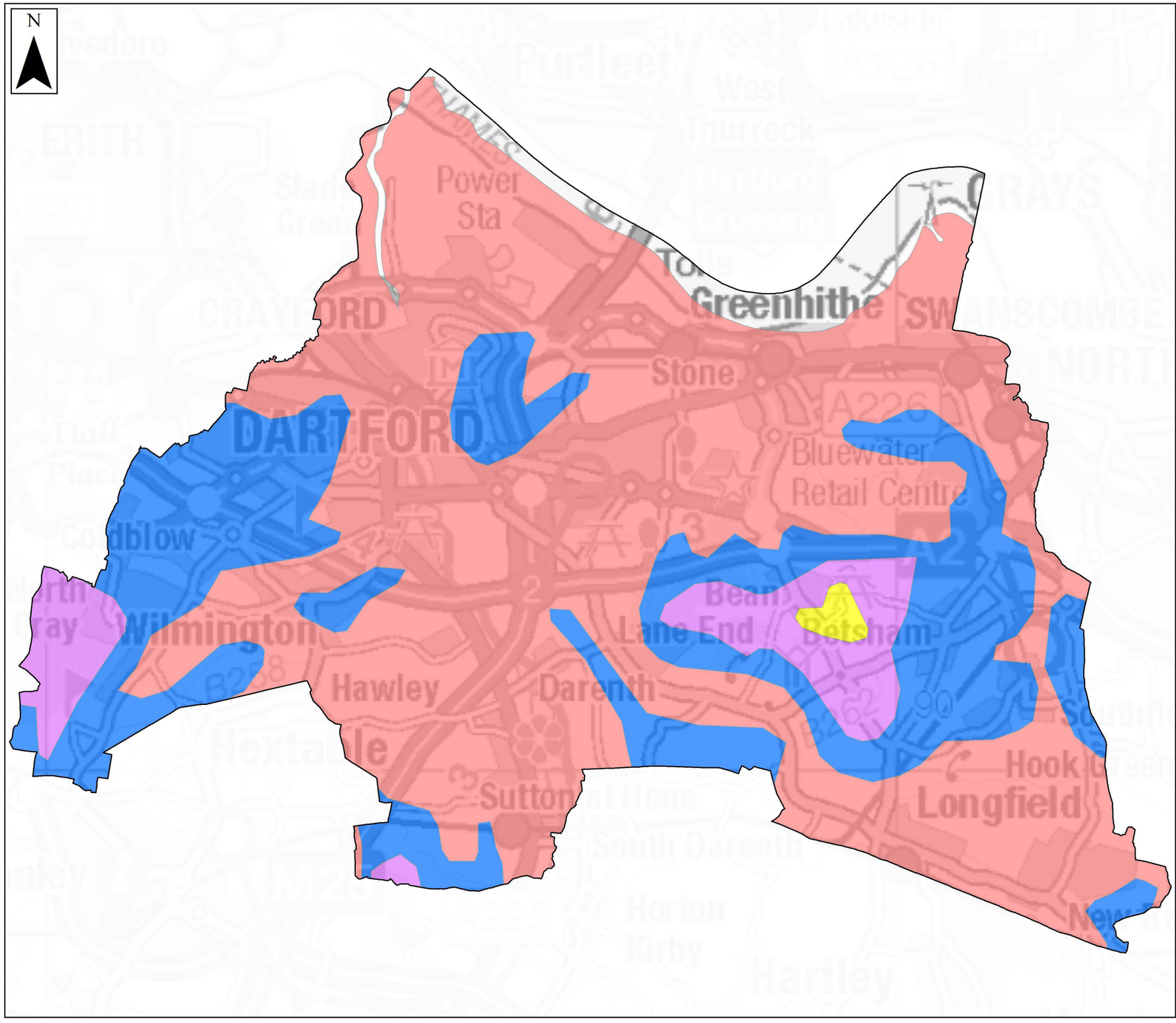


Figure 7-2: Bedrock geology in the Local Plan area



Key Plan

Legend

- Dartford Borough

Bedrock geology

- Lambeth Group
- Thames Group
- Thanet Sand Formation
- White Chalk Subgroup

0 1 2 Kilometres

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Figure 7-3: Superficial deposits in the Local Plan area

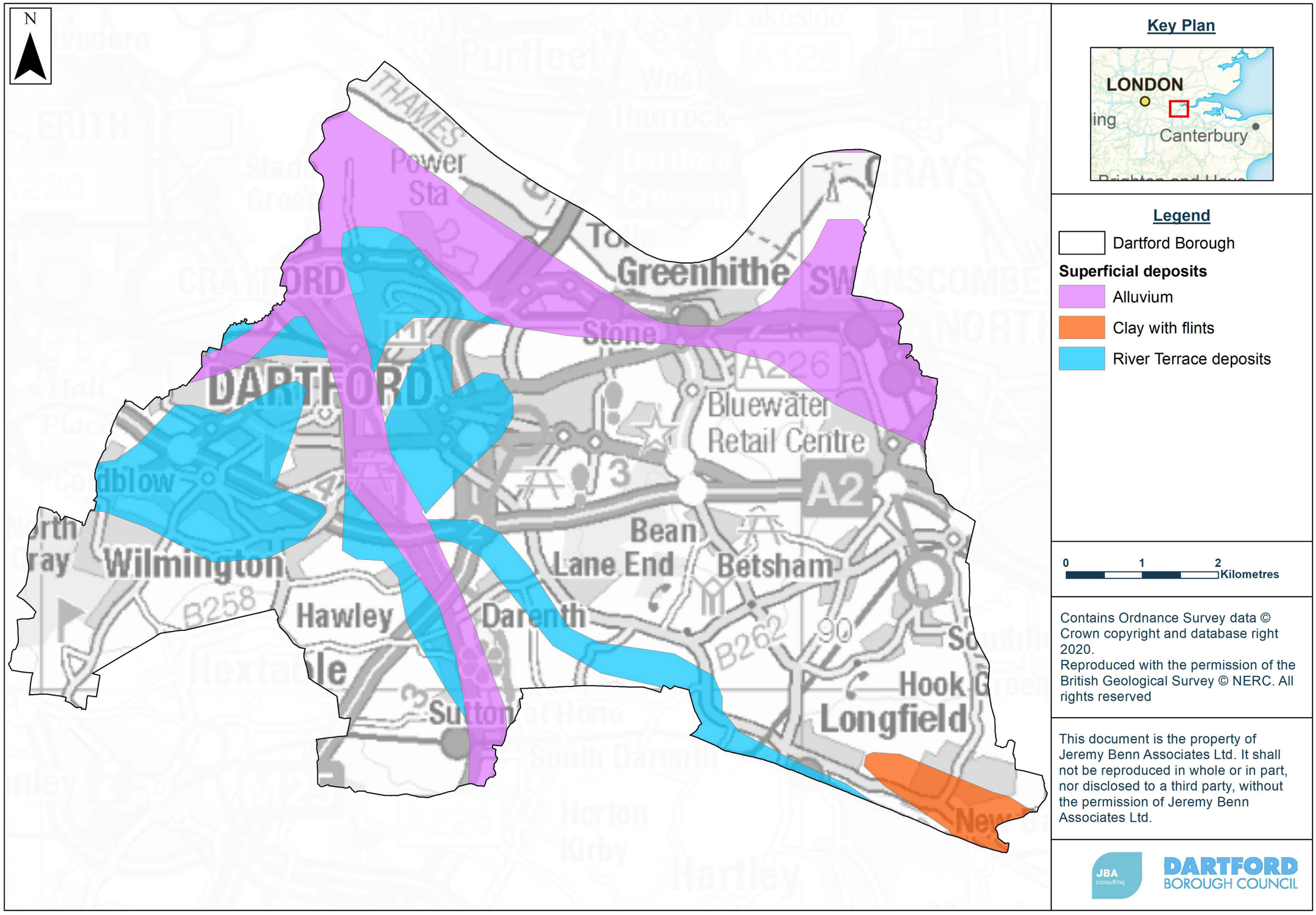


Figure 7-4: Bedrock aquifer designation in the Local Plan area

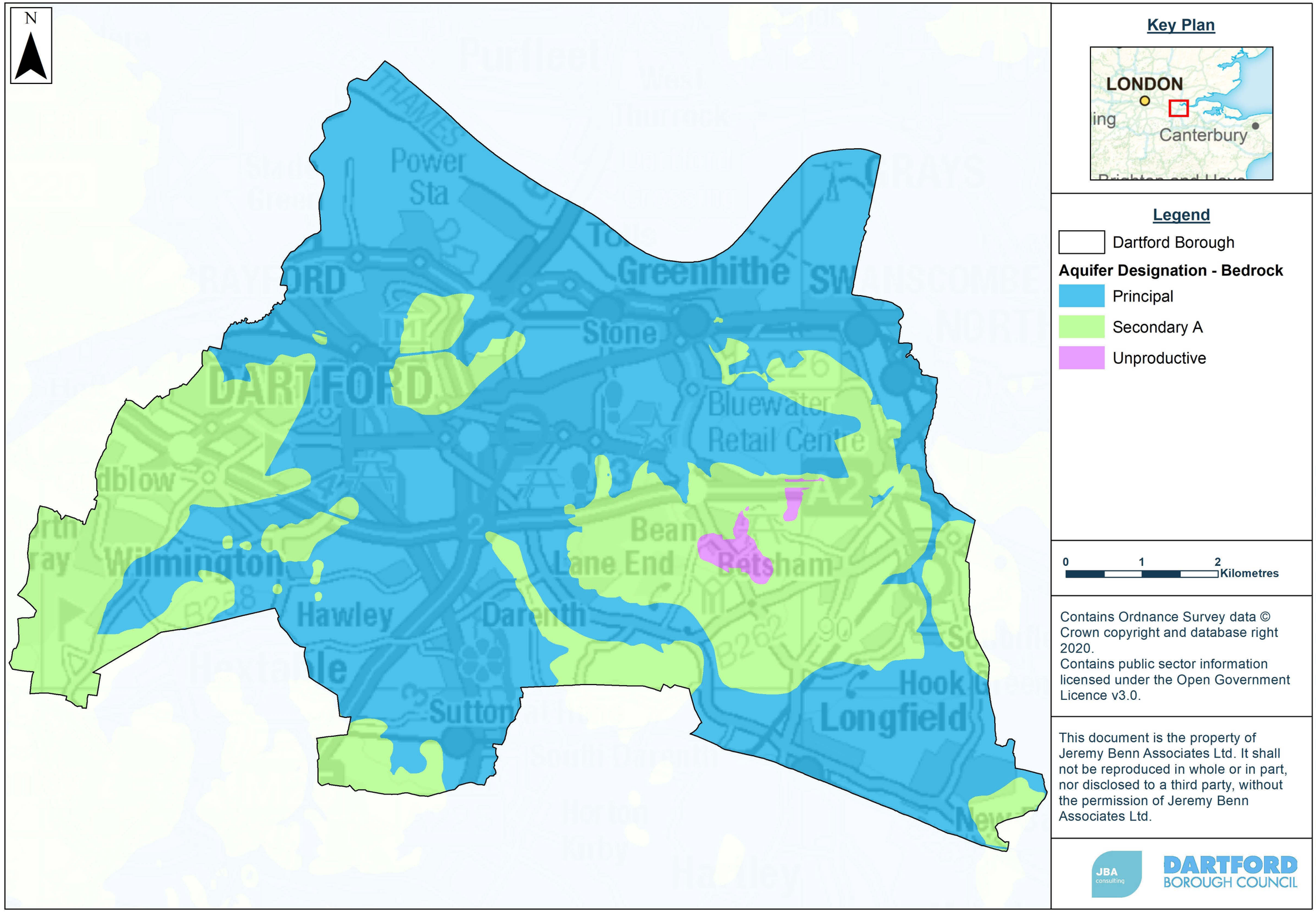
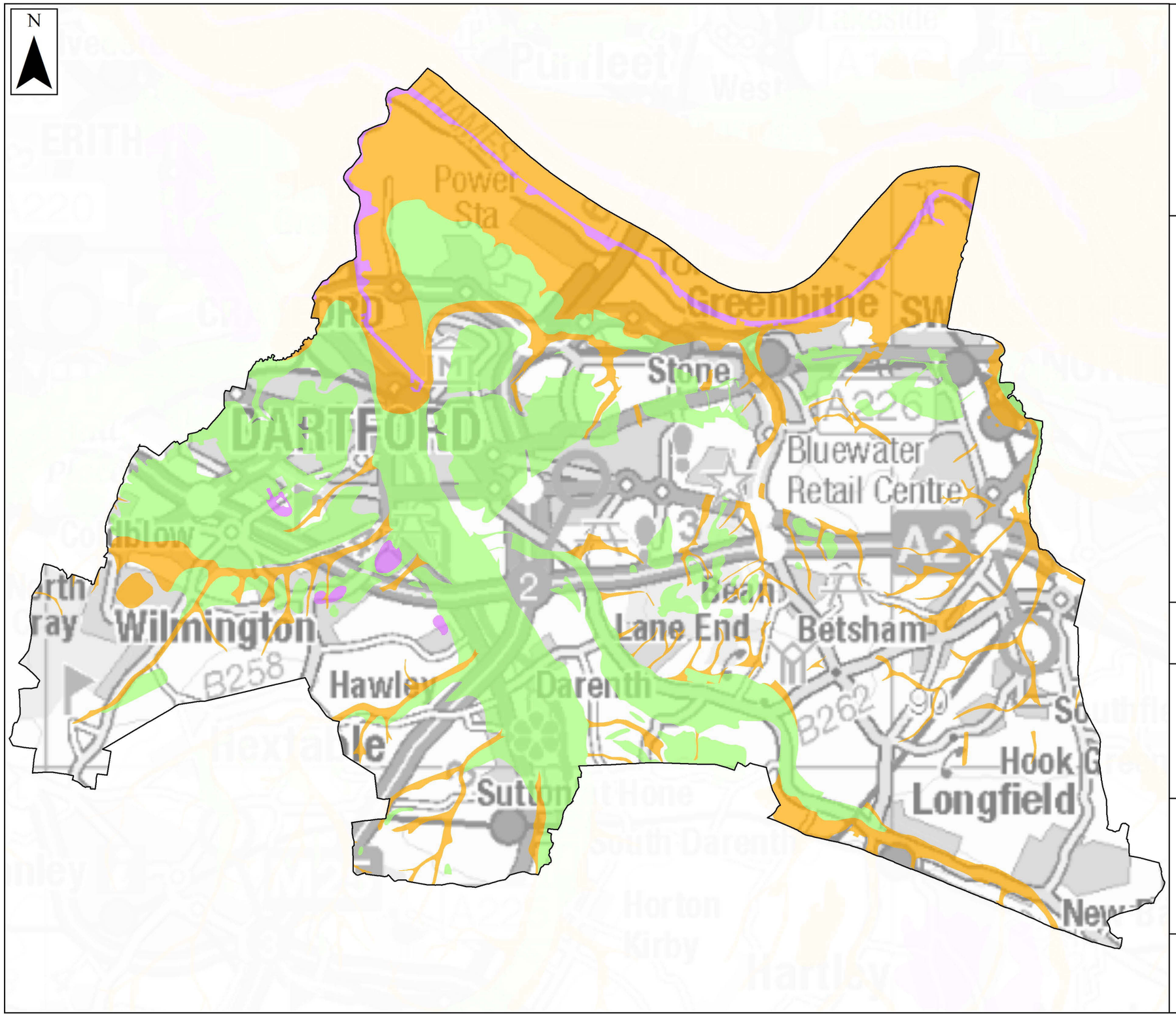


Figure 7-5: Superficial aquifer designation in the Local Plan area



7.3 Watercourses

The River Thames runs along the northern boundary of the Local Plan area, with all watercourses in Dartford Borough draining towards it. The River Darent flows from south to north into Dartford Borough, and receives water from the River Cray close to its junction. The Darent flows through the Dartford and Crayford marshes where it discharges to the tidal Thames. The Ebbsfleet River runs along the northeast boundary before entering Gravesend Borough where it discharges to the tidal Thames. There is complex network of drains in the marshes in the north of the borough, with several designated as Main Rivers.

A summary of the main watercourses in the Local Plan area is provided in Table 7-1. Mapping indicating the location of the principal watercourses can be found in Appendix C.

Table 7-1: Watercourses in the study area

Watercourse	Description
River Thames	The River Thames flows along the northern boundary of Dartford Borough, though is not designated as Main River downstream of the confluence with the River Darent.
River Darent	The River Darent flows north from Sutton at Hone and through the centre of Dartford, before joining the River Thames in the northwest of the borough.
River Cray	The River Cray is a tributary of the River Darent, flowing along a small section of the Dartford Borough boundary in the northwest of the Local Plan area.
Stanham River	Stanham River is a small watercourse running along a section of the Dartford Borough boundary in the northwest of the Local Plan area, where it joins the River Cray.
Dartford Marsh River	This watercourse consists of an area of a collection of drains in the north of Dartford around the A206, with a section of the network designated as Main River.
Ebbsfleet River	Ebbsfleet River runs along the north eastern boundary of the Local Plan Area before entering Gravesend Borough, where it joins the River Thames.
Drains	There are several unnamed drains located in the north of the study area flowing into the River Thames from the area of marshes. Three of these networks of drains are designated as Main River.

7.4 Fluvial flood risk

One of the main sources of flooding in the Local Plan area is fluvial flooding, with several recorded flood events along the River Darent in particular.

Fluvial flooding often occurs concurrently with surface water and sewer flooding in response to extreme rainfall events and constrictions within the drainage systems.

Fluvial flooding in the lower reaches of the River Darent, River Cray, and Ebbsfleet River are influenced by tidal levels, with the potential for tide locking to occur if incoming high tides prevent fluvial flows from discharging into the sea.

The key settlements at fluvial flood risk are summarised in Table 7-2.

Table 7-2: Settlements at risk of fluvial flooding

Settlement	Source of fluvial flood risk
Dartford Town Centre	River Darent
Powder Mill Lane area	River Darent
Sutton at Hone	River Darent

It should be noted that flood risk management measures (defences) are present within the Local Plan 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 adjacent to the river channel. 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 Dartford Borough are presented in Section 8 and the Flood Zones are described in Section 4.2.1.

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

In addition to flood risk shown by the flood risk mapping, there are a number of small watercourses and drains in the north of the Local Plan area which may pose a risk to development. Modelling of these watercourses is not available as the Environment Agency have only prepared generalised Flood Zone mapping (where more detailed modelling investigations have not been carried out) 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.

7.5 Tidal flood risk

Tidal flooding is caused by extreme tide levels exceeding ground and / or defence levels and is the most significant source of flood risk in the borough. The tidal flood risk to the Local Plan area has been assessed based on the North Kent Coast flood risk and Dartford & Crayford modelling studies. Flood Zone mapping can be found in Appendix D and the effects of climate change can be found in Appendix E.

The Local Plan area is bounded to the north by the tidal River Thames, meaning the north of the borough is at risk of tidal flooding. The most notable recorded tidal flood events within Dartford Borough occurred in 1953 and 1978.

The watercourses mentioned in Table 7-1 are all at risk of tidal flooding in their lower reaches.

7.6 Surface water flood risk

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.

Tide locking is also an issue where high tides prevent surface water from draining from gravity outfalls, particularly within the complex network of drainage ditches located in the marshes in the north of the borough.

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. Mapping of the RoFSW

throughout the Local Plan area is provided in Appendix F, showing the modelled extents of surface water flooding predicted to occur during 3.33%, 1% and 0.1% AEP rainfall events. Mapping showing the impact of climate change on surface water provided is in Appendix G, detailing predicted flood extents for circumstances where the 1% AEP rainfall event is uplifted by 20% and 40%. A brief overview of the surface water flood risk mapping within each area of Dartford Borough is provided in Figure 7-6 and Table 7-5.

The Thameside Level 1 SWMP identified that a common cause of surface water flooding in Dartford Borough was highway flooding as a consequence of surcharged drains. The Level 2 SWMP identified six hotspots for surface water flooding within Dartford: Stone, Hawley Road, Riverside Industrial Park, Windsor Drive, Greenhithe and Bow Arrow. These hotspots are also identified as being areas of higher surface water flood risk in the RoFSW mapping shown in Appendix F. The Riverside Industrial Park was considered the highest priority of the hotspots due to a number of recorded incidents of surface water flooding of residential properties in the area. Flood risk within these hotspots is generally characterised as localised surface water flooding, generally impacting highway, though with some incidents of internal property flooding.

7.7 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.

Mapping of the whole borough has been provided showing the Areas Susceptible to Groundwater Flooding (AStGWF) dataset, with mapping provided in Appendix H. The information provided within the AStGWF dataset indicates that susceptibility to groundwater flooding is generally greatest along the routes of the River Darent and River Cray, in particular at the confluence of the two watercourses and the area north of Darenth where up to 50-75% of the 1km grid squares are considered to be susceptible to groundwater flooding. The areas of higher susceptibility to groundwater flooding are linked to the geology in the borough, generally being highest in areas of alluvial deposits.

The AStGWF data should be used only in combination with other information, for example local data or historical data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist.

7.8 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 (such as pumps) failure occur in the sewerage system. The flow of surface water into manhole openings, the soil or groundwater may cause high flows in sewers for prolonged periods of time.

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.

Southern Water and Thames Water have provided records of reported incidents of internal / external property flooding relating to public foul, combined or surface water

sewers. For confidentiality reasons, this data has been supplied on a postcode basis from Southern Water's SIRF hydraulic overload database and Thames Water's SFHD. The collated information from the SFHD and SIRF records is shown in Table 7-3.

A total of 59 incidents of sewer flooding are recorded in the Local Plan area. The most frequently flooded postcodes are: DA1 1 (Dartford Town Centre - 12 incidents), DA2 7 (Wilmington - 8 incidents), and DA3 7 (Longfield - 8 incidents). It is important to recognise that the information does not indicate the cause of the sewer flooding incidents. Additionally, the records only detail incidents of sewer flooding that have been reported and only represent a snapshot in time that may become outdated following future rainfall events. The risk of flooding may be reduced in some locations by capital investment to increase of 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 to enhance understanding of flood risk from sewers at a given location.

Table 7-3: Reported incidents of sewer flooding in Dartford Borough SFRA area

Post code	Recorded flood incidents	Post code	Recorded flood incidents
DA1 1	12	**DA2 8**	1
DA1 2	2	**DA3 7**	8
DA1 3	2	**DA4 9**	1
DA1 4	4	**DA9 9**	5
DA1 5	1	**DA10 0**	7
DA2 6	3	**DA13 9**	3
DA2 7	8	**DA14 5**	2
Total recorded flood incidents: 59			

7.9 Flooding from reservoirs

Reservoirs with an impounded volume greater than 25,000 cubic metres in England 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 reservoirs is relatively low. Recent changes to legislation under the Flood and Water Management Act require the Environment Agency to designate the risk of flooding from these reservoirs. The Environment Agency is currently progressing a 'Risk Designation' process so that the risk is formally determined.

The risk of inundation due to reservoir breach or failure of reservoirs within the area has been assessed using the Risk of Flooding from Reservoirs dataset made available by the Environment Agency. The mapping shows only a small area in the northwest of Dartford Borough is at risk of flooding from a reservoir breach or failure, with the risk from reservoirs located in the Cray Valley. The area at risk is largely restricted to the floodplain at the confluence of the River Darent and River Cray, as well as the Stanham River, though the flood extents extend across a section of the A206. No reservoirs are located within the Local Plan area. Reservoirs located within neighbouring authorities that predicted to impact the Local Plan area are detailed in Table 7-4.

Table 7-4: Reservoirs predicted to impact the Dartford Borough Local Plan area

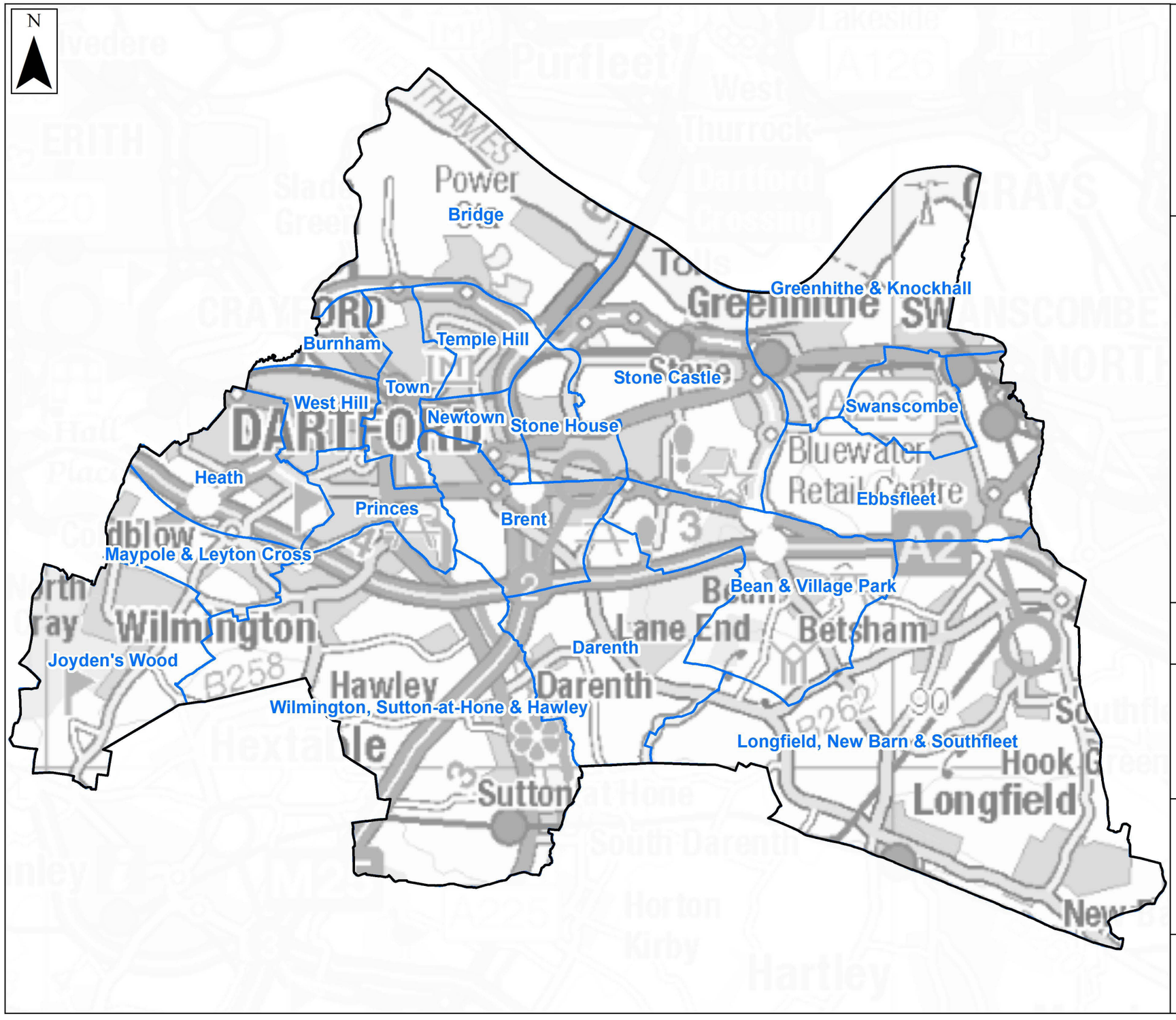
Reservoir	Location (grid ref)	Reservoir owner	Environment Agency area	Local authority
Danson Park Lake	547620, 174665	Bexley Council	Kent, South London and East Sussex	Bexley Council
Hall Place FRR	550890, 174364	Environment Agency	Kent, South London and East Sussex	Bexley Council

Reservoir flooding is very different from other forms of flooding. It may happen with little or no warning. The Environment Agency maps represent a credible worst-case scenario. In these circumstances, it is the time to inundation, the depth of inundation, the duration of flooding and the velocity of flood flows that will be most influential. The Environment Agency Risk of Flood from Reservoir Map is available from the **Flood Warning Information Service**.

7.10 Summary of flood risk to key areas

A high-level review of the flood risk to areas in the Dartford Borough has been undertaken and is summarised in Table 7-5, with the area boundaries shown in Figure 7-6. This is based on the available risk mapping and Flood Zone mapping.

Figure 7-6: Area boundaries within Dartford Borough



Key Plan

Legend

- Dartford Borough
- Area boundaries

0 1 2 Kilometres

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Table 7-5: Summary of flood risk to areas in Dartford Borough

Area	Fluvial/tidal flood risk	Formal flood defences	Surface water flood risk	Reservoir inundation	Areas Susceptible to Groundwater flooding
Bean & Village Park	Not in Flood Zones.	None	There are some areas of surface water ponding and highway flooding predicted in the village of Bean, as well as areas of ponding upslope of the A2.	None	Across the majority of Bean & Village Park <25% of the area is predicted to be susceptible to groundwater flooding, though this rises to 25-50% in the north of the area.
Brent	The River Darent flows along the west of the area. The Environment Agency historic flood outline dataset shows there has been a history of fluvial flooding in the west of the area.	See Section 8	Mapping shows that surface water flood risk largely follows roads throughout the area, with high risk areas including the A282 and the Princes Road. During a 0.1% AEP storm event areas of surface water ponding are predicted to form, most notably south of Trolling Down Road.	None	Groundwater flood risk is greatest in the west of the area near the River Darent, where up to 50-75% of the area is susceptible to groundwater flooding.
Bridge	The River Darent flows along the west of the area, with the Stanham River and River Cray also located in the southwest of the area. The Environment Agency historic flood outline dataset shows records of tidal and fluvial flooding occurring in the past.	See Section 8	Mapping shows surface water ponding is predicted to occur in the industrial areas in the east of the area, with relatively small occurrences of surface water ponding predicted in the west of the area and across the marshes, where flood risk generally follows the route of the local drainage network.	Inundation from Danson Park Lake and Hall Place FRR possible around confluence of River Darent and River Cray	Groundwater flood risk is greatest in the south of the area near the confluence of the River Darent and River Cray, where up to 50-75% of the area is susceptible to groundwater flooding.
Burnham	The River Darent flows along the east of the area, with the Stanham River flowing through the north of the area. The Environment Agency historic flood outline dataset shows records of tidal and fluvial flooding occurring in the past.	See Section 8	Mapping shows there is a large area at risk of surface water flooding around Priory Road and Lawson Road. Flooding is also predicted to occur along highways, such as Burnham Crescent and Chatsworth Road.	Inundation from Danson Park Lake and Hall Place FRR possible around Stanham River and the A206.	Groundwater flood risk is greatest in the north of the area near the River Darent and River Cray, where up to 50-75% of the area is susceptible to groundwater flooding.
Darenth	The River Darent flows along the west of the area. The Environment Agency historic flood outline dataset shows there has been a history of fluvial flooding in the west of the area.	See Section 8	Mapping shows that surface water flood risk in the area generally follows dry valleys, most notably in the area around the B260.	None	Groundwater flood risk is greatest in the west of the area near the River Darent, where up to 50-75% of the area is susceptible to groundwater flooding.
Ebbsfleet	The River Ebbsfleet runs along the east of the area. The Environment Agency historic flood outline dataset shows records of tidal and flooding occurring in the past.	None	Mapping shows that there are relatively large areas predicted to be at risk of surface water flooding along the railway line, including at Ebbsfleet International Station, as well as along Southfleet Road and areas associated with quarrying.	None	Across the majority of Ebbsfleet <25% of the area is predicted to be susceptible to groundwater flooding, though this rises to 25-50% in the west of the area.
Greenhithe & Knockhall	The area is bounded by the tidal River Thames to the north, with the River Ebbsfleet running along the southeast of the area. There are also several small unnamed watercourses and drainage ditches located in the north of the area. The Environment Agency historic flood outline dataset shows records of tidal and fluvial flooding occurring in the past.	See Section 8	Mapping shows there are small areas of surface water ponding predicted to occur in residential areas of Greenhithe, including around Ingress Park Avenue and Park Cliff Road. Surface water ponding is also predicted to occur in the areas around Manor Way, particularly during the larger events.	None	Across the majority of Greenhithe & Knockhall <25% of the area is predicted to be susceptible to groundwater flooding, though this rises to 25-50% in the north of the area.
Heath	Not in Flood Zones.	None	Mapping shows that areas of surface water ponding are predicted to occur in residential areas to the south of Princes Road and Dartford Road. Overland flow paths are also predicted to impact highways and properties around Knole Road, Ashen Drive and Windsor Drive.	None	Groundwater flood risk is generally negligible, with only a small area in the north of the area where 25-50% of the area is susceptible to groundwater flooding.

Area	Fluvial/tidal flood risk	Formal flood defences	Surface water flood risk	Reservoir inundation	Areas Susceptible to Groundwater flooding
Joyden's Wood	Not in Flood Zones.	None	Mapping shows there are several surface water flow paths predicted to form across the area, including open spaces east of Birchwood Road. Highways and surrounding properties are also predicted to be at risk across the area, including around Summerhouse Drive, and Silver Birch Close.	None	Groundwater flood risk is negligible across the area.
Longfield, New Barn & Southfleet	The River Ebbsfleet is located in the northeast corner of the area. The Environment Agency historic flood outline dataset does not show any recorded incidents of flooding within the area.	None	Mapping shows there are several overland flow paths along dry valleys within the area , most notably along the B260 where surrounding roads and properties are predicted to be at risk of flooding. There is also a relatively large flow path predicted to flow north from Southfleet towards a large area of ponding south of the A2. There are also areas of ponding predicted to occur west of the railway line near Betsham.	None	Groundwater flood risk is generally negligible, with only a small area in the north of the area where <25% of the area is susceptible to groundwater flooding.
Maypole & Leyton Cross	Not in Flood Zones.	None	Mapping shows surface water flood risk is greatest along the topographic low running through the north of the area, with ponding generally predicted in areas of open space. Roads predicted to be at a high risk of surface water flooding include Common Lane, Sandringham Drive, and Heath End Road.	None	Groundwater flood risk is generally negligible, with only a small area in the west of the area where <25% of the area is susceptible to groundwater flooding.
Newtown	The River Darent flows along the west of the area. The Environment Agency historic flood outline dataset shows there has been a history of fluvial flooding in the west of the area.	See Section 8	Mapping shows there is a high surface water flood risk in the area along the railway and the A282. There are also areas of surface water ponding predicted to impact highways and properties around Overy Street and St Vincents Road / Carlisle Road. An area of surface water ponding is also predicted to form north of Park Road during the 0.1% AEP event.	None	Groundwater flood risk is generally negligible, with only a small area in the west of the area where 25-50% of the area is susceptible to groundwater flooding.
Princes	The River Darent flows along the east of the area. The Environment Agency historic flood outline dataset shows there has been a history of fluvial flooding in the east of the area.	See Section 8	Mapping shows there is surface water flood risk in the lower lying areas around the River Darent and Brooklands Lake. There are also a number of overland flow paths predicted to impact highways and properties, including around Laburnum Avenue, Phoenix Place, Holly Road, and Princes Road.	None	Groundwater flood risk is greatest in the east of the area near the River Darent, where up to 50-75% of the area is susceptible to groundwater flooding.
Stone Castle	The area is bounded by the tidal River Thames to the north. There are also several small unnamed watercourses and drainage ditches located in the north of the area. The Environment Agency historic flood outline dataset shows records of tidal and fluvial flooding occurring in the past.	See Section 8	Mapping shows there are relatively large areas of surface flood risk in residential areas in the east of the area, with ponding predicted to occur along Steel Avenue and the surrounding streets, as well as in the area around Castleridge Drive. Additionally, there are areas of surface water ponding in the industrial area of Crossway north of the A208 and the Bluewater Shopping Centre. A large surface water flow path is predicted to occur in the west of the area.	None	Groundwater flood risk is greatest in the southeast of the area, where up to 25-50% of the area is susceptible to groundwater flooding.
Stone House	Not in Flood Zones.	None	Surface water flows are predicted to accumulate around the A228 and the railway. There are a number of surface water flow paths where properties are at risk, including around Bevis Close, Kirby Road, and Almond Road. There is also an overland flow path predicted to form in the east of the area, running along Lingfield Avenue, Milestone Road and Osbourne Road.	None	Groundwater flood risk in the area is generally negligible, though in the east of Temple Hill <25% of the area is susceptible to groundwater flooding.

Area	Fluvial/tidal flood risk	Formal flood defences	Surface water flood risk	Reservoir inundation	Areas Susceptible to Groundwater flooding
Swanscombe	Not in Flood Zones.	None	Mapping shows that surface water flood risk is largely follows roads in the area, with high risk roads including Milton Street, Stanhope Road and Park Road. Surface water ponding is also predicted in the area west of Craylands Lane and the area south of Alkerden Lane.	None	Across the area <25% of the area is predicted to be susceptible to groundwater flooding.
Temple Hill	There are no Main Rivers or Ordinary Watercourses within the area, though Temple Hill is predicted to be impacted by fluvial flooding from the River Darent in the east of the area and the Stanham River in the west. The Environment Agency historic flood outline dataset shows no records of tidal and fluvial flooding occurring in the past.	None	Mapping shows surface water flood risk generally follows highways, including along Attlee Drive, Henderson Drive and Perry Grove. Additionally, areas of surface water ponding are predicted around Chaucer Way, Barnwell Road and the A206.	None	Groundwater flood risk is greatest in the west of the area, where up to 25-50% of the area is susceptible to groundwater flooding.
Town	The River Darent flows through the centre of the Town area. The Environment Agency historic flood outline dataset shows records of tidal and fluvial flooding occurring in the past.	See Section 8	Mapping shows there are large areas within Town area predicted to be at risk of surface water flooding, including industrial areas north of the A2026, and around The Priory and The Orchard Shopping Centres. Roads predicted to be at a high risk of surface water flooding include Lowfield Street, Hythe Street, Home Gardens and Victoria Road. At the Dartford and Crayford marshes surface water flood risk generally follows the route of the local drainage network.	Inundation from Danson Park Lake and Hall Place FRR likely to be restricted to River Darent.	Groundwater flood risk is greatest in the north of the area near the River Darent, where up to 50-75% of the area is susceptible to groundwater flooding.
West Hill	There are no Main Rivers or Ordinary Watercourses within the area, though Temple Hill is predicted to be impacted by fluvial/tidal flooding from the River Darent in the west of the area and from the tidal Thames in the north. The Environment Agency historic flood outline dataset shows records of tidal flooding in the west of the area.	None	Mapping shows there is high surface water flood risk in the area along the railway line, as well as to the south where water ponds upslope of the track. Surface water flooding is also predicted to impact highways and surrounding residential properties, with high risk areas including around Wilmot Road, Christchurch Road, and Hallford Way.	Inundation from Danson Park Lake and Hall Place FRR possible towards Stanham River.	Groundwater flood risk is greatest in the west of the area, where up to 25-50% of the area is susceptible to groundwater flooding.
Wilmington, Sutton-at-Hone & Hawley	The River Darent flows along the east of the area. The Environment Agency historic flood outline dataset shows there has been a history of fluvial flooding in the east of the area.	See Section 8	Surface water flood risk in the area is generally greatest alongside the River Darent, along a dry valley located north of the M25 and along a topographic low through Wilmington. In Hawley and Sutton-at-Hone the surface water flood risk is generally restricted to highways, though there are small areas where properties are predicted to be at risk.	None	Groundwater flood risk is greatest in the east of the area near the River Darent, where up to 50-75% of the area is susceptible to groundwater flooding.

8 Fluvial and tidal defences

This section provides a summary of the existing flood defence assets within the Dartford Borough. Planners should note the areas that are protected by defences where further work to understand the actual and residual flood risk through the 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.

A high-level review of flood defences was carried out for this SFRA and this involved an interrogation of existing information on asset condition and standard of protection. The Environment Agency's Spatial Flood Defences dataset was primarily used to understand the flood risk associated with defences in the borough.

Defences are categorised as either raised flood defences (e.g. walls / embankments) or Flood Storage Areas (FSAs). The assessment of the Environment Agency dataset has considered raised defences which potentially provide a standard of protection from a 5% AEP event or more. Man-made and natural defences which may arise for instance due to the presence of naturally high ground adjacent to a settlement have been considered. The defences and their locations are summarised in the following sections.

8.1 Defence standard of protection and residual risk

One of the principal aims of the SFRA is to outline the present risk of flooding across the Dartford Borough Local Plan 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 Local Plan 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.

Consideration of the actual and residual risk behind flood defences has been undertaken as part of this study. 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. Developers should also consider the standard of protection provided by defences and residual risk 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 or 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 mean sea level 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 a number of factors that determine the

protection that they can provide e.g. outflow rates, number of watercourses that flow into the Flood Storage Area.

8.2 Defence condition

Formal structural defences are given a rating by the Environment Agency based on a grading system for their condition[4]. A summary of the grading system used by the Environment Agency for condition is provided in Table 8-1.

Table 8-1: 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.

8.3 Tidal and fluvial defences in the Local Plan area

Defences along the River Thames, and the lower reaches of the River Darent and River Cray provide protection against tidal flood events e.g. where still water sea levels exceed the defence crest. Fluvial defences are present further upstream along the River Darent, as well as defences protecting against fluvial and tidal flooding.

Defences in Dartford Borough along the River Thames and lower reaches of the Rivers Darent and Cray generally provide a standard of protection of 0.1% AEP. The majority of defences along the River Darent through Dartford provide a standard of protection of at least 2% AEP, though there are several areas with a standard of protection of 5% AEP.

The Environment Agency defence data shows that most defences within Dartford Borough are in 'good' or 'fair' condition. There is a section of tidal defences along Riverside Walk in the north of Dartford where the defence condition is not specified within the Environment Agency dataset.

[4] Condition Assessment Manual, Environment Agency (2012)

The maps shown in Appendices I.1-4 provide a summary of the defences included in the Environment Agency's spatial defence dataset with a standard of protection against a 5% AEP event or greater in Dartford Borough. Defences with a standard of protection of 5% AEP or greater are shown as these defences are considered in the delineation of Flood Zone 3b. The maps in Appendix I.2-4 show the defence type, condition and standard of protection, using the spatial defence data provided by the Environment Agency.

8.4 Alleviation Schemes

The Dartford Barrier is a flood barrier located on the River Darent near the confluence with the River Thames. The barrier was built as part of the Thames Barrier (Tidal Defences) system in 1981 and is operated by the Environment Agency, with the barrier able to be lowered to protect against tidal flooding from the River Thames. The barrier protects the areas adjacent to the lower reaches of the River Darent and River Cray from tidal flooding.

There are no Flood Storage Areas recorded in the Local Plan area in the Environment Agency's 'Flood Map for Planning – Flood Storage Areas' dataset.

8.5 Future schemes

8.5.1 Thames Estuary 2100 Plan

The Thames Estuary 2100 Plan describes the strategy and approach for managing and maintaining the River Thames Tidal defences (and Thames Barrier). Under the TE2100 Dartford Borough is given a 'Policy 4' flood risk management policy, whereby action will be taken to keep up with climate change and land use change so that flood risk does not increase. This will be achieved by maintaining and enhancing existing defences within the Borough, with the plan highlighting there may be scope to combine new defences with new development, as well as the potential to retreat the defence line in some areas with resilient development on the riverward side. The TE2100 also recommends that the Crayford, Dartford, and Stone Marshes are retained as an area of green space, potentially for use as a tidal flood storage area, as well as the provision of habitats and recreation. Further details about the current policy and recommendations for managing flood risk in the Local Plan area can be found within the 2012 **TE2100** report.

The TE2100 plan, approach and strategy is currently being updated in response to reflect changes to legislation, guidance and practice and also to reflect the most up to date predictions with respect to predicted sea level rise. The process of updating the plan involves substantive consultation and engagement and it is anticipated that the updated plan will be finalised by 2022.

8.5.2 Dartford Town Centre

JBA Consulting carried out further work with Dartford Borough Council and the Environment Agency to investigate the effectiveness of potential mitigation works to reduce fluvial flood extents in Dartford town centre for the 1% AEP plus climate change event, with the aim of supporting new development in the area. This considered three potential options to address this issue:

- Brooklands Lake: Optimising storage at Brooklands Lake to prevent it filling before the onset of flooding to property in Dartford. This was attempted by raising the level of the footpath bounding the eastern side of the lake.
- Flood Relief Channel: Limiting flows down the main channel of the River Darent through Dartford Central Park and divert more flow down the existing flood relief channel.

- Flapped Outfalls through Tidal Flood Defences: The flaps open to allow fluvial flood water ponding on the landward side of the defence to discharge when the tide is lower than the level of the flap. This reduces the duration of flooding to properties.

Further optimisation work was carried out in relation to the flood relief channel option as it was considered that this could potentially be the most practicable option. This found that:

- Diverting more flow down the flood relief channel and constructing a bund along its left bank would provide some benefit in reducing flood extents and depths. An area around the Priory Centre would be removed from the maximum modelled flood extent in the 100-year plus 35% climate change event. Elsewhere in Dartford town centre, flood depths would be reduced by up to 0.05m in this event. However, Overy Liberty Bridge would remain a significant constriction. The bridge is downstream of the main/ flood relief channel confluence, and causes flows to back up and overtop from the main channel in larger events
- A low spot in the main channel left bank between Bridge House and Overy Liberty Bridge would be the primary overtopping location leading to flooding in Dartford Town Centre.
- The constriction at Overy Liberty Bridge would remain even if bridges constricting flows on the main channel at Bridge House were removed.

Given the limited benefits and potential costs of such a scheme, it is not being pursued at the current time. Instead, it is expected that developments in the affected areas will mitigate the potential impacts by locating more vulnerable uses above climate change level with freeboard allowance, ensuring that water is not displaced or flow routes blocked, and developing proposals in consultation with the Environment Agency.

8.6 Residual flood risk

Residual 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, failure of pumping stations or blockages due to debris that affect the performance of assets and structures.

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. Significant changes to sea level rise projections over the lifetime of a development will also result in residual risk. It is the responsibility of the developer to fully assess flood risk, propose measures to address it and demonstrate that any residual risks can 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 NPPF, all sources of flooding need to be considered. If a breach event were to occur, then the consequences to people and property could be high. Developers should 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 in a detailed Flood Risk Assessment. The assessment of residual risk should take into account:

- The flood hazard, depth and velocity that would result from overtopping or breach of defences. Flood gate or pumping station failure and/ or culvert blockage (as appropriate). The Environment Agency can provide advice at site-specific development level for advice on breach/ overtopping parameters for flood models.
- The design of the development to take account of the highest risk parts of the site e.g. allowing for flood storage on parts of the site and considering the design of the development to keep people safe e.g. sleeping accommodation above the flood level.
- A system of warning and a safe means of access and egress from the site in the event of a flood for users of the site and emergency services.

8.6.1 Defence breach

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

Breach modelling covering the study area by the Environment Agency as part of the 2018 Thames Estuary Breach Assessment, which was intended to provide a consistent approach to modelling the residual risk associated with a defence breach across London. The study modelled individual breaches of the Thames defence line between the Thames Barrier and Gravesend / Linford, with the outputs of each breach scenario combined in maximum flood extents, depths, hazard and velocity outputs. The modelling includes breaches of the Thames tidal defences within Dartford Borough, including the Dartford Barrier, though breaches along the River Darent and River Cray are not represented. The breach scenarios were modelled for the 0.5% and 0.1% AEP events for the 2005 and 2115 epochs.

Breach modelling has also been prepared as part of the 2020 Dartford and Crayford modelling study, with four breach locations selected by the Environment Agency where properties are at risk and the floodplain levels are lower than the defences they are protected by. The possibility of breach failure at other locations is plausible and further analysis should be undertaken as part of site-specific flood risk assessments where defences are present and sites may therefore be at risk of a breach event.

Appendix K shows the modelled breach extents from the Thames Estuary and Dartford and Crayford breach models. The mapping shows modelled breaches for the 'Present-day' and 2115 scenarios. Flood flows from breach events can be associated with significant and rapid change in 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 considered. 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.

9 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.

9.1 Over-arching principles

This SFRA focuses on delivering a strategic assessment of flood risk within the Dartford Borough Local Plan area. Prior to any construction or development, site-specific assessments will need to be undertaken, as appropriate so all forms of flood risk at a site are fully addressed. It is the responsibility of the developer to provide an FRA in support of a planning application.

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

Some sites may additionally require the application of the Exception Test following the Sequential Test which is detailed in Section 4.4.

9.2 Requirements for site-specific flood risk assessments

9.2.1 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.

Paragraph 068 of the NPPF Flood Risk and Coastal Change Planning Practice Guidance sets out a checklist for developers to assist with site specific flood risk assessments.

9.2.2 When are site specific FRAs required?

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 1 hectare or greater in Flood Zone 1 due to their surface water impact which will be dealt with through a surface water drainage strategy.
- 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 the site is intended to discharge to the catchment or assets of a water management authority which requires a site-specific FRA
- 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
- At locations where proposals could affect or be affected by substantial overland surface water flow routes

A Surface Water Drainage Strategy is required for any major development.

9.2.3 Objectives of site specific FRAs

The aim of an FRA is to demonstrate that the development is protected to the 1% AEP fluvial and 0.5% AEP tidal 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 over the lifetime of the development;
- Whether a proposed development will increase flood risk elsewhere;
- Whether the measures proposed to deal with the effects and risks are appropriate;
- Assess the potential cumulative impact of development on flood risk (as described in Section 4.7);
- 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, if applicable.

FRAs for sites located in the Local Plan area should follow the approach recommended by the 2019 NPPF (and associated guidance) and guidance provided by the Environment Agency and Kent County Council. This includes:

Site-specific Flood Risk Assessment: Checklist (NPPF PPG, Defra)

Standing Advice on Flood Risk (Environment Agency)

Flood Risk Assessment for Planning Applications (Environment Agency)

Drainage and Planning Policy (Kent County Council)

The following sections provide information for Dartford Borough Council and developers to assist in the preparation of FRAs.

9.3 For Dartford Borough Council

One of the key objectives of the SFRA is to provide an evidence base, which will inform the preparation of the Local Plan with respect to local flood risk issues and the location of future development.

The local planning authority can play an important role in strategic flood risk management. The overall aim should be to direct development to areas of lower flood risk wherever possible and resist development in areas of flood risk unless the type of development is commensurate with the type of flood risk.

The Council should also seek flood risk reduction in every new development and redevelopment through design, changes in land use and drainage requirements.

9.3.1 Reviewing of FRAs

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**.

9.4 For developers

Developers should consider flood risk at an early stage in deciding the layout and design of a site to provide an opportunity to reduce flood risk within the development.

In general, all future developments should demonstrate:

- That the probability and consequences of flooding will be reduced.
- How actual and residual flood risk to the development and flood risk to others from all sources will be managed over the lifetime of the development, taking into account climate change.
- That development will be safe through the layout, form and floor levels of the development and mitigation measures.
- That surface water runoff is being managed.
- A development will have certain requirements to fulfil, dependent upon which Flood Zone it is located within.

The following subsections contain information to assist developers where flood risk to and from a development is identified which should be read alongside the guidance documents listed in section 9.2.3.

9.4.1 Climate change projections

In order to assess whether a development will be safe from flooding over its lifetime it is important to look at the impact of climate change as outlined in Section 5.

9.4.2 Smaller watercourses

As described in Section 7.4, the Environment Agency's Flood Maps may suggest that there is not a flood risk along small watercourses (watercourses with a catchment less than 3km^2). 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.

9.4.3 Reducing fluvial and tidal flood risk through site design and layout

Flood risk 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.

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 be based on 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 for to ensure that accumulated hydrocarbons and other vehicle related pollutants are not released to the aquatic environment. Particular consideration should be given to designing drainage systems that reduce the risk of groundwater ingress, as this is a known existing problem.

Waterside areas, or areas along known flow routes, can act as 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.

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.

If it has been agreed with the Environment Agency that, in a particular instance, the raising of floor levels is acceptable, 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 1% AEP fluvial event plus an allowance for climate change
- a minimum of 300mm above the 0.5% AEP tidal event plus an allowance for climate change
- 300mm above the general ground level of the site.

Finished Floor Levels for sleeping accommodation should normally be set to whichever is higher of the following:

- a minimum of 600mm above the 1% AEP fluvial event plus an allowance for climate change
- a minimum of 600mm above the 0.5% AEP tidal event plus an allowance for climate change
- 300mm above the general ground level of the site.

If it is not practical to raise floor levels to those specified above, consultation with the Environment Agency will be required to determine alternative approaches.

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, culvert or bridge and 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 would 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. Access should be situated 300mm above the design flood level and waterproof construction techniques used.

Modification of ground levels

Modifying ground levels to raise the land above the required flood level is 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 be provided, and would normally be on a level for level, volume for volume basis on land that does not currently flood but is adjacent to the floodplain (in order for it to fill and drain). It should be in the vicinity of the site and within the red line of the planning application boundary. When assessing flood storage volumes, existing buildings on a site should normally be assumed to flood internally unless it can be demonstrated that measures have historically been in place to exclude floodwater. Additionally, when providing compensatory flood storage, water should be able to enter and drain from the storage area without hindrance for the lifetime of the development, and any sediment or debris deposited should be easily removed by the maintainer of the property. This precludes the use of underfloor voids in most circumstances.

Raising ground levels can also deflect flood flows, so analyses should be performed to demonstrate that there are no adverse effects on third party land or property.

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 assessed as part of a detailed flood risk assessment.

Development and flood defences

Construction of localised raised floodwalls, embankments or flood gates to protect new development is not a preferred option, as a residual risk of flooding will remain if they are overtopped or breached. Existing flood gates should not be retained unless it can be demonstrated that they are necessary.

If defences are 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. Compensatory storage must be provided where raised defences remove storage from the floodplain. 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 for a new development 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, responsibility for maintenance and the cost of replacement when they deteriorate.

In most cases it will be preferable for riverbanks to be naturalised but where development proposes to retain existing river wall / defence infrastructure, the developer will be expected to ensure that the condition of any such structures is checked and where necessary improved as part of the development so that they will have a residual life greater than or equal to the lifetime of the development. Improvements will be expected to have regard for the need to improve the ecological value of the river corridor.

Culverts

Flood risk assessments will be required to identify the correct alignment of culverted watercourses within the boundary of a site and where appropriate include proposals to restore these to a natural open river channel. Where, exceptionally, it is necessary to retain an existing culvert on site applicants must demonstrate that the residual lifetime of the culvert structure meets or exceeds that of the proposed development, that the culvert will provide sufficient flow capacity for the lifetime of the development, that the

development will not result in any adverse loading that could threaten the integrity of the culvert structure, and that all built development will be set back to allow future works to the culvert. New culverts will only be allowed where it can be demonstrated that it is the only viable solution for a watercourse crossing, they must be as short as possible, and the invert must be set deep enough to allow a natural bed to form within.

Buffer strips

The provision of a buffer strip to 'make space for water', allows additional capacity to accommodate climate change and ensure access to the watercourse, structures and defences is maintained for future maintenance purposes. It also enables the 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 the riverbanks and the building itself, making future maintenance of the river much more difficult. Development should therefore seek to leave an undeveloped margin of 8m next to fluvial watercourses and 16m margin next to tidal watercourses.

Any development within 8m either side of a Main River or within 16m from the foot of any sea defence may require the separate consent of the Environment Agency under local land drainage byelaws.

Additionally, it should be noted that for development which falls partly or wholly within the tidal flood defence raising zone alongside the River Thames or Dartford Creek careful consideration should be given to proposals in proximity to soft or hard defences as these might be constrained by the space needed to raise those defences in future (the Environment Agency and the Council should be consulted in these circumstances).

Proposals for Developments within the TE2100 area should seek further pre-application advice from the Environment Agency. Where appropriate, developments may be expected to incorporate a raised defence in line with TE2100 recommendations. Any new defence should also seek to deliver biodiversity net gain on the frontage. Where defences are not being raised to the full TE2100 height, developers will be expected to demonstrate that their proposals do not constrain options for future raising or other flood risk management works. This may involve geotechnical investigations and calculations by a specialist consultant. Usually, future maintenance of the defence will be the responsibility of the landowner.

9.4.4 Reducing flood risk through site design from other sources

Surface water

Reference should be made to the Environment Agency's Risk of flooding from Surface Water Map. KCC expect that the site should be designed so that the natural surface water flow routes are preserved. This will mitigate the need for resistance and resilience measures at the new development. If residual surface water flood risk remains, the likely flow routes and depths across the site should be modelled.

Sustainable Drainage Systems (SuDS) aim to mimic the natural processes of greenfield surface water drainage by encouraging water to flow along natural flow routes and thereby reduce runoff rates and volumes during storm events while providing some water treatment benefits. More detailed guidance on the use of SuDS is providing in Section 10.

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 would be 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 would also 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 on or off site. Developers should provide evidence and ensure that this will not be a significant risk.

Sewer flooding

Developers should discuss public sewerage capacity with the water utility company at the earliest possible stage. The development should improve the drainage infrastructure to reduce flood risk on site and the wider area.

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 storm event are retained within the site if any flap valves shut. This must be demonstrated with suitable modelling techniques. Consideration should be given to designing drainage systems that reduce the risk of groundwater ingress.

Reservoir or defence breach

The risk to development from a breach of reservoirs or flood defences is residual but developers should consider these sources of flooding during the planning stage.

Developers should apply the sequential approach to locating development within the site. The following questions should be considered

- can risk be avoided through substituting less vulnerable uses or by amending the site lay-out?
- can it be demonstrated that less vulnerable uses for the site have been considered and reasonably discounted? and
- can layout be varied to reduce the number of people or flood risk vulnerability or building units located in higher risk parts of the site?

Where a site is shown to be at risk of flooding from reservoir breach, developers should seek to contact the reservoir owner to obtain information which may include

- reservoir characteristics: type, dam height at outlet, area/volume, overflow location;
- operation: discharge rates / maximum discharge;
- discharge during emergency drawdown; and
- inspection / maintenance regime both now and for the lifetime of development.

Consultation should be undertaken with relevant authorities regarding emergency plans in case of a breach event.

In addition to the risk of inundation, those considering development in areas affected by breach events should also assess the potential hydraulic forces imposed by the rapid flood event and check that the proposed infrastructure fabric can withstand the loads imposed on the structures by a breach event.

9.4.5 Resistance and Resilience measures

There may be instances where flood risk to a development remains despite implementation of such site design and layout measures as those outlined above. For example, where the use is water compatible where 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 in a flood 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 measures

Most of the resistance measures should be regarded as reducing the rate at which flood water can enter a property during an event and considered an improvement on what could be achieved with sand bags. They are often deployed with small scale pumping equipment to control the 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 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 temporary snap on covers for airbricks and air vents can also be fitted to prevent the entrance of flood water.

Resilience measures

Interior design measures to reduce damage caused by flooding. For example:

- Electrical circuitry installed at a higher level with power cables being carried down from the ceiling rather than up from the floor level
- Water-resistant materials for floors, walls and fixtures
- If redeveloping existing basements for non-residential purposes, new electrical circuitry installed at a higher level with power cables being carried down from the ceiling rather than up from the floor level to minimise damage if the development floods.
- 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.

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 on the Environment Agency's **Flood risk Assessment in Flood Zones 2 and 3** webpage. The Kent Resilience Forum also provides information and advice on resilience measures in its **Protect Your Home** section.

9.4.6 Cumulative effects

At some locations it will be necessary to include consideration in an FRA of not only the flood risk at a particular site, but also the cumulative effects of all proposed plan allocations within a catchment. Reference should be made to Section 13.4 with respect to the consideration that should be given to- the scope of the assessment in these circumstances.

9.4.7 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. However, new developments should normally not require consideration of community resistance measures.

The Kent Resilience Forum provides advice on **Community Flood Resilience**, containing resources and information on how properties and communities can be made as prepared and resilient for flooding as possible.

9.4.8 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 an emergency plan and a safe refuge point if the development site has been identified to be at risk of flooding. The Local Authority and Emergency Services should be consulted when designing an emergency plan. For further details on emergency planning, see Section 11.

9.4.9 Making space for water

The **PPG** sets out a clear aim in Flood Zone 3 to create space for flooding by restoring functional floodplain and generally development should be directed away from these areas.

All new development close to rivers should consider the opportunity presented to improve and enhance the river environment. Developments should look at opportunities for river restoration and enhancement as part of the development, and to link blue and green infrastructure together Options include backwater creation, de-silting, in-channel habitat enhancement and removal of structures. 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

Consideration for making space for water should also be applied to surface water generated by impermeable surfaces. All new developments should aim to incorporate SuDS to minimise the amount of surface water that is generated. Through a sequential design, known areas of flood risk from surface water can be set aside as open space to ensure flow routes are not blocked, preventing water from building up to potentially dangerous depths. The provision of SuDS also allows water related features to become part of the landscape, offering improved aesthetics to a development and removing the need for underground storage or culverting.

9.5 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).

DEFRA's Flood and Coastal Risk Management Grant in Aid (FCRMGiA)[5] 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 FCRMGiA and therefore any shortfall in funds will need to be found from elsewhere when using Resilience Partnership

5 Principles for implementing flood and coastal resilience funding partnerships (Environment Agency, 2011)

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 mean the development is appropriate as other policy aims must also be met. Funding from developers should be explored prior to the granting of planning permission and in partnership with the Council and the Environment Agency.

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

The Environment Agency is also 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.

10 Surface water management and SuDS

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

10.1 Introduction

Sustainable Drainage Systems (SuDS) are management practices which enable surface water to be drained in a more sustainable manner and to mimic 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.

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

As of April 2015[6] local planning policies and decisions on planning applications relating to major development or major commercial development should make provision for sustainable drainage systems to manage run-off, where major developments are 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 Local Planning Authority must satisfy themselves that clear arrangements are in place for future management of the maintenance arrangements and the LLFA (Kent County Council), as statutory consultee must be consulted on the drainage and Sustainable Urban Drainage proposals.

When considering planning applications, local planning authorities should seek advice from the relevant flood risk management bodies, principally the LLFA on 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 through reference to Defra's **'Non-statutory technical standards for SuDS' document** and should take into account design and construction costs.

It is essential that developers consider sustainable drainage at an early stage of the development process – ideally at the 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 regarding 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 rate with due consideration for climate change via a micro-catchment based approach

6 House of Commons: Written Statement (HCWS161) Written Statement made by: The Secretary of State for Communities and Local Government (Mr Eric Pickles) on 18 Dec 2014. Department for Communities and Local Government (2014). Accessed online at: https://www.parliament.uk/documents/commons-vote-office/December%202014/18%20December/6.%20DCLG-sustainable-drainage-systems.pdf

- **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/Biodiversity: should be incorporated within "open space" or "green corridors" within the site and designed with a view to performing a multifunctional purpose.

10.3 SuDS opportunities in Dartford Borough

10.3.1 Infiltration

Sites underlain by higher permeability bedrock provide opportunities for infiltration techniques, like soakaways and infiltration trenches. A key Kent County Council policy set out in the **Drainage and Planning Policy** is to maximise infiltration through SuDS schemes wherever possible, with efforts made to utilise opportunities for infiltration where sites are underlain by lower permeability soils and bedrock. Where lower permeability bedrocks are overlain by more permeable superficial deposits, such as sands and gravels, there may be opportunities for shallow infiltration SuDS, such as filter drains. As such, infiltration of surface water is expected by KCC for new developments.

Site characteristics can vary greatly over small areas and therefore each site should be individually investigated to ensure suitability of the proposed infiltration technique. Infiltration testing should be undertaken to demonstrate whether infiltration is possible. If infiltration is possible then the rate of infiltration should be provided in the drainage proposal as part of the planning application.

Large parts of Dartford Borough are located within Groundwater Source Protection Zones (GZPZs). Kent County Council and the Environment Agency have confirmed that infiltration is possible within GSPZs 1, 2 and 3. However, this will be constrained within SPZ1 and only clean roof drainage will be permitted. In GSPZ 2 and 3, infiltration is possible for surface run-off from roads, car parking and public or amenity provided the SUDS management train is used to treat the drainage. Further guidance regarding infiltration within GSPZs can be found in the **C753 CIRIA SuDS Manual** (2015) and **the Environment Agency's approach to groundwater protection**. GSPZs in Dartford Borough are discussed further in Section 10.3.7.

10.3.2 Other SuDS opportunities

SuDS can be integrated into the design of all new development within Dartford Borough. The **Water, People, Places** guidance identifies specific site characteristics and constraints that can limit the effectiveness of SuDS including (but not limited to) existing flood conditions, runoff characteristics, high groundwater levels and Groundwater Source Protection Zones, topography, soil type, geology, contaminated land, existing infrastructure, land ownership, ecology and space constraints.

Areas with low permeability soils and bedrock may still have potential for surface detention features, such as ponds and basins, while areas at risk of fluvial flooding can provide attenuation and biodiversity through the implementation of conveyance features, such as swales, and wetland areas. In more densely populated areas, like Dartford Town Centre, space efficient SuDS approaches may be suitable, such as green roofs, rills and permeable paving. However, when assessing suitable SuDS, consideration should be given to the constraints associated with the presence of any GSPZs in the area, as noted in Section 10.3.1.

Additionally, Kent County Council prefer the application of 'green' and open SuDS, such as attenuation ponds, rills and swales, where possible, as opposed to 'hard' SuDS, such as permeable paving.

10.3.3 C753 CIRIA SuDS Manual (2015)

The **C753 CIRIA SuDS Manual** (2015) provides the latest guidance and best practice on planning, design, construction and maintenance of SuDS. The document is designed to help the implementation of SuDS features into new and existing developments, whilst maximising the key benefits regarding flood risk and water quality. It is recommended that developers and the LPA utilise the information within the manual to help design SuDS which are appropriate for development.

10.3.4 Defra Non-Statutory Technical Guidance (2015)

The **guidance** was developed to sit alongside PPG and provide non-statutory standards as to the expected design and performance for SuDS. The LPA will make reference to these standards when determining whether proposed SuDS are considered reasonably practicable and appropriate.

10.3.5 Kent County Council's Drainage and Planning Policy (adopted November 2019)

KCC's **Drainage and Planning Policy** sets out the requirements for sustainable drainage and how drainage strategies and surface water management provisions will be reviewed for SuDS schemes specific to Kent.

The policy provides the following requirements for developments on greenfield and previously developed sites:

- For developments on greenfield sites peak runoff rates from the 1 in 1-year (100% AEP) to the 1 in 100-year (1% AEP) rainfall events should be limited to the peak greenfield runoff rates for the same events.
- For developments on brownfield sites, the peak runoff rate must be as close as reasonably practicable to the greenfield runoff rate but should never exceed the existing rate of discharge prior to redevelopment. Unless it can be demonstrated to be reasonably impracticable, a 50% reduction in the peak runoff rate is expected.
- The drainage system must be designed to operate without flooding on any part of the site during any rainfall event up to (and including) a 1 in 30-year (3.3% AEP) rainfall event.
- The drainage system must also be designed to operate without flooding in any building up to (and including) a 1 in 100-year (1% AEP) plus climate change rainfall event, without exacerbating off-site flood risk.
- Exceedance flows that cannot be managed within the drainage system must be managed via exceedance routes that minimise the risks to people and property.
- Attenuation storage volumes provided by drainage areas must half empty within 24 hours to enable runoff from subsequent storms to be received. If the time taken to drain from full to empty exceeds 24 hours long duration events should be assessed to ensure drainage is not negatively impacted by inundation.

Kent County Council expect betterment of runoff rates from developments on brownfield sites where possible at the majority of potential development sites.

The policy statement is supported by Kent County Council's **Making it Happen**, guidance which consists of technical appendices advising on the construction and design of SuDS features. Additionally, Kent 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. This document is called **Water, People, Places: A guide for master planning sustainable drainage into developments**.

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

10.3.6 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 Environment Agency's groundwater vulnerability map can be found on **Defra's Magic Interactive mapping website**. The groundwater vulnerability maps 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.

10.3.7 Groundwater Source Protection Zones (GSPZ)

The Environment Agency also defines Groundwater Source Protection Zones in the vicinity of groundwater abstraction points. 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. **The Environment Agency's approach to groundwater protection** document defines what restrictions are placed on infiltration in these zones, including those on the use of infiltration SUDS features.

The definition of each zone is shown below:

- **Zone 1 (Inner Protection Zone)** – Most sensitive zone: defined as the 50-day travel time from any point below the water table to the source. This zone has a minimum radius of 50 metres.
- **Zone 2 (Outer Protection Zone)** – Also sensitive to contamination: defined by a 400-day travel time from a point below the water table. This zone has a minimum radius around the source, depending on the size of the abstraction.
- **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.

The locations of GSPZs in Dartford Borough are shown in Figure 10-1, with large parts of the south and west of the Local Plan area located within Zone 1, Zone 2 or Zone 3.

10.3.8 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 Local Plan area are shown in Figure 10-2, with a large area in the south of Dartford Borough within a Groundwater NVZ.

Figure 10-1: Groundwater Source Protection Zones in the Local Plan area

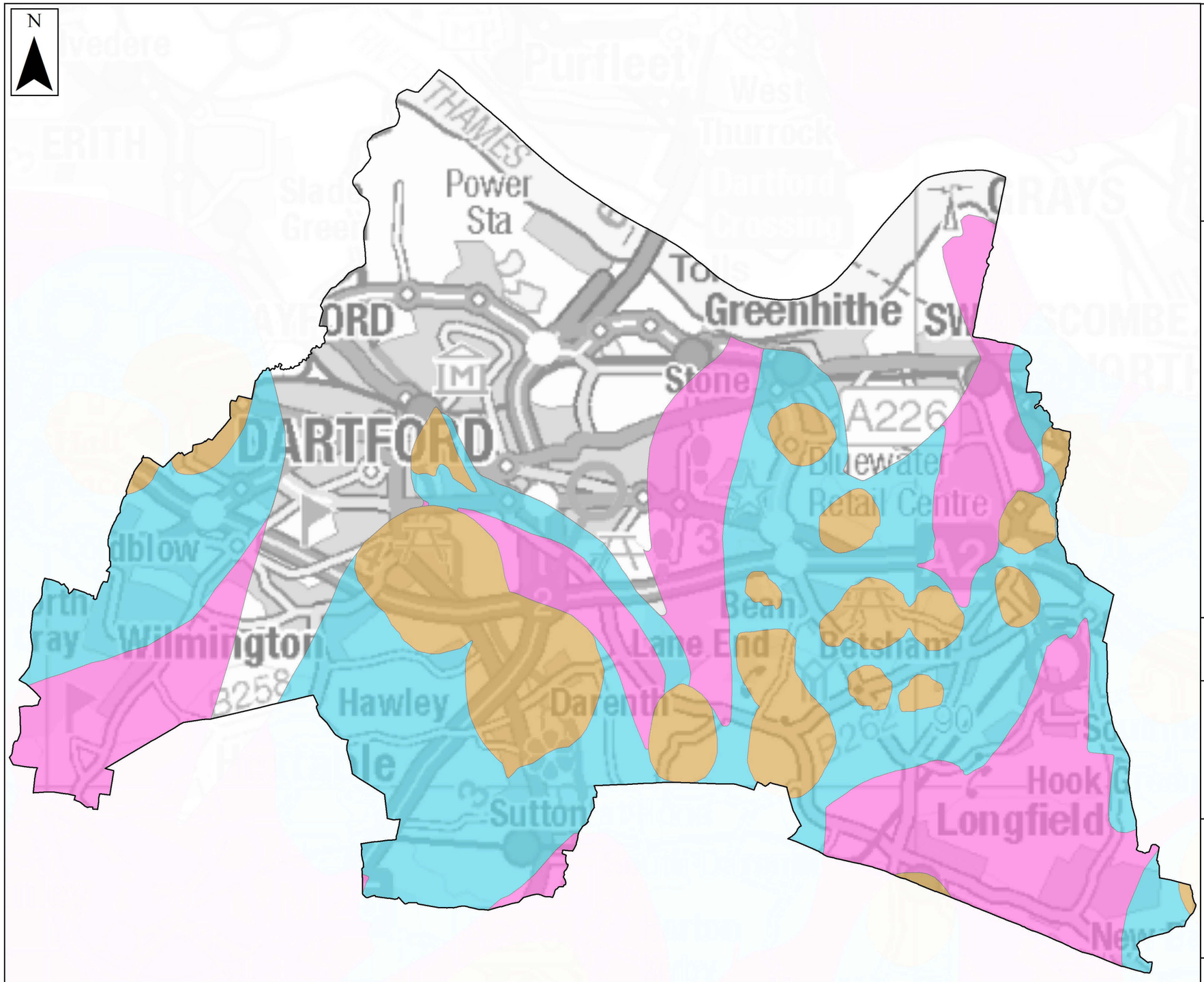
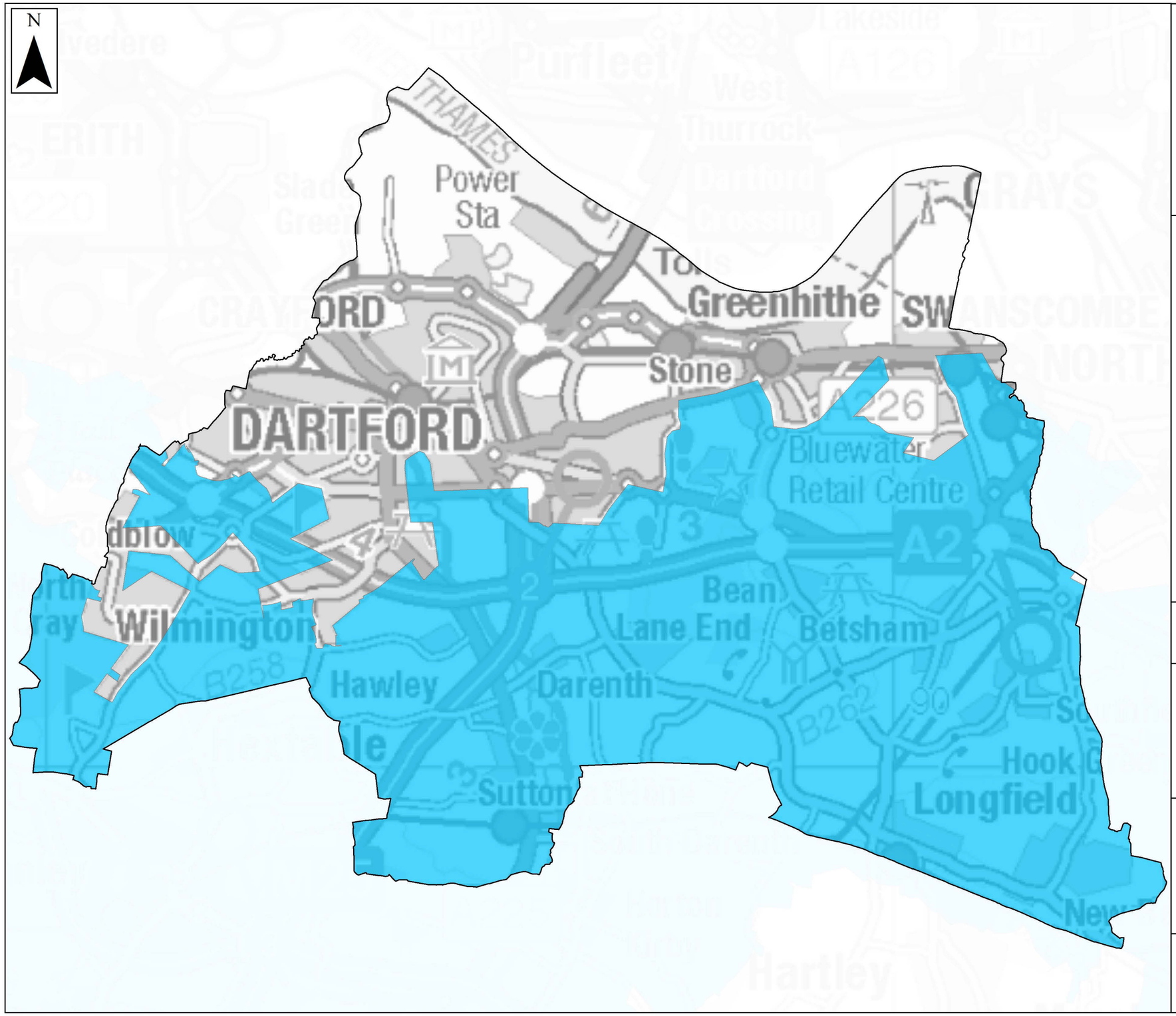


Figure 10-2: Nitrate Vulnerable Zones in the Local Plan area



11 Flood warning and emergency planning

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

11.1 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 (where appropriate) and the Environment Agency.

There are circumstances where a flood warning and evacuation plan[7] is required and / or advised:

- It is a **requirement under the 2018 NPPF** that safe access and escape routes are included in an FRA where appropriate, 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 estimate flood level.

It is recommended that Emergency Planners at Kent County Council (where appropriate) 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 acknowledge the following:

- 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.

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

- Proposed new development that places additional burdens on the existing response capacity of the Council 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 them. 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). These allocations should be assessed against the outputs of the SFRA and where applicable, a site-specific Flood Risk Assessment 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**

11.2 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 11-1.

Table 11-1: 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	• Move family, pets and valuables to a safe place

Flood Warning Symbol	What it means	What to do
	action to protect themselves and their property.	• 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 in order 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.

11.2.1 Flood Alert and Warning Areas in the Local Plan area

There are currently four Flood Alert Areas (FAAs) and six Flood Warning Areas (FWAs). These are displayed in Appendix J. A list of the FAAs in the study area are shown in Table 11-2 and a list of FWAs are shown in Table 11-3.

Table 11-2: Flood Alert Areas within Dartford Borough Local Plan area

Flood Alert Code	Flood Alert Name	Source of flooding	Description
064WAF7Darent	River Darent from Westerham to Dartford	River Darent	The River Darent from Westerham to Dartford, including Sutton at Hone

Flood Alert Code	Flood Alert Name	Source of flooding	Description
064WAT1ThamesEst	Coast from Dartford to Allhallows	River Thames, River Darent, River Cray (Tidal)	Areas at risk of tidal flooding from Dartford to Allhallows, including Crayford, Greenhithe, and the North Kent Marshes
064WAF7ShutCray	Shuttle and Cray	River Cray, River Shuttle	The River Cray from St Mary's Cray to Crayford, including Hall Place and the River Shuttle from Blackfen through Sidcup to Old Bexley
064FAG99SElondon	Groundwater flooding in South East London	Groundwater	This FAA covers a very limited area of Dartford Borough along its western border with the London Borough of Bexley

Table 11-3: Flood Warning Areas within Dartford Borough Local Plan area

Flood Warning Code	Flood Warning Name	Source of flooding	Description
064FWF7Otford	River Darent from Otford to Darenth	River Darent	River Darent in Sutton-at-Hone and Darenth to Hawley
064FWT1Seaward	Properties seaward side of tidal defences from Greenhithe to Gravesend	River Thames (Tidal)	Areas at risk of tidal flooding on seaward side of tidal defences from Greenhithe to Denton
064FWF7Dartford	River Darent at Dartford Trade Park, Brooklands and Dartford to the Thames estuary	River Darent	River Darent in Hawley, the Dartford Trade Park, Brooklands, Dartford Town Centre, Dartford and Crayford Marshes
064FWT1Gravesend	Gravesend and Northfleet	River Thames (Tidal)	Areas at risk of tidal flooding in Gravesend and Northfleet, including Swanscombe
064FWF7Cray	River Cray in St Marys Cray, Sidcup, Bexley and Crayford	River Cray	The River Cray in Crayford to the River Darent

Flood Warning Code	Flood Warning Name	Source of flooding	Description
064FWT1Dartford	Dartford, Crayford and Greenhithe	River Thames, River Darent, River Cray (Tidal)	Areas at risk of tidal flooding in Dartford, Crayford and Greenhithe

11.2.2 Reservoirs

Reservoir flooding is very different from other forms of flooding. It may happen with little or no warning and evacuation will need to happen immediately. The likelihood of such flooding is difficult to estimate, but it is very much less likely than flooding from rivers or surface water. It may not be possible or safe to seek refuge upstairs from floodwater as buildings could be unsafe or unstable due to the force of water from the reservoir breach or failure.

11.2.3 Local arrangements for managing flood risk

The **Dartford Major Emergency Response Plan** includes details about the Council's responsibilities as a Category 1 responder, as well as responsibilities of Dartford Borough Council and Kent County Council in relation to flooding. Dartford Borough Council's website also provides information on emergency planning, community action, and the Council's responsibilities as a Category 1 responder. Additionally, the **Kent County Council Flood Response Plan** outlines the response of the Local Authority to a flooding event, with information on actions, roles and responsibilities, with coastal, fluvial, surface water and groundwater flooding all accounted for.

11.3 Emergency planning and development

11.3.1 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 on 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 (February, 2016). 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. In particular sites should be considered in relation to the areas of drainage critical problems highlighted in the relevant SWMPs.

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

11.3.2 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[8]. 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. 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 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 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 Dartford Borough Council 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.

11.3.3 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[9]:

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 and application of the Sequential Test aims to avoid inappropriate development in flood risk areas. However, 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 at lower risk of flooding, with development which has a lower vulnerability (parking, open space etc.) in the highest risk areas, unless there are overriding reasons to prefer a different location[10]. Where the overriding reasons cannot be avoided, safe and practical evacuation routes must be identified.

[8] NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 039, Reference ID: 7-056-20140306) March 2014
[9] NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 057, Reference ID: 7-057-20140306) March 2014
[10] NPPF Planning Practice Guidance, Reducing the causes and impacts of flooding Paragraph: 053 Reference ID: 7-053-20140306

The Environment Agency and Defra provide standing advice for undertaking flood risk assessments for planning applications. Please refer to **the government website** for the criteria on when to follow the standing advice. Under these criteria, you 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:

- 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[11].

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 allocations should be assessed against the outputs of the SFRA and where applicable, a site-specific Flood Risk Assessment to help develop appropriate emergency plans.

11.3.4 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 used for holiday or short-let caravans and camping and are important at any site that has transient occupants (e.g. hostels and hotels).

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 for useful links).

It is recommended that emergency planners at Kent County Council are consulted prior to the production of any emergency flood plan. The council will 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 Kent County Council 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.

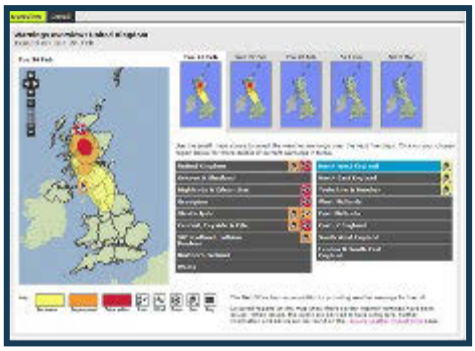
Guidance documents for preparation of flood response plans

- **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**

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

11.3.5 Other sources of information

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 practice 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.

12 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 to address existing flood risk and / or mitigate the effects of development

12.1 Introduction

Strategic flood risk solutions serve more than one development site and may offer a potential opportunity to reduce flood risk in the Local Plan area. The following sections outline different options which could be considered for strategic flood risk solutions. Any strategic solution 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.

12.2 Flood storage schemes

Flood storage schemes aim to reduce the flows passed downriver to mitigate downstream flooding. Development 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. Flood storage schemes have the advantage that they generally benefit areas downstream, not just the local area.

12.3 Flood defences

There are a number of formal flood and coastal defences present within the study area (see Section 8 for further information). The flood risk at several potential sites identified within Dartford Borough 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. Maintenance arrangements, including funding mechanisms, for the defences will need to be evidenced for the lifetime of development.

12.4 Land raising

Increasing the elevation of land for whole or parts of the sites could be implemented to prevent flood flows affecting the land up to the design level. The elevation selected could be determined to coincide with the re-designation of the site (or part of the site) from one Flood Zone to another (e.g. from Flood Zone 3a to Flood Zone 2).

Raising of land which floods would reduce the volume of storage on the floodplain in a flood event. Such ground level adjustments would therefore require level for level floodplain volume compensation (so no loss of floodplain storage occurs) and also analysis to evidence that the increase in ground levels does not result in adverse changes in flood risk (or other environmental issues) elsewhere, e.g. through deflection of flood water or loss of conveyance.

In low-lying areas of land with little topographic gradient it is likely that conveyance of fluvial flood water may be less critical than the loss of floodplain volume, whereas in areas with greater topographic gradient, conveyance may become more critical.

For tidal areas, flood volumes may be less critical given the role of the tidal ingress or coastal water levels. However, conveyance and constriction may be a critical consideration if the development obstructs the ingress or outflow of tidal water, for instance in the tidal Dartford floodplain, potentially leading to deflection of water and elevation of water levels from the pre-development case. Also, in circumstances where there is land raising in a coastal flood cell consideration would need to be given that the loss of storage volume in the cell due to land raising did not exacerbate flooding elsewhere. There may be some benefit of land raising directly on the tidal frontage, where it would create an 'unbreachable' defence.

12.5 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. The policies and guidance produced by KCC as the LLFA are summarised in Section 10.

12.6 Natural Flood Management

Natural Flood Management (NFM) is the use of natural functions of catchments, floodplains, rivers and the coast to reduce flooding and coastal erosion.

Consideration of 're-wilding' rivers upstream could provide cost efficiencies as well as addressing 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.

12.6.1 Catchment and Floodplain restoration

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

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.

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 emerging Local Plan 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. Any losses of floodplain connectivity could potentially increase flooding.

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

Structures, both within watercourses and adjacent to them can have significant impacts upon rivers including alterations to the geomorphology and hydraulics of the channel through water impoundment and altering 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, including the passage of fish and invertebrates.

Many artificial in-channel structures (examples include weirs and culverts) are often redundant and / or serve little purpose and developers should seek opportunities to restore culverted watercourses to a natural open river channel 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 weir 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. This will allow more natural water level variations upstream of the weir and remove a barrier to fish migration.

12.6.3 Bank Stabilisation

Bank erosion should generally be avoided, and landowners are 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, with soft engineering options preferred over hard engineering. 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.

However, bank erosion can be part of natural riverine processes, and should be allowed to happen in some circumstances.

12.6.4 Working with Natural Processes

Developments provide opportunities to work with natural processes to reduce flood and erosion risk, benefit the natural environment and reduce costs of schemes. NFM requires integrated catchment management and involves those who use and shape the land. It also requires partnership working with neighbouring authorities, organisations and water management bodies. The Environment Agency and JBA Consulting have developed **Working with Natural Processes mapping** which displays opportunities for NFM. The mapping highlights areas surrounding the River Darent as the main region of Dartford Borough where there are opportunities for NFM.

12.7 Green Infrastructure

Green Infrastructure (GI) or a 'Green Grid' is a planned and managed network of natural environmental components and green spaces that intersperse and connect the urban centres, suburbs and rural fringe and 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 sustainable growth. It 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 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 opportunity for leisure, economic activity and biodiversity.

The **Adopted Dartford Local Plan Core Strategy** (2011) provides detail on how the council will implement a Green Grid in Policy CS 14, as well as recognising the role of the green infrastructure network will play in managing and mitigating flood risk in Policy CS 24. Figure 7 of the Dartford Development Policies Plan (2017) shows an updated indication of green spaces and links within the Borough.

12.8 Engaging with key stakeholders

Flood risk to an area or development can often be attributed to a number of sources such as 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 highlighted 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 river bed 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).

13 Level 1 assessment

This section details the site screening of potential development sites that was carried out as part of the Level 1 SFRA, as well as the cumulative impact assessment.

13.1 Introduction

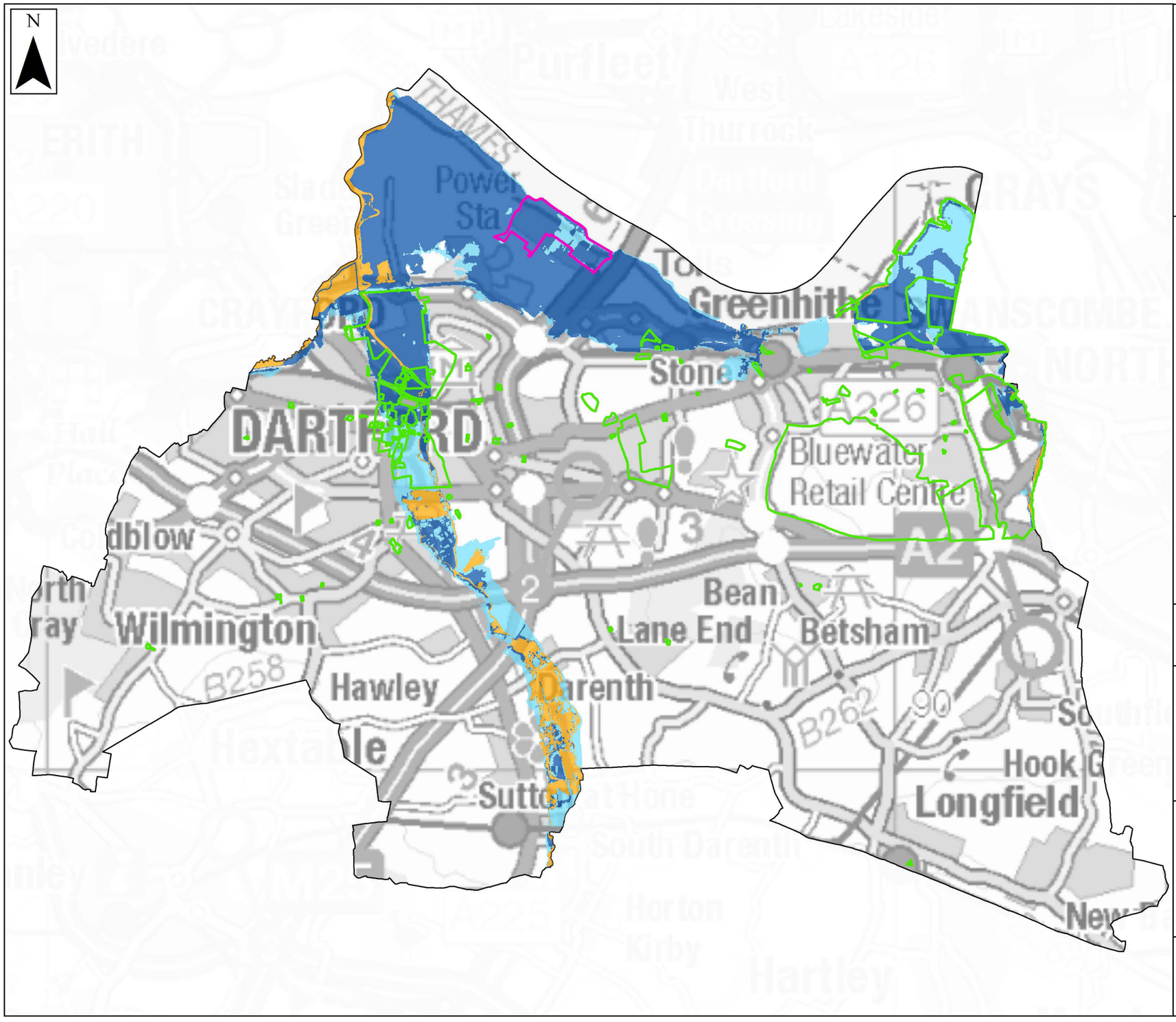
A total of 109 sites were provided by Dartford Borough Council, as shown in Figure 13-1. The sites that were screened include potential development locations identified as part of a Strategic Housing Land Availability Assessment (SHLAA) for the emerging Local Plan, as well as existing development locations adopted in the 2017 Development Policies Plan. The sites that were screened also include locations that have already been given planning permission. 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 L).

The information considered includes the flood risk datasets listed below:

- Environment Agency Flood Zones 2 and 3
- Flood Zone 3b
- Fluvial and tidal 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 Historic Flood Map
- Areas Susceptible to Groundwater Flooding

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 13-1: Sites screened with Flood Zones



13.2 Overview of risk at identified sites

A summary of the flood risk at each of the sites in light of the screening is provided below. Please note that the summary does not include the 27 sites with existing planning permission:

- Flood Zone composition is varied across the sites. However, the majority of the sites have Flood Zone 1 comprising the largest proportion of their area, with 45 sites completely located within Flood Zone 1.
- 27 sites are partially located within Flood Zone 2
- 25 sites are partially located within Flood Zone 3a
- 7 sites are at least partially located within Flood Zone 3b
- 29 sites are predicted to be at risk of fluvial flooding in the future due to climate change
- 38 sites are predicted to be at risk from tidal flooding in the future due to climate change
- 62 sites are predicted to be at risk of surface water flooding from a 0.1% AEP event
- 26 sites intersect the Environment Agency's historic flood outlines
- 66 sites are at least partially located within a 1km grid cell a proportion of the area is susceptible to groundwater flooding.

13.3 Sequential Testing

The SFRA does not include the Sequential Test of the development sites that were screened. However, Appendix L 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, broad locations and strategic 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 an emerging Local Plan 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 an emerging Local Plan. The assessments undertaken for this SFRA will assist Dartford Borough Council in the preparation of the Sequential Test.

13.4 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 2018 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 156).

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 Local Plan, to the planning application and development design stages.

The cumulative impacts will be considered in more detail on an individual site basis within the 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.

As part of the Level 1 SFRA, an assessment of the cumulative effects within catchments in Dartford has been undertaken.

13.4.1 Approach and methodology

The approach is based on providing an assessment of catchments where the allocation of more than one site could result in effects that increase the flood risk to third parties. At a strategic level this involves comparison of catchments, to assess 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, which provide a balance between predicted and observed flooding data recorded by 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

13.4.2 Datasets

Catchments

Dartford Borough was divided into 10 catchments with which to base a cumulative impact assessment, with the catchments delineated using the EA's LIDAR dataset.

Current developed area

OS OpenMap buildings layer was used to assess the current developed area in each catchment.

Proposed level of growth

To understand areas of the Dartford borough that are likely to experience the greatest pressure for future growth, all potential future development sites which have been considered to take forward in the Local Plan have been analysed. These include sites which are part of a strategic site, strategic sites, broad locations, suitable sites, possible sites and sites with planning permission.

Neighbouring authorities have also been taken into account within the proposed level of growth for each catchment. The following data from the neighbouring authorities has been assessed:

- **Bexley**

  Confirmation from Bexley council has been received which states that their publication of the draft Local Plan is scheduled to take place later this year. As such, they are currently undertaking work to determine which sites will be allocated in the Local Plan and the sites were unavailable at the time of preparing this SFRA. Therefore, the Opportunity Areas and Employment Land within the **Bexley Growth Strategy** have been used to indicate potential future development sites.

- **Bromley**

Although not a neighbouring authority, two catchments lie within the Bromley authority area. As such, the allocated sites in the **Bromley Local Plan** have been used to assess potential development in the catchments.

- **Sevenoaks**

  Sevenoaks District Council provided their Local Plan Submission Sites to use within the assessment.

- **Gravesham**

  Gravesham Borough Council provided their Key Sites and Opportunity Areas within their adopted Local Plan Core Strategy (2014) to use within in the assessment.

- **Ebbsfleet Development Corporation**

  The Ebbsfleet Garden City outline was provided by Ebbsfleet Development Corporation for use in the assessment.

It should be noted that it was assumed that all sites will be developed, and the entire footprint will be developed.

The proposed development areas allowed the calculation of the overall increase in development from the existing scenario, 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, then it is more likely to give rise to cumulative effects.

Historic Flood Risk

A historic flood risk score was derived for each catchment within the study area using the total current area of building footprint within the Environment Agency's historic flood map in each catchment.

Properties sensitive to increased flood risk

It is important to understand which catchments are most sensitive to increases in flood flows which may theoretically be caused by new development. Predicted flood risk was assessed using the following datasets:

- Total area of building footprint within the merged 1% AEP surface water flooding extent and fluvial Flood Zone 3a for each catchment
- Total area of building footprint within the merged 0.1% AEP surface water flooding extent and fluvial Flood Zone 2 (excluding historic outlines).

The difference in the number properties at risk in these two datasets has then been used as an indicator to identify which catchments are more sensitive to increases in flood flows.

13.4.3 Ranking of catchments

To identify which catchments are more sensitive to cumulative impacts, each catchment was given a ranking for each of the three metrics (proposed level of growth, historic flood risk and properties sensitive to growth). These rankings were then combined to give an overall ranking which was divided into three categories, high, medium and low according to how sensitive each catchment is to cumulative impacts relative to one another.

13.4.4 Conclusions of the Cumulative Impact Assessment

A summary of the Cumulative Impacts Assessment results is shown in Figure 13-2. The Cumulative Impact Assessment highlights areas where there is a high chance of encountering cumulative effects from planned development. In these catchments this

should be considered by developers and specifically addressed within FRAs for proposed development.

Including consideration of cumulative effects requires that FRAs should assess:

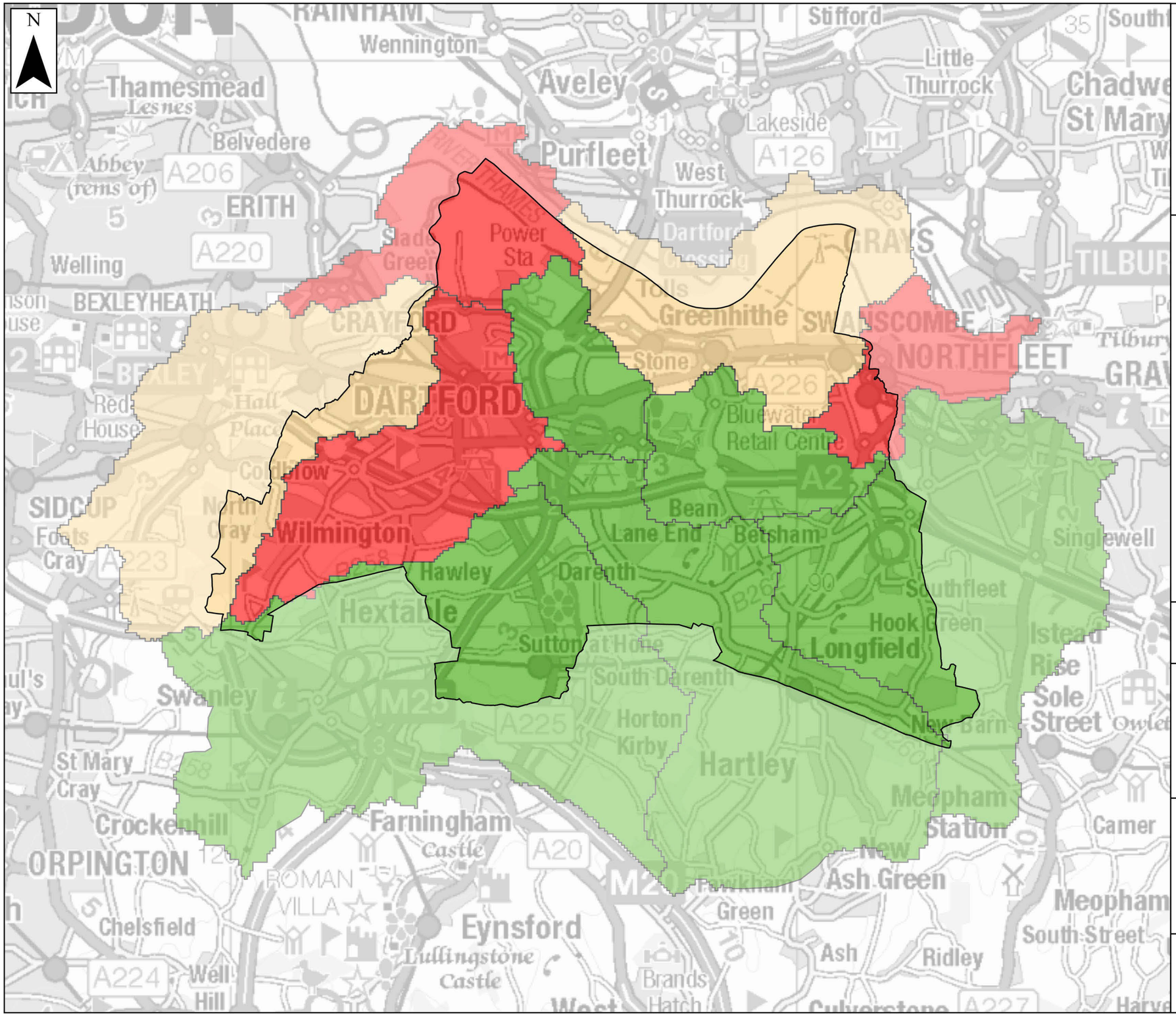
- The location and sensitivity of receptors to cumulative effects and the mechanisms that potentially result in flooding (e.g. locations that are reliant on the performance of pumped drainage systems to manage flood risk, locations where existing flooding is experienced and can be exacerbated by relatively small changes in flood flow magnitude, volume or flood duration, etc)
- The potential quantum of proposed cumulative development within a River Basin 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 Basin
- The long-term commitments to management and maintenance

13.4.5 Next steps

The Cumulative Impact Assessment is used in the following ways:

- The assessment highlights the catchments in the borough where the cumulative impacts of development on flood risk could potentially be greatest. Developers and Dartford Borough Council should take the assessment into consideration when identifying appropriate sites for development.
- For sites in catchments identified as being at high or medium risk of cumulative impacts FRAs should contain an assessment of the potential cumulative impacts of development further as outlined within Section 13.4.4.
- For sites taken forward to a Level 2 SFRA, the cumulative impacts of development are considered in further detail.

Figure 13-2: Relative sensitivity to cumulative impacts by catchment



14 Level 2 assessment

14.1 Introduction

The primary purpose of the Level 2 Strategic Flood Risk Assessment (SFRA) is to provide an appropriate understanding of the level of actual risk affecting development included in the Local Plan. It should be noted that the actual risk is the predicted flooding including for the presence of the effect of flood defences and other flood risk management measures, whereas Flood Zones describe the risk without taking account of the effect of flood defences and flood risk management measures (where there are no flood defences or flood risk management measures the actual risk is the same as shown on the Flood Zones). Having understood the risk, the assessment identifies, as appropriate outline arrangements so development can be implemented safely and remain safe over the intended life.

The Level 2 assessment provides an understanding of actual risk, and so in circumstances where there are existing flood risk management measures, it is important to understand the level of protection these afford and how the standard of protection changes over time as a consequence of climate change effects. There are locations in Dartford, such as along the Thames Frontage where existing tidal and coastal defences should be considered to understand the actual risk. There are also locations where the risk of flooding from surface water and groundwater must be evaluated, together with the commitment to measures that maintain the safety of development over the intended life. The Level 2 assessment also provides further information on flood depths, extent of flooding, flood velocities and flood hazard for the present-day situation as well as flood extents for climate change conditions allowing the change over the lifetime of proposed development to be understood.

The focus of the Level 2 assessment is to provide evidence to support planning decisions about the design and location of any development or flood risk management features or structures. The principles and approach adopted for the assessment should also be applied to windfall sites (proposed development not included in the plan), particularly with respect to providing evidence within Flood Risk Assessments (FRAs) that flood risk will be appropriately managed over the life of proposed new development.

In Dartford Borough, not all development can be allocated outside of flood risk areas. Therefore, a Level 2 SFRA was required in addition to the Level 1 assessment.

Sites allocated for development and potential allocations were provided by Dartford Borough Council for assessment in the SFRA. In the Level 1 assessment, site screening of 109 sites provided by Dartford Borough Council was conducted. Details of this can be found in Section 13. Following the Level 1 assessment it was identified that a Level 2 assessment should be performed on 11 sites. The Level 2 assessment is based on the potential flood risk from all sources, including coastal, tidal, fluvial, surface water and groundwater flood risk to the sites. The sites included in the Level 2 SFRA are listed in Table 14-1 which also provides justification as to why these sites were considered in the Level 2 SFRA.

Table 14-1: Level 2 sites and justification for inclusion in the Level 2 assessment

Site Name	Justification
Prospect Place	This site is an opportunity to contribute to the regeneration of Dartford Town Centre. The site has been shown to be at risk from tidal / fluvial flooding.
Priory Shopping Centre	This site is an opportunity to contribute to the regeneration of Dartford Town Centre. The site has been shown to be at risk from both fluvial and surface water flooding
Town Centre North East	This site is an opportunity to contribute to the regeneration of Dartford Town Centre. The site has been shown to be at risk from both tidal / fluvial and surface water flooding
The Vicarage, Overy Liberty	This site is in close proximity to Dartford Town Centre which is an area of regeneration. The site has been shown to be at risk from tidal / fluvial and surface water flooding Please see the note in Section 14.4 regarding the outcome of the Level 2 site summary for this site.
Glentworth Club	This site is an opportunity to contribute to the regeneration of Dartford Town Centre. The site has been shown to be at risk from both fluvial and surface water flooding
Burnham Trading Estate	This site is currently an underused employment area with the opportunity for redevelopment
Lower Hythe Street and Central Road	This site is an opportunity to contribute to the regeneration of the Northern Gateway. The site has been shown to be at risk from both fluvial and tidal flooding
Ebbsfleet Central	This site is a longstanding opportunity for regeneration development centred around Ebbsfleet International Station, now within Ebbsfleet Garden City. The site has been shown to be at risk from both fluvial and tidal flooding
Swanscombe Peninsula	Part of this area is brownfield land which has the potential for regeneration development as part of Ebbsfleet Garden City (N.B. The wider Peninsula is proposed for the London Resort). The area has been shown to be at risk of tidal flooding.
Former Littlebrook Power Station	This site has potential for employment development to augment areas which already have planning permission. The site has been shown to be at risk of tidal flooding
South of Steele Avenue	This site has the potential for a health facility and residential development in an area with good access to facilities and public transport. The site has been shown to be at risk from both tidal and surface water flooding

14.2 Site summary tables

As part of the Level 2 SFRA, detailed site summary tables have been prepared for each of the sites brought forward for the Level 2 analysis. Table 14-2 details the information set out in the summary tables. Additionally, each site summary table provides more detailed information on:

- the resolution and detail of the analysis used to assess the flood risk (more detailed data and higher resolution flood modelling has been prepared so appropriate evidence is available to consider the implications of satisfying the Exception Test);
- the severity and extent of actual flood risk across proposed sites;
- the site-specific flood risk assessment requirements; and
- the implications for the preparation of local policies to provide for sustainable developments as well as reducing flood risk to existing communities.

Table 14-2: Information content of the Level 2 site summary tables

Section	Information
Site details	OS Grid reference Local Authority Area Current land use (greenfield or brownfield) Proposed site use Flood risk vulnerability Topography
Sources of flood risk	Existing watercourses Flood history Fluvial/Tidal risk Surface water risk Tidally influence groundwater and surface water risk Groundwater risk Reservoir risk
Flood risk management infrastructure	Defences Residual risk
Emergency planning	Flood warning Access and egress
Climate Change	Modelled increases in flood extent compared to the 1% AEP fluvial / 0.5% AEP tidal event, and the implications for the site. Modelled impact of climate change on surface water risk and the implications for the site.
Requirements for drainage control and impact mitigation	Bedrock geology Superficial Geology Soils Groundwater Source Protection Zone Historic Landfill Site Broadscale assessment of possible SuDS Cumulative impacts of development
Recommendations for Local Plan policy:	Sequential Test and Exception Test requirements Recommendations for requirements of site-specific Flood Risk Assessment, including guidance for developers

14.3 Accompanying mapping

To accompany each site summary table, higher resolution flood mapping has been prepared. The mapping is intended to be read alongside the appropriate site summary table. Mapping of flood risk from all sources of flooding is displayed as the sequential and exception test should be applied to all sources of flooding. The accompanying mapping displays flood risk data in compliance of the government standing advice that flood risk assessments must establish estimated flood level for the lifetime of development and must also consider other sources of flooding for the lifetime of development. Further details of requirements for a flood risk assessment and the government standing advice are located in Section 9 Flood risk information on the higher resolution mapping includes:

- **Site boundary**
- **Environment Agency Flood Zones 2, 3a and 3b (functional floodplain) -** these are used to identify the requirements for a Flood Risk Assessment and to support the Sequential Test and Exception Test. Further details on these are provided in the Sequential Test and Exception Test requirements section of each site sheet.
- **Modelled Fluvial 1% AEP plus 25%, 35% and 70% flood extents showing the predicted actual risk (if available)** – these are used to consider the potential effects of climate change on development. The allowances selected are based on the type of development being assessed. The Environment Agency provide guidance on this through the *Flood risk assessments: climate change allowances*[12] webpage.
- **Modelled Tidal/Coastal 0.5% AEP 2120 EPOCH Higher Central and Upper End flood extents (if available)** - these are used to consider the potential effects of climate change on development. The allowances selected are based on the type of development. The Environment Agency provide guidance on this through the *Flood risk assessments: climate change allowances*[1] webpage.
- **Modelled 1% AEP fluvial/ 0.5% tidal depth, velocity and hazard outputs (if available)** – these are used to describe the site-specific risk of flooding including depth, velocity and hazard.
- **Environment Agency's recorded flood outlines** – these are used to show previous flood events that have impacted the site.
- **Risk of Flooding from Surface Water 3.33%, 1% and 0.1% AEP flood extents** – these are required to support the exception test. It is important that surface water management is considered and therefore the Risk of Flooding from Surface Water (RoFSW) dataset has been used to identify those sites which are potentially at risk of flood from surface water.
- **Risk of Flooding from Surface Water 1% AEP depths, hazards and velocities** – these are used to describe the site-specific risk of flooding from surface water including the depth and velocity.
- **Risk of Flooding from Surface Water 1% AEP plus 20% and 40% climate change uplifts** – these are used to show the potential risk of flooding from surface water, taking into account the potential future flood risk as a result of climate change.

12 https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

- **Environment Agency's Areas Susceptible to Groundwater Flooding mapping**– this dataset is used to identify areas at potential groundwater flood risk to support the assessment of flood risk from other sources.
- **Thames Frontage 2018 Breach modelling –** mapping displays modelling outputs of breach analysis conducted on defences along the Thames frontage. This dataset is used to identify areas at potential residual risk to support the assessment of flood risk from other sources.

14.4 The Vicarage

A Level 2 site summary and mapping was prepared for The Vicarage site and can be found in appendices M and N. However, the results of the assessment highlighted a significant fluvial and tidal flood risk at the site both during the present day and future scenarios. Although additional modelling outlined in Section 8.5.2 was undertaken, there were no measures identified which could make the site safe for its lifetime and provide safe access and egress. Although included within the Level 2 SFRA, it is understood from Dartford Borough Council that this site will not be taken forward within the Local Plan.

15 Summary

15.1 Overview

This Level 1 SFRA delivers a strategic assessment of all sources of flooding in the Local Plan area. It also provides an overview of policy and provides guidance for planners and developers. The study area comprises the administration area of Dartford Borough Council.

15.2 Sources of flood risk

The sources of flood risk in Dartford have been assessed, further information on the data sources used can be found in Section 6 and the findings can be found in Section 7. A summary is outlined below.

15.2.1 Historic flooding

There have been several recorded flood incidents across the study area, with tidal and fluvial flooding both impacting large areas of Dartford Borough in the past.

Fluvial flood risk in the borough is largely associated with the River Darent, with fluvial flooding from the watercourse recorded in 1968, 1993 and 2002/03. Fluvial flooding has also been recorded along the River Cray and from small watercourses / drainage channels in the north of the borough.

The study area has also been affected by historic tidal flood events, most notably in 1953 and 1978.

Surface water flooding has been recorded across the borough, predominantly impacting highways.

Groundwater flooding has been recorded in the southern part of Sutton at Hone. Additionally, sewer flooding has been recorded in settlements across the Local Plan area, most frequently in Dartford Town Centre, Joydens Wood, Longfield and Swanscombe.

The Environment Agency's Recorded Flood Outline mapping can be found in Appendix B.

15.2.2 Fluvial flood risk

There are several watercourses throughout the study area which are identified to contribute to fluvial flood risk, such as the River Darent, River Cray, and the Ebbsfleet River. Main Rivers and Ordinary Watercourses within Dartford Borough are mapped in Appendix C. Flood Zone mapping and climate change mapping of the fluvial flood risk in the Local Plan area has been prepared as part of the Level 1 SFRA and can be found in Appendices D and E.

15.2.3 Tidal flood risk

The study area is bound by the Thames Estuary to the north and as such there is a notable tidal flood risk across the north of the borough. Additionally, many of the river networks are tidally influenced, including the lower reaches of the River Darent and River Cray. The combination of high tides and high river levels can result in tidal locking of watercourses as they are unable to discharge. There is also the possibility that tidal defences can fail or be overtopped. The assessment of the 'residual' risk of defence failure should be considered on a site by site basis. Appendix D shows the tidal Flood Zones and Appendix E includes the effect of climate change on the tidal flood risk.

15.2.4 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 ponding in low lying areas. The Risk of Flooding from Surface Water maps are shown in Appendix F. Mapping showing the impact of climate change on surface water flood risk is shown in Appendix G.

15.2.5 Groundwater flood risk

The Areas Susceptible to Groundwater Flooding indicates that the susceptibility to groundwater flooding is generally greatest along the routes of the River Darent and River Cray. The Areas Susceptible to Groundwater Flooding mapping can be found in Appendix H.

15.2.6 Sewer flood risk

Historical incidents of sewer flooding are detailed by the Southern Water SIRF and Thames Water SFHD datasets, and a summary can be found in Table 7-3. 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 59 incidents have been recorded.

15.2.7 Flooding from reservoirs

The Risk of Flooding from Reservoirs dataset (informed from the National Reservoir Inundation Mapping study) shows worst case inundation extents of two reservoirs impacting a small area of Dartford Borough near the confluence of the River Darent and River Cray. The mapping is available from the **Flood Warning Information Service**.

15.3 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.

Mapping showing the residual flood risk associated with breaches from defences along the River Thames and River Darent is available in Appendix K.

15.4 Key policies

There are many relevant regional and local key policies which have been considered within the SFRA (Section 2), such as the North Kent Rivers Catchment Flood Management Plan, Thames River Basin Management Plan, the Preliminary Flood Risk Assessment, the TE2100 and Kent Local Flood Risk Management Strategy. Other policy considerations have also been incorporated, such as sustainable development principles, climate change and flood risk management.

15.5 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 (Section 4). Links have been provided for various guidance documents and policies published by other Risk Management Authorities, such as Kent County Council as the LLFA and the Environment Agency.

16 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 Dartford Borough Council to consider as part of Flood Risk Management in the study area.

16.1 Development management

16.1.1 For Dartford Borough Council

Sequential and Exception tests

The SFRA has identified that areas of Dartford Borough are at high risk of flooding from, tidal, surface water and fluvial sources. Therefore, it is expected that several proposed development sites will be required to pass the Sequential and, where necessary, Exception Tests in accordance with the NPPF. Dartford Borough Council should use the information in this SFRA when deciding which development sites to take forward in the emerging Local Plan.

In accordance with the NPPF guidance the Sequential Test should use the present-day flood zones for the consideration of site allocations and windfall sites. However, it is recommended that the Council gives consideration to the climate change maps to understand how the flood zones are predicted to change over the lifetime of the development. All other sources of flooding should also be considered as part of 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. It is the responsibility of Dartford Borough Council to be satisfied that the Sequential Test has been passed.

Council review of planning applications

The Council should consult the Environment Agency's '**Flood Risk Assessment: Local Planning Authorities**', last updated 1 March 2019, 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. Southern Water, Thames Water) that have an interest in the planning application.

Future flood management

For successful future flood risk management, it is recommended that local planning authorities adopt a catchment partnership working approach in tackling flood risk and environmental management.

16.1.2 For developers

Sequential approach to development

The NPPF supports a risk-based and sequential approach to development and flood risk in England, so that development is located in the lowest flood risk areas where possible; it is recommended that this approach is adopted for all future developments within the borough.

New development and re-development of land should wherever possible seek opportunities to reduce overall level of flood risk at the site, for example by:

- Reducing volume and rate of runoff through the use of SuDS, as informed by the **Water, People, Places: A guide for master planning sustainable**

drainage into developments, the **Kent County Council Drainage and Planning Policy**, Kent County Council's **Making it Happen** guidance for the relevant wastewater treatment catchment

- Relocating development to zones with lower flood risk
- Creating space for flooding
- GI should be considered within the mitigation measures for surface water runoff from potential development and consider using Flood Zones 2 and 3 as public open space
- Consideration must be given to the potential cumulative impact of development on flood risk.

Site-specific flood risk assessments

Site specific FRAs 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 passes part b of the Exception Test. The requirements for developers in preparing FRAs are set out in Section 9.4.

Developers should, where required, undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extents (including latest climate change allowances), inform development zoning within the site and prove, if required, whether the Exception Test can be passed. Where a site-specific FRA has produced modelling outlines which differ from the Flood Map for Planning then a full evidence-based review would be required. Where the watercourses are embanked, the effect of overtopping and breach must be considered and appropriately assessed.

All new development within the 1% AEP (Annual Exceedance Probability) flood extent including an allowance for climate change (for the lifetime of the development) must not normally result in a net loss of flood storage capacity. Where possible, opportunities should be sought to achieve an increase in the provision of floodplain storage. Where proposed development results in a change in building footprint, the developer should ensure that it does not impact upon the ability of the floodplain to store or convey water and seek opportunities to provide floodplain betterment. Similarly, where ground levels are elevated to raise the development out of the floodplain, compensatory floodplain storage within areas that currently lie outside the floodplain should normally be provided so the total volume of the floodplain storage is not reduced. Any flood risk management measures should be consistent with the wider catchment policies set out in the Catchment Flood Management Plan, Flood Risk Management Plan and Local Flood Risk Management Strategy.

A **revised NPPF** was published on 24 July 2018 (last updated June 2019) setting out the Government's planning policies for England and how these are expected to be applied. This revised framework replaces the previous NPPF published in March 2012.

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 (NPPG, Defra)

It should be noted that the **UKCP18** was published on 26 November 2018. The UKCP18 projections replace the UKCP09 projections and is the official source of information on how the climate of the UK may change over the rest of this century. The Environment Agency climate change guidance was updated in late December 2019. When undertaking an FRA, please refer to the most up to date climate change allowances provided by the Environment Agency.

Developers should consult with Dartford Borough Council, Kent County Council, the Environment Agency and Southern Water / Thames Water at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling, and drainage assessment and design. Additionally, developments within the TE2100 area should seek further pre-application advice from the Environment Agency.

Residual risk

Residual risk is the risk that remains after mitigation measures are considered. 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.

Further, any developments located within an area protected by flood risk management measures, where the condition of those defences is 'fair' or 'poor', where the standard of protection is not of the required standard or where the failure of the intended level of service gives rise to unsafe conditions should be identified and appropriate responses identified.

The risk to development from reservoirs is residual but developers should consider reservoir flooding during the planning stage. They should seek to contact the reservoir owner to obtain information and should apply the sequential approach to locating development within the site. Developers should also consult with relevant authorities regarding emergency plans in case of reservoir breach. The long term commitment to management and maintenance of appropriate standards of safety should be established as being appropriate.

Safe access and egress

Minimum finished floor levels for development is set out in Section 9.4.3. If it is not practical to raise floor levels to those specified above, consultation with the Environment Agency will be required to determine alternative approaches.

Safe access and egress will need to be demonstrated at all development sites. Emergency vehicular access should be possible during times of flood.

Where development is located behind, or in an area benefitting from, defences, consideration should be given to the potential safety of the development, finished floor levels and for safe access and egress in the event of rapid inundation of water due to a defence breach with little warning.

Resilience measures will be required if buildings are situated in the flood risk area, and opportunities to enhance green infrastructure and reduce flood risk by making space for water should be sought.

Drainage strategies and SuDS

Planners should be aware of the conditions set by the LLFA for surface water management and ensure development proposals and applications are compliant with the **Kent County Council Drainage and Planning Policy** for the relevant catchment.

Large parts of Dartford Borough are located within Groundwater Source Protection Zones (GZPZs). Kent County Council and the Environment Agency have confirmed that infiltration is possible within GSPZs 1, 2 and 3. However, this will be constrained within SPZ1 and only clean roof drainage will be permitted. In GSPZ 2 and 3, infiltration is possible for surface run-off from roads, car parking and public or amenity provided the SUDS management train is used to treat the drainage. Further guidance regarding infiltration within GSPZs can be found in the **C753 CIRIA SuDS Manual** (2015) and **the Environment Agency's approach to groundwater protection**. GSPZs in Dartford Borough are discussed further in Section 10.3.7.

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 an amenity and recreational purposes. Development that may adversely affect green infrastructure assets should not be permitted.

The information provided in the SFRA should be used as a basis for investigating potential strategic flood risk solutions within the study area. Opportunities could consist of the following:

- Catchment and floodplain restoration;
- Flood storage areas;
- Opening up culverts, weir removal, and river restoration;
- The Regional Habitat Creation Programme; and
- Green infrastructure.

16.2 Technical recommendations

16.2.1 Potential modelling improvements

The Environment Agency regularly reviews its flood risk mapping, and it is important that they are approached to determine whether updated (more accurate) information is available prior to commencing a site-specific FRA.

16.2.2 Updates to SFRA

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 a range of sources, and the potential impacts of future climate change.

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 new modelling is incorporated into the Environment Agency's flood maps. Additionally, in time, the Flood Map for Planning website may be the most up to date for current day Flood Zones as the Environment Agency will update when any further modelling is undertaken in the Plan area and this may be before the SFRA is updated.

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 available from Risk Management Authorities.

It is recommended that the SFRA is reviewed internally, in line with the Environment Agency's Flood Zone map updates to ensure latest data is still represented in the SFRA, allowing a cycle of review and a review of any updated data by checking for any new information available from RMAs including the Environment Agency, Dartford Borough Council, and Kent County Council.

APPENDICES

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