Strategic Flood Risk Assessment Level 1

Hertfordshire Minerals and Waste Local Plan 2040

Hertfordshire County Council

Hertfordshire

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Hertfordshire

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1. Introduction

Previous Level 1 SFRAs

1.1. Hertfordshire County Council began a review of the adopted Minerals Local Plan in 2015 and the adopted Waste Local Plan in 2017, through the preparation of a separate Minerals Local Plan (MLP) and Waste Local Plan (WLP). During that time the emerging MLP had been through several rounds of consultation, the most recent being the Proposed Submission Minerals Local Plan (Regulation 19) in January 2019. The Draft WLP was most recently consulted in January 2021.

1.2. In support of the Proposed Submission Minerals Local Plan, a Level 1 Strategic Flood Risk Assessment (SFRA) and addendum was prepared and published alongside the consultation. Similarly, a Level 1 SFRA and addendum was also prepared for the Draft Waste Local Plan. The Environment Agency and Lead Local Flood Authority had been involved at all stages of the production of those previous SFRA documents.

1.3. On 14 December 2021 the County Council approved the withdrawal of the emerging Minerals Local Plan, emerging Waste Local Plan, and emerging Waste Facilities Design Guide Supplementary Planning Document (SPD), and agreed to bring together the work done so far on those documents into a single Minerals and Waste Local Plan.

1.4. The withdrawal of the emerging Minerals Local Plan and emerging Waste Local Plan also meant the withdrawal of the supporting evidence which included the SFRAs. The previous SFRAs have however served as the basis for the preparation of this SFRA document (and should be read in conjunction with it) and has been updated where appropriate.

1.5. Three mineral extraction sites proposed for allocation in the Minerals and Waste Local Plan (MAS01: The Briggens Estate, MAS02: Hatfield Aerodrome and MAS03: Land adjoining Coopers Green Lane) were previously assessed in an addendum to the previous MLP SFRA which subjected each site to the Sequential Test. The test concluded that none of the sites assessed required the implementation of an ‘exception test’ to justify their inclusion in the Plan. This SFRA should be read in conjunction with the previous MLP SFRA addendum.

1.6. The three proposed Mineral Allocation Sites are shown in the maps within Appendix 1 of this document to illustrate their location with respect to the different flood data within the county.

The Hertfordshire Level 1 SFRA

1.7. Hertfordshire County Council as both Minerals Planning Authority (MPA) and Waste Planning Authority (WPA) has produced this Level 1 Strategic Flood Risk Assessment (SFRA) to support the Minerals and Waste Local Plan (MWLP). This SFRA is intended to fulfil the requirements of paragraph 160 of the National Planning Policy Framework (July 2021), which 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."*

1.8. This Level 1 SFRA has been developed in-line with the guidance published by Department for Communities and Local Government (March 2012)[1] and the Flood Risk and Coastal Change chapter of the Planning Practice Guidance (PPG), which was issued in March 2014 and last updated in August 2021. Furthermore, this document takes account of the National Planning Policy Framework (NPPF) (July 2021); relevant sections of the PPG; and updates to district and borough SFRAs and other relevant data sets.

1.9. The purpose of a Level 1 SFRA is set out in the PPG and is summarised below:

1.10. "A Level 1 Assessment should be carried out in local authority areas 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 to the location of development and to identify whether development can be allocated outside high and medium flood risk areas, based on all sources of flooding, without application of the Exception Test. The Environment Agency and lead local flood authorities can advise on the key outputs from a Level 1 Strategic Flood Risk Assessment."

1.11. SFRAs are important documents that inform the plan making process, as the potential predicted impacts from climate change and the spread of built development have often increased the severity and frequency to which flooding occurs. This means that the risk of flooding should be assessed in order to inform the planning process.

[1] now the Department for Levelling Up, Housing and Communities (DLUHC)

1.12. This Level 1 SFRA is therefore primarily a desk-based study that identifies areas of flood risk within Hertfordshire. In addition to the guidance outlined in paragraph 1.8, this SFRA has also been written in accordance with available information from published district/borough SFRAs within the county and other reports that identify areas at risk of flooding.

1.13. The information contained within this Level 1 SFRA can be used to apply the 'Sequential Test' when assessing potential sites for both minerals extraction and waste management facilities. It is recognised that after the application of the sequential test, some potential mineral extraction and waste management sites may still be located within, or partly within flood zones 2 and 3.

Locality

1.14. Hertfordshire is geographically located in South East England and covers an area of 634 sq. miles. It is situated immediately north of London and adjoins the counties of Buckinghamshire, Bedfordshire, Cambridgeshire and Essex. The county contains a number of diverse settlements from the historic market towns of Hertford, St Albans and Watford, the Garden Cities of Letchworth and Welwyn Garden City and the post-war new towns of Hatfield, Hemel Hempstead and Stevenage.

1.15. There are no regional airports in the county; however, the close proximity of Luton and Stansted and their proposed extensions could have significant effects for the county. Part of East Hertfordshire also falls within the Government's London-Stansted-Peterborough-Cambridge Corridor Growth Area, which means that additional developments arising directly from this will have to be planned for. Further growth of Dunstable and Luton to the north could affect North Herts district, whilst urban extensions planned for Harlow could have implications for part of East Herts district.

Geology

1.16. Hertfordshire is a geologically rich county and contains a number of natural mineral resources. This ranges from the claylands of the London Basin to extensive chalklands that form the Chiltern Hills, which are situated in the north west of the county. This forms an important aquifer and provides a vital source of drinking water from wells and pumped boreholes that are also a source used by industry and agriculture.

1.17. Glacial clays and gravels overlie much of the north-east of the county and river gravels occupy the Vale of St Albans and many of the river valleys. The south and middle areas of Hertfordshire are situated within the sand and gravel belt and this was identified as such in the 'Mineral Consultation Areas

in Hertfordshire Supplementary Planning Document', adopted in January 2008 and continues to be identified in the emerging Minerals and Waste Local Plan. The county contributes to the mineral extraction needs of industry through the operation of multiple sand and gravel quarries. The intention of the emerging Minerals Local Plan is to ensure that Hertfordshire continues to contribute a steady and adequate supply of minerals. The intention of the Waste Local Plan is to ensure that Hertfordshire is net self-sufficient with the waste that is produced annually.

Watercourses

1.18. The following watercourses listed below, are classified as 'main rivers' that intersect the county. 'Main rivers' are usually larger streams and rivers, but some of them are small watercourses of significance. They include certain structures that control or regulate the flow of water in, into or out of the channel. Other rivers, streams, ditches, drains, culverts etc, are classified as an 'ordinary watercourse' which may also contribute to flood risk within the county.

- River Ash: Originates near the village of Brent Pelham in North Herts and flows through Little, Ford and Much Hadham until it reaches the River Lea near Stanstead Abbotts.
- River Bulbourne: Runs from Dudswell in Northchurch and flows through Berkhamsted, Bourne End and Boxmoor until it reaches the River Gade at Two Waters in Apsley.
- River Cam or Rhee: Flows to the north of Letchworth Garden City in North Herts.
- River Chess: Runs from Chesham in Buckinghamshire until it reaches the River Colne in Rickmsansworth.
- River Colne: Flows through London Colney. Joins the River Thames at Staines-Upon-Thames in Surrey.
- River Gade: Originates in Dagnall, Buckinghamshire and flows through Hemel Hempstead, Kings Langley, Croxley Green and Rickmansworth where it joins the River Colne.
- River Hiz: Originates in the village of Charlton and flows through Hitchin where it meets the Rivers Oughton and Purwell.
- River Ivel: Flows to the north of Baldock in North Herts.
- River Lee or Lea: Originates near Leagrave, Luton and flows through Hertford and passes Hatfield, Wheathampstead and Harpenden and flows south to London where it reaches the River Thames.
- River Lynch: A minor tributary of the River Lea in Hoddesdon.
- Rivers Mimram & Beane: A tributary of the River Lea and flows through Hertford.
- River Oughton: Flows to the north of Hitchin in North Herts where it originates.
- River Purwell: Flows through Hitchin in North Herts.

- River Quin: Originates near Barkway in North Herts and flows to the east of Buntingford in East Herts.
- River Rib: Originates near the village of Buckland in East Herts and flows through Buntingford, Westmill, Braughing, Puckeridge until it reaches the River Lea near Hertford.
- River Stort: Originates near Clavering in Essex and flows through Bishops Stortford until it reaches the River Lea near Hoddesdon.
- River Ver: Originates near the village of Markyate in Dacorum and flows through Flamstead, Redbourn, St Albans and Park Street until it reaches the River Colne at Bricket Wood.
- New River: Starts between the towns of Ware and Hertford and flows through Great Amwell, Broxbourne and Cheshunt until it reaches Stoke Newington in the London Borough of Hackney.
- Grand Union Canal: Originates in London and flows through Tring and Hemel Hempstead until it reaches Birmingham in the West Midlands.

2. Flood Risk Policy

2.1. This section summarises the relevant flood risk policies that are deemed to be applicable when assessing potential mineral sites and waste management sites for inclusion within Hertfordshire's Minerals and Waste Local Plan. These are considered to be:

- The EU Water Framework Directive;
- The River Basin Management Plans (RBMPs) that cover Hertfordshire;
- The Catchment Flood Management Plans (CFMPs) that cover Hertfordshire, including their relevant policy units, messages and recommendations;
- The Lower Lee Flood Risk Management Strategy;
- The Local Flood Risk Management Strategy (LFRMS) 2 for Hertfordshire 2019-2029;
- Level 1 Strategic Flood Risk Assessments that have been produced by the county's ten district/borough local planning authorities.

EU Water Framework Directive

2.2. The EU Water Framework Directive came into force in December 2000 and was transposed into British Law three years later in December 2003. Its objective is to achieve a 'good status' for all ground and surface waters (rivers, lakes, transitional waters, and coastal waters out to one mile from low-water) within the EU. Given that Hertfordshire is a landlocked county, the protection and enhancement of estuaries and coastal waters are not applicable.

2.3. One of the main aims of the Directive is to ensure there is no deterioration in the water environment and to seek more naturally functioning water bodies. There is also an aim to achieve at least 'good' status for all water bodies by 2015, where this is not possible and subject to the criteria set out in the Directive, good status should be achieved by 2021 or 2027.

River Basin Management Plans (RBMPs)

2.4. River Basin Management Plans (RBMPs) are published by the Environment Agency and aim to achieve the objective of the EU Water Framework Directive. They provide a comprehensive plan for river basin management and also provide a broad context for Catchment Flood Management Plans (CFMPs) that are summarised in paragraphs 2.12 - 2.31.

2.5. RBMPs have been published for the two river basins that cover Hertfordshire. These are the Thames and the Anglian and are both summarised below:

2.6. RBMP for the Thames River Basin District. This RBMP was originally published in December 2009 and was updated in December 2015. The majority of Hertfordshire is situated within the Thames River Basin District, which covers a total area of 6,229 square miles from Swindon in the west to Crawley in the south. In Hertfordshire, the main towns of St Albans, Watford, Hatfield, Welwyn Garden City, Hemel Hempstead, Hertford, Ware and Stevenage are situated within it. The Thames River basin is also one of the most populated parts of Britain covering 1079 miles of the river network.

2.7. The location and extent of the Thames RBMP is shown below:

Figure 1 - Thames RBMP Map

2.8. The RBMP for the Thames River Basin District has predicted the following statuses for surface water (ecological and chemical status); groundwater (quantitative and chemical status); all elements for all surface water bodies; and selected elements that contribute to the ecological status of surface waters, respectively, by 2021[2] as a result of measures included in the plan:

	Ecological status				Chemical status	
	Bad	Poor	Mod	Good or better	Fail	Good
Current status	27	112	320	39	5	493
Predicted 2021 status	22	109	317	50	5	493
Predicted change	-5	-3	-3	11	0	0

[2] Tables 17-21 of Part 1 of the Thames River Basin District River Basin Management Plan, December 2015

	Quantitative status		Chemical status	
	Poor	Good	Poor	Good
Current status	22	25	18	29
Predicted 2021 status	19	28	18	29
Predicted change	-3	3	0	0

	Ecological status				Chemical status	
	Bad	Poor	Mod	Good or better	Fail	
Current status	110	350	538	2670	5	1178
Predicted 2021 status	95	328	551	2691	5	1178
Predicted change	-15	-22	13	21	0	0

		Bad	Poor	Mod	Good or better
Fish	Current status	25	64	51	55
	Predicted 2021 status	21	64	51	59
	Predicted change	-4	0	0	4
Invertebrates	Current status	12	37	84	237
	Predicted 2021 status	10	38	83	239
	Predicted change	-2	1	-1	2
Plants (macrophytes and phytobenthos)	Current status	2	44	167	65
	Predicted 2021 status	1	44	162	68
	Predicted change	-1	0	-5	3

2.9. RBMP for the Anglian River Basin District. This RBMP was also originally published in December 2009 and updated in December 2015. The remainder of Hertfordshire is situated within the Anglian River Basin, which covers an area of 10,768 square miles from Lincoln in the north to Chelmsford in the south. In Hertfordshire, the main towns of Letchworth Garden City, Hitchin and Royston are situated within it. The Anglian river basin covers 1056 miles of the river network.

2.10. The location and extent of the Anglian RBMP is shown below[3]:

[3] Image extracted from p.10 of the Anglian River Basin District River Basin Management Plan, December 2015.

Figure 2 - Anglian RBMP Map

2.11. The RBMP for the Thames River Basin District has predicted the following statuses for surface water (ecological and chemical status); groundwater (quantitative and chemical status); all elements for all surface water bodies;

and selected elements that contribute to the ecological status of surface waters, respectively, by 2021[4] as a result of measures included in the plan:

	Ecological status				Chemical status	
	Bad	Poor	Mod	Good or better	Fail	Good
Current status	13	106	419	65	7	596
Predicted 2021 status	10	95	419	79	7	596
Predicted change	-3	-11	0	14	0	0

	Quantitative status		Chemical status	
	Poor	Good	Poor	Good
Current status	16	15	15	16
Predicted 2021 status	13	18	15	16
Predicted change	-3	3	0	0

	Ecological status				Chemical status	
	Bad	Poor	Mod	Good or better	Fail	Good
Current status	66	349	589	3,186	8	911
Predicted 2021 status	62	306	572	3,240	8	911
Predicted change	-4	-43	-17	54	0	0

		Bad	Poor	Mod	Good or better
Fish	Current status	9	62	65	78
	Predicted 2021 status	7	53	68	86
	Predicted change	-2	-9	3	8
Invertebrates	Current status	6	25	115	304
	Predicted 2021 status	6	24	110	310
	Predicted change	0	-1	-5	6
Plants (macrophytes and phytobenthos)	Current status	3	56	116	83
	Predicted 2021 status	3	52	107	86
	Predicted change	0	-4	-9	3

[4] Tables 17-21 of Part 1 of the Anglian River Basin District River Basin Management Plan, December 2015

Catchment Flood Management Plans (CFMPs)

2.12. The Environment Agency has published a number of Catchment Flood Management Plans (CFMPs) that consider all types of inland flooding, from rivers, groundwater, surface water and tidal flooding across individual river catchments that fall within specific river basin districts. CFMPs also provide a strategic approach to flood risk management and make recommendations for managing flood risk over the next 50-100 years.

2.13. CFMPs are grouped by river basin district. There are a total of three CFMPs that fall within the Thames River Basin District and ten that fall within the Anglian River Basin District. CFMPs that cover Hertfordshire are:

- The Thames Catchment Flood Management Plan published in December 2009. This CFMP falls within the Thames River Basin District and is summarised in paragraphs 2.14 - 2.21;
- The Great Ouse Catchment Flood Management Plan published in December 2009. This CFMP falls within the Anglian River Basin District and is summarised in paragraphs 2.22 - 2.29.

2.14. The Thames CFMP covers the majority of Hertfordshire, (with the exception of some areas of North Herts District and Stevenage Borough). The Thames catchment flood area covers most of London and extends as far as Banbury to the north, Swindon to the west and Guildford to the south. The location and extent of the Thames CFMP is shown below[5]:

[5] Image extracted from p.5 of the Thames Catchment Flood Management Plan Summary Report, December 2009.

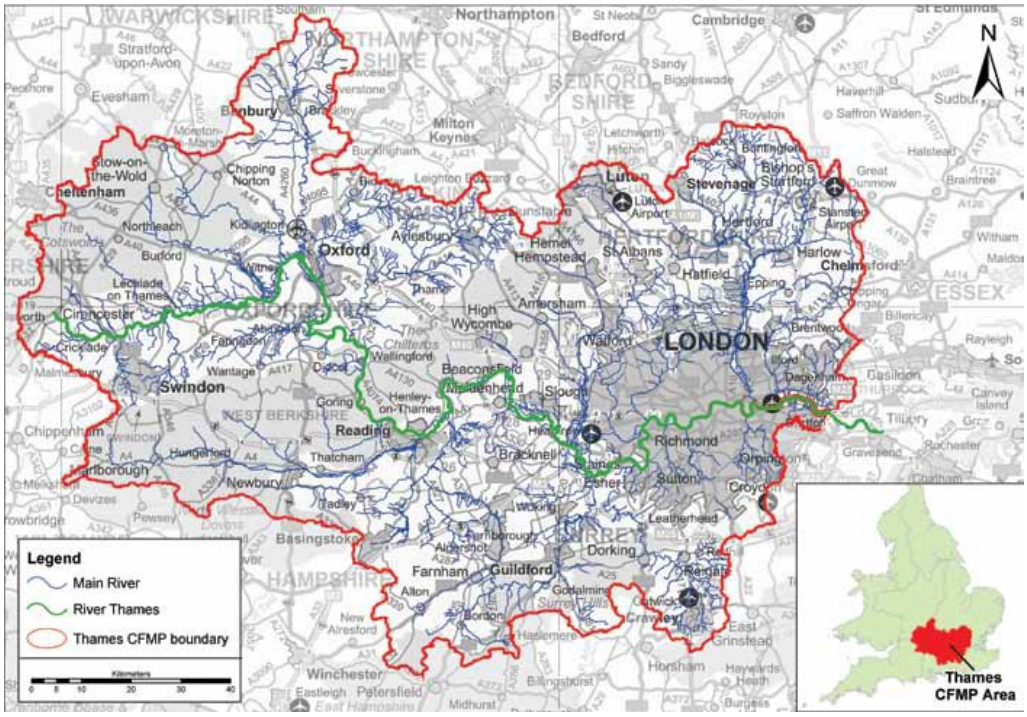

Figure 3 - Thames CFMP Map

2.15. The Thames CFMP has the following four strategic messages, which are the basis of the Environment Agency's approach to managing flood risk in a sustainable way within this river catchment area:

1. Climate change will be the major cause of increased flood risk in the future;
2. Flood defences cannot be built to protect everything;
3. Development and urban regeneration provide a crucial opportunity to manage food risk;
4. The flood plain is our most important asset in managing flood risk.

2.16. The effects of climate change on the Thames River catchment area, means that fluvial flooding from rivers is likely to become more frequent. Rising sea levels and higher peak flows, coupled with land tilt in the south-east means that there is also likely to be an increase in the probability of tidal and coastal flooding.

2.17. In the River Lee, the 1% Annual Exceedance Probability (AEP) flood extent is likely to increase by 19%. The CFMP predicts that there could be 6,400 properties at risk of flooding from 1% AEP fluvial event in the overall Thames CFMP. Planning applications for minerals and waste related development should take on board the implications of climate change in terms of the increase in fluvial flooding, and suggest (through individual Flood Risk Assessments) flood alleviation measures if necessary.

2.18. The Thames CFMP has been divided into 43 sub-areas that generally follow river catchment or urban area boundaries. There are six policy options within

this CFMP for the management of flood risk and these have been applied to each sub-area, depending upon the level of flood risk that has been assessed.

2.19. The map below shows the CFMP policy for each sub-area within the Thames CFMP[6].

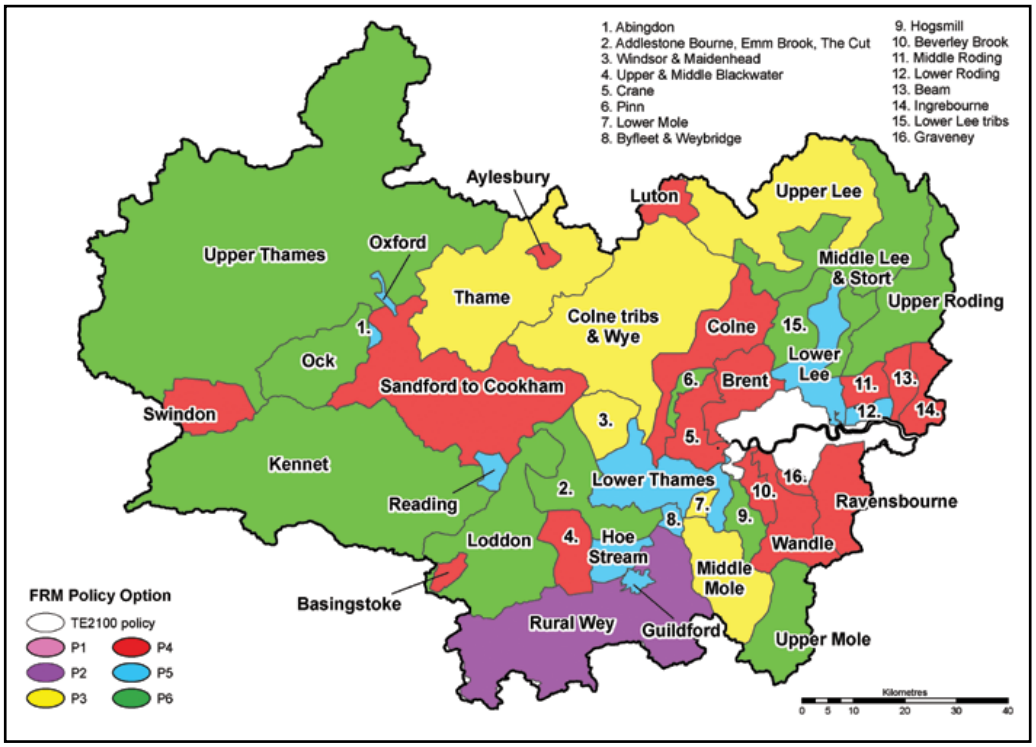

Figure 4 - Thames CFMP Policy Option Map

2.20. There are a total of seven sub-areas within the Thames CFMP that cover Hertfordshire. A summary of the sub-area's characteristics, along with the relevant policy option and district/borough they fall within is outlined in Table 1 below:

Table 1 - Thames CFMP Sub-Areas that fall within Hertfordshire

Sub-Area and Policy	Sub-Area Characteristics	District/Borough coverage
Colne (Policy 4)	Generally urban areas with some river flood defences	Hertsmere, St Albans, Three Rivers, Watford
Colne Tributaries & Wye (Policy 3)	Newer and expanding urban areas often towards the headwaters of river	Dacorum, St Albans, Three Rivers, Watford

[6] Image extracted from p.28 of the Thames Catchment Flood Management Plan Summary Report, December 2009.

Sub-Area and Policy	Sub-Area Characteristics	District/Borough coverage
	catchments	
Lower Lee (Policy 5)	Developed floodplain with major built flood defences	Broxbourne
Lower Lee Tributaries (Policy 6)	Developed floodplain with major built flood defences	Broxbourne
Middle Lee & Stort (Policy 6)	Mainly natural floodplain, with market towns and villages	Broxbourne, East Herts, St Albans, Welwyn Hatfield
Thame (Policy 3)	Mainly natural floodplain, with market towns and villages	Dacorum
Upper Lee (Policy 3)	Mainly natural floodplain, with market towns and villages	East Herts, North Herts, St Albans, Stevenage, Welwyn Hatfield

2.21. None of the Thames CFMP sub-areas that fall within Hertfordshire are covered by policy options 1 and 2. An explanation of policy options 3-6 which are of relevance to the sub-areas that fall within the county are outlined below:

- Policy 3: Areas of low to moderate flood risk where generally existing flood risk is managed effectively;
- Policy 4: Areas of low, moderate or high flood risk where generally existing flood risk is managed effectively but further action may need to take place to keep pace with climate change;
- Policy 5: Areas of moderate to high flood risk where the Environment Agency can generally take further action to reduce flood risk;
- Policy 6: Areas of low to moderate flood risk where the Environment Agency will take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits.

2.22. The Great Ouse CFMP covers the remaining parts of the county that are situated outside the Thames River catchment area. The Great Ouse catchment flood area extends northwards, and covers parts of East Anglia

and the South Midlands. The location and extent of the Great Ouse CFMP is shown below:[7]

Figure 5 - Great Ouse CFMP Map

2.23. The Great Ouse CFMP has the following six strategic messages, which are the basis of the Environment Agency's approach to managing flood risk in a sustainable way within this river catchment area:

1. No active intervention (including flood warning and maintenance). Continue to monitor and advise;
2. Reduce existing flood risk management actions (accepting that flood risk will increase over time);
3. Continue with existing or alternative actions to manage flood risk at the current level;
4. Take further action to sustain the current level of flood risk into the future (responding to the potential increase in risk from urban development, land use change and climate change);
5. Take further action to reduce flood risk (now and/or in the future);
6. Take action with others to store water or manage run-off in locations to provide overall flood risk reduction or environmental benefits, locally or elsewhere in the catchment (which may constitute an overall flood risk reduction, for example for habitat inundation).

2.24. The Great Ouse CFMP does not identify significant flood risk issues in the areas of Hertfordshire that it covers. However, it is anticipated that climate

[7] Image extracted from p.5 of the Great Ouse Catchment Flood Management Plan Summary Report, January 2011.

change will be the biggest increase in flood risk within this river catchment area.

2.25. This increase is down to a combination of higher river peak levels and a rise in sea levels causing an increase in the probability of flooding in areas that are currently within flood zones 2 and 3. The small areas of Hertfordshire that are covered by the Great Ouse CFMP means that no significant towns are identified to be at future risk from flooding resulting from climate change.

2.26. Similarly to the Thames CFMP, the Great Ouse CFMP has also been divided into a number of sub-areas that generally follow river catchment or urban area boundaries. There are six policy options for the management of flood risk and these have been applied to each sub-area, depending upon the level of flood risk that has been assessed.

2.27. The map below shows the CFMP policy for each sub-area within the Great Ouse CFMP.[8]

[8] Image extracted from p.12 of the Great Ouse Catchment Flood Management Plan Summary Report, January 2011.

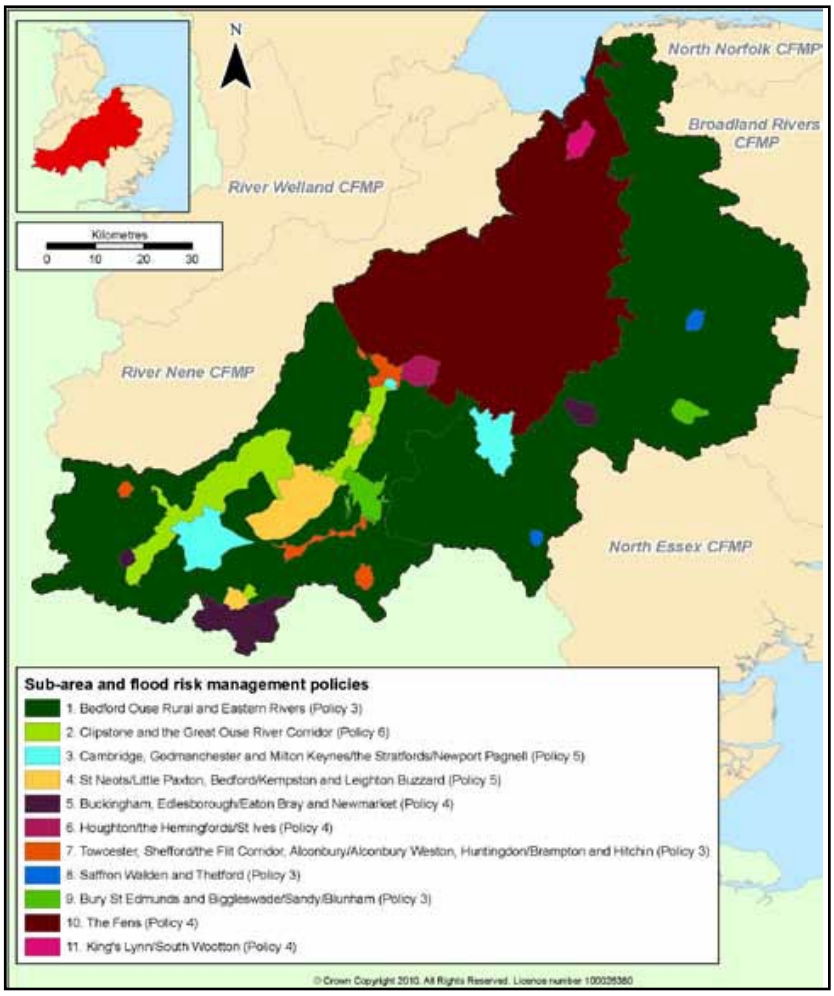

Figure 6 - Great Ouse CFMP Policy Map

2.28. There are a total of two sub-areas within the Great Ouse CFMP that cover Hertfordshire. A summary of the sub-area's characteristics, along with the relevant policy option and district/borough they fall within is outlined in Table 2:

Table 2 - Great Ouse Sub-Areas that fall within Hertfordshire

Sub-Area and Policy	Sub-Area Characteristics	District/Borough coverage
Bedford Ouse Rural and Eastern Rivers (Policy 3)	Within the Lower Bedford Ouse Catchment. Predominantly rural with market towns and villages	North Herts, Stevenage
Hitchin (Policy 3)	Predominantly urban, consisting of the town of Hitchin and the village of Ickleford	North Herts

2.29. Only policy option 3 is of relevance to the Great Ouse CFMP sub-areas that fall within Hertfordshire. Policy 3 is outlined below:

- Policy 3: Areas of low to moderate flood risk where generally existing flood risk is managed effectively.

2.30. CFMP Policy Units. The Environment Agency has developed policy units for all sub-areas that are situated within the CFMPs. These sub-area policy units identify:

- Key messages for each policy unit;
- The nature of flood risk within each policy unit;
- Measures that need to be undertaken to reduce flood risk.

2.31. A summary of each individual policy that are applicable to the sub-areas which cover Hertfordshire are outlined in Appendix 2 (sub-areas within the Thames CFMP) and Appendix 3 (sub areas within the Great Ouse CFMP).

Lower Lee Flood Risk Management Strategy

2.32. The Lower Lee Flood Risk Management Strategy[9] (FRMS) is a strategy for managing flood risk in the Lower Lee catchment. It looks ahead for the next 100 years and makes recommendations for short, medium and long term measures to manage flood risk within the catchment. The strategy considers how to implement the Thames CFMP's agreed policies for fluvial flooding and provides a basis for implementing these policies specifically in the Lower Lee catchment.

2.33. Approximately one third of Hertfordshire is situated within the Lower Lee catchment area, with the majority of East Herts, and parts of Welwyn Hatfield and Stevenage also being included. It also extends into parts of Bedfordshire, Essex and London to the south.

2.34. The study has identified a number of initiatives that need to be carried forward and acted upon in the short term and further initiatives where there is a need to influence regional, sub-regional and local spatial planning in the longer term.

2.35. Specific initiatives that have been identified for Hertfordshire within the Lower Lee FRMS, are as follows:

- The need to protect the town of Hertford in the short to long term. The strategy has recognised that within five years a further study is needed to look at this

[9] Managing flood risk in the Lower Lee catchment, today and in the future, Environment Agency (2013)

area in further detail as the management of flood risk in Hertford is particularly complex;
- The next 5-100 years could see the implementation of non-structural and structural measures, to be evaluated through Environmental Impact Assessments (EIAs) in, and immediately surrounding Hertford;
- There is a need to influence regional, sub-regional and local spatial planning in areas upstream of Hertford and throughout the Stort catchment area in the next 100 years. There would also need to be future support given to future flood risk management in line with CFMP policy.

2.36. The Lower Lee FRMS recognises the need for areas to be safeguarded for flood storage, as there are areas within the catchment that have greater environmental acceptability to accommodate such schemes within land that is currently used for agriculture or, which is derelict.

2.37. The strategy proposes to construct four flood storage areas, two of which (Cobbins and Salmons Brooks) are already in progress. The other two are suggested at Pymmes and Nazeing Brooks.

Local Flood Risk Management Strategy for Hertfordshire

2.38. The Flood and Water Management Act 2010, requires all unitary and county councils in England and Wales to be designated as a Lead Local Flood Authority (LLFA). Under the act, LLFAs are responsible for managing the risk of flooding from surface water, groundwater and ordinary watercourses. The Environment Agency maintains responsibility for managing the risk of flooding from main rivers, reservoirs, estuaries and the sea.

2.39. Hertfordshire's LLFA also has a duty to develop, maintain, apply and monitor a strategy for local flood risk management in the county. The Hertfordshire LLFA will also establish and maintain a register of structures or features likely to have a significant effect on flood risk in its area, including their ownership and state of repair.

2.40. The county council has an adopted Local Flood Risk Management Strategy, the LFRMS 2 (February 2019)[10] which focuses on local flood risk due to flooding from surface water, groundwater and ordinary watercourses and identifies opportunities for a range of risk management authorities and key stakeholders to work together to improve the management of local flood risk. The current strategy covers a ten-year period from 2019-2029.

[10] https://www.hertfordshire.gov.uk/services/recycling-waste-and-environment/water/managing-flood-risks.aspx

2.41. The strategy identifies the county as being at risk from a variety of sources of flooding which are known to interact with each other. The main sources of flood risk include surface water, groundwater, rivers, climate change and ordinary watercourses. These sources of flooding are outlined in greater detail in Assessment of Flood Risk in Hertfordshire of this report. As well as events caused by a single source there may be in combination effects for example elevated river levels impeding surface water drainage which then results in flooding, where the state of the river and volumes of surface water in isolation would not have been problematic. Flooding from all these sources is expected to increase in frequency or severity as a result of climate change.

2.42. Flooding is a natural process which plays an important part in shaping the environment, but it can also be affected and manipulated by man-made processes and land use. Flooding can cause substantial physical, financial and emotional damage, adversely affecting quality of life. It is therefore important to understand flood risk within Hertfordshire and how the impacts can be avoided or reduced.

2.43. Historic records of flooding vary greatly, making it difficult to provide a consistent picture of past flooding within Hertfordshire. Historic records are not consistent across the county and data is held by a number or organisations in a variety of forms. Where information is more comprehensive, this is generally for only the past 30 years or so. This is probably due to how the current organisations with an interest in flood risk management and legislation have evolved. The structure of local government was revised in the mid-1970s and responsibility for local drainage passed from councils to the Water and Sewerage Companies formed in the 1990s.

Level 1 SFRAs within Hertfordshire

2.44. Since 2007, local planning authorities in Hertfordshire have been compiling individual Level 1 SFRAs that cover their respective administrative areas. These SFRAs identify and map most forms of flooding that have taken place within each of their local authority study areas. These Level 1 SFRAs also map areas that are considered to be at a higher risk of flooding, which are shown as flood zone 3a (high risk) and flood zone 3b (the functional floodplain).[11]

[11] The Environment Agency maps areas that are located within flood zones 2 and 3. It is the responsibility of individual district/borough SFRAs to identify and map areas that are considered to be within the functional floodplain (zone 3b) in agreement with the Environment Agency.

2.45. Some SFRAs in the county have been updated since they were first published but not all of the local planning authority Level 1 SFRAs refer to the most up to date data and legislation. Publication details of each district/borough Level 1 SFRA are listed in Table 3 below:

Table 3 - SFRA Publication Timetable in Hertfordshire

District/Borough	Publication Date	Web Site Address
Broxbourne [12]	May 2016	www.broxbourne.gov.uk
East Herts	August 2016	www.eastherts.gov.uk/sfra
Hertsmere	May 2018	www.hertsmere.gov.uk
North Herts	September 2016	www.north-herts.gov.uk
Stevenage	June 2016	www.stevenage.gov.uk
Three Rivers [13]	January 2012	www.threerivers.gov.uk
Watford [14]	May 2012	www.watford.gov.uk
Welwyn Hatfield	June 2016	www.welhat.gov.uk
Dacorum [15] St Albans Three Rivers Watford	May 2019 (South West Hertfordshire combined SFRA)	www.dacorum.gov.uk www.stalbans.gov.uk www.threerivers.gov.uk www.watford.gov.uk

2.46. Hertsmere Borough Council published an updated level 1 SFRA in May 2018 as part of the evidence base for the new Borough Local Plan. The previous SFRA was published in May 2008 as part of the evidence base for the Core Strategy and Site Allocations and Development Management (SADM) Policies Plan. The updated level 1 SFRA included the latest datasets and flood modelling at the time of production and followed updated national guidance to include the effects of climate change on fluvial flood risk.

[12] Broxbourne Borough Council also undertook a Level 2 SFRA for the assessment of 13 sites preferred for development, published in April 2017.

[13] Three Rivers District Council SFRA (2012) assesses only 17 potential development sites as part of the evidence base for the Local Development Framework. Twelve of these sites have been subject to a level 2 SFRA.

[14] Watford Borough Council also undertook a Level 2 SFRA, which assessed specific development areas within the borough. This was published in September 2014.

[15] Dacorum Borough Council has also undertaken a Level 2 SFRA (June 2008) which assesses flood risk in more detail in the towns of Hemel Hempstead & Berkhamsted.

2.47. Dacorum Borough, St. Albans City and District, Three Rivers District and Watford Borough Councils have updated their combined level 1 SFRA to form the South West Hertfordshire Level 1 SFRA. This has been updated with the latest available data and guidance at the time of production. The assessment aims to inform the need for the individual authorities to produce a level 2 SFRA and will form part of the evidence base of emerging local plans.

2.48. Each district/borough Level 1 SFRA, includes guidance in the form of advice to developers when preparing site-specific Flood Risk Assessments (FRAs) and to inform developing district/borough council policy through each local planning authority's emerging Local Plan. They also contain more detailed information on flood risk management measures and the coverage of any existing flood warning systems that may fall within each district/borough.

2.49. All relevant flood risk objectives from each district/borough Level 1 SFRA have been summarised and are listed in Table 4 below:

Table 4 - Flood Risk Policy Recommendations for Hertfordshire

Relevant Summary of Objective	
Achieve Flood Risk Reduction through Spatial Planning and Site Design	Use the Sequential Test to steer new development to areas of least flood risk, and within the site, so that the highest risk areas are undeveloped and used for green space or soft-landscaping/permeable parking surfaces. The Sequential Test should be used at a site level to inform the site layout.
Reduce Flood Risk Through Mitigation	Assess and mitigate the impacts of groundwater flooding. Promote flood resilience/resistance measures at the individual property level.
Enhance and Restore the River Corridor	Avoid further culverting and building over of culverts. All new developments with existing culverts should de-culvert rivers for flood risk management. Set development back from rivers with a minimum 8 metre wide undeveloped buffer zone. Opportunities should be sought to make space for water in order to accommodate climate change.
Reduce the Risk of Groundwater Flooding	Development should be avoided in areas where there is a risk of frequent groundwater flooding. Where development is allowed to occur in areas where groundwater flooding has occurred, then appropriate mitigation measures should be imposed.
Improve Flood	Improve the emergency planning process using

Relevant Summary of Objective	
Awareness and Emergency Planning	outputs from the SFRA. Ensure robust emergency (evacuation) plans are implemented for new developments greater than 1ha.
Reduce Surface Water Runoff in New Developments	A surface water flood risk assessment should be undertaken for all development over 1ha. Sustainable urban drainage systems (SUDS) should be a requirement for all new development on brownfield and greenfield land and on sites greater than 1ha.
Safeguard the Functional Floodplain and Areas for Future Flood Alleviation Schemes	Protect functional floodplains from future development and where possible reinstate areas of functional floodplain where development has taken place. Safeguard areas identified for potential flood storage (Lower Lee Flood Risk Management Strategy) and identify sites where developer contributions could be used to fund flood risk management schemes.
Improve Multi-Agency Working and Collaboration	Ensure that site specific flood risk assessments are submitted to key consultees in order to identify any developer contributions. Ensure consultation takes place with neighbouring councils in order to make sure that cross boundary flood storage areas are safeguarded from development.

Sensitive Development Locations within Hertfordshire

2.50. Some of the county's Level 1 SFRAs suggest locations within the county where development would significantly increase flood risk elsewhere. These locations, summarised below, can apply to minerals and waste related development and will be considered by the WPA during the production of the Plan:

2.51. Borough of Broxbourne: The borough council's Level 1 SFRA has identified two types of potential growth areas within the borough that may increase flood risk:

- Areas in the Green Belt (release sites) along the western tributaries of the River Lea. Due to the 'flashy' nature of these tributaries and the potential impacts on the urban areas downstream, potential developments will have a significant impact on flood risk. SuDS should therefore be implemented;
- Infill developments around the existing urban areas along the River Lea.

2.52. As the borough is located within the sand and gravel belt, there is the potential that the Minerals Planning Authority may seek the opportunistic extraction of sand and gravel from some of these Green Belt release sites, should any of them be identified in the emerging Broxbourne Borough Local Plan.

2.53. Dacorum Borough, St Albans City & District, Three Rivers District, Watford Borough: The Level 1 SFRA that covers these four local authority areas suggests that additional development should be avoided in the following two localities:

- The Sandridge and Marshalswick area of St Albans, as this area has a significant risk of groundwater flooding;
- The Lower High Street in Watford, as there is a significant risk of surface water flooding which could be exacerbated by further development within Watford Town Centre if suitable controls on drainage are not implemented.

2.54. As both of these locations are within the urban areas of St Albans and Watford, neither of these areas are suitable locations for the identification of potential mineral extraction sites in the review of the Minerals Local Plan.

2.55. North Herts District: The district council's Level 1 SFRA suggests that development to the east of Luton, could potentially exacerbate fluvial flood risk within the Mimram and Kim catchments due to connectivity between local hydrogeological and fluvial catchments. It is considered that this will need to be assessed within a site-specific Flood Risk Assessment. Land to the east of Luton, which falls within North Herts district, contains only one waste site (sewage treatment works). It is considered that proposals for future waste operations located within this area will need comprehensive flood risk assessments to minimise the impacts and effects. Land to the east of Luton is not situated within the sand and gravel belt and it is considered therefore that future sand and gravel workings will not be located within this area.

2.56. Stevenage Borough: The borough council's Level 1 SFRA assesses whether development to the west and north of Stevenage could potentially exacerbate flooding in other areas within the borough. It concluded that although large scale urban development within these areas would not significantly increase flood risk within Stevenage borough, it could have significant implications for increased flood risk to land and property downstream of the borough, unless substantial runoff attenuation measures are adopted. Since both of these locations contain Employment Land Areas of Search (ELAS) suitable for waste development, it is considered that future proposals for waste operations must be accompanied by a site-specific flood risk assessment and management strategy.

2.57. Welwyn Hatfield Borough: The borough council's Level 1 SFRA recognises that groundwater flooding has been noted as occurring in the areas of Brookmans Park, Cuffley and to the east of Hatfield, and highway flooding occurring in a number of areas within the borough. From a flood risk perspective, the assessment does not suggest that these locations should be excluded from further development, provided that site specific Flood Risk Assessments are prepared at the planning application stage and addresses these key findings.

2.58. In areas where there is likely to be the generation of increased surface water run-off, a Surface Water Management Plan may be needed. [16]

[16] Please see Appendix 4 for a definition.

3. Assessment of Flood Risk in Hertfordshire

3.1. The Local Flood Risk Management Strategy 2 (LFRMS) for Hertfordshire 2019-2029, identified the following types of flooding that could occur within the county:

- Surface water flooding;
- Groundwater flooding;
- Fluvial flooding;
- Sewer flooding;
- Canal flooding;
- Aqueduct flooding;
- Reservoir flooding;
- Climate change.

3.2. Definitions of these types of flooding have been taken from paragraphs 2.1-2.6 of the LFRMS 2.

Surface Water Flooding

3.3. Surface water flooding is caused when local drainage capacity and infiltration is unable to cope with the volume of water experienced during periods of sustained or heavy rainfall. Flooding then results from overland flows causing ponding of water where it becomes obstructed or collects in low lying areas.

3.4. The risk of surface water flooding in the county is likely to increase as the extent of built-up areas and the area of impermeable hard surfacing (such as driveways, car parking, paths and extensions) is added too across the county. It is therefore essential that suitable mitigation such as Sustainable Drainage Systems (SuDS) [17] is put in place to reduce and manage this risk where possible. In addition climate change predictions are indicating that the likelihood and frequency of surface water flooding will increase and this increase in risk has to be considered when planning for new development in the county.

3.5. Modelling the potential impact of storm events gives an insight into the risk of future flooding. It is difficult to accurately predict where surface water flooding will happen as it is dependent on ground levels, rainfall, and the local drainage network. Using the Environment Agency's Risk of Flooding from Surface Water (RoFfSW) mapping as a starting point, along with locally

[17] Further reference to SuDS is outlined in paragraphs 4.45-4.57.

derived surface water flood risk modelling, enables a better understanding of local flood risk. Based on this information, over 62,000 properties are in areas where there is potential for flooding up to a depth of 0.15m in an event which has a 1% probability (1 in 100 chance) of occurring in any year.

3.6. The potential for surface water flooding is predicted in most of Hertfordshire's major settlements. Map 2 to 2c in the county council's LFRMS 2 for Hertfordshire contains maps showing areas within the county that are susceptible to surface water flooding. This was based upon information obtained from the Environment Agency in 2018.

3.7. The PPG requires SFRAs to identify areas at risk from surface water flooding and drainage issues, taking account of the surface water flood risk map that was published by the Environment Agency in December 2013 and most recently updated in December 2019.[18] In 2016 the name of the updated Flood Map for Surface Water was changed to the Risk of Flooding from Surface Water. The Environment Agency updates the Risk of Flooding from Surface Water maps annually. Map 9 of the LFRMS 2 shows the extent of areas within the county that are at risk of surface water flooding (1 in 100 year event). Whilst areas that are likely to be affected by surface water flooding should not in itself be used to discount future development, such flooding should be taken into account at the site allocation stage. Any applicable Surface Water Management Plans should also be used.

Groundwater Flooding

3.8. Groundwater flooding occurs when the water held underground rises to a level where it breaks the surface in areas away from usual channels and drainage pathways. It is generally a result of exceptional extended periods of heavy rain, but can also occur as a result of reduced abstraction, underground leaks or the displacement of underground flows. Once groundwater flooding has occurred, the water can remain at the surface for extended periods of time.

3.9. The presence of the chalk aquifer in Hertfordshire and other under groundwater bearing areas such as the river gravel deposits mean that there is potential for groundwater flooding in Hertfordshire. There are confirmed cases of groundwater flooding in the county ranging from localised emergence affecting single properties to a number of larger events that have impacted at the settlement scale.

[18] The surface water flood risk map published by the Environment Agency in December 2019 is the most up to date data available in relation to surface water flood risk and should be used as an indication of where it may flood under different return periods.

3.10. The Environment Agency defines Groundwater Source Protection Zones (GSPZ). The zones indicate a risk to a groundwater source (boreholes, wells, or springs) from any polluting activity that may occur in the area. There are three GSPZs defined:

- Zone 1 – inner protection zone: 50 day travel time from any point below the water table to the source (minimum radius 50m).
- Zone 2 – outer protection zone: 400 day travel time from a point below the water table (minimum radius 250-500m).
- Zone 3 – total catchment: the area around a source within which all groundwater recharge is presumed to be discharged at the source.

3.11. Map 6 in of the LFRMS 2 shows the areas of the county that are susceptible to groundwater flooding within the county. These are based on 1km squares where the percentage of the area has the potential for groundwater emergence above 25%. The majority of Hertfordshire is not shown to be at risk above this level, with very few km squares with a percentage greater than 50%.

Flooding from Rivers (Fluvial)

3.12. Fluvial flooding occurs when the capacity of a watercourse is exceeded, causing water to spill out of the channel onto adjoining areas, known as the floodplain. In some areas, the floodplain of the river may be undeveloped or have more flood compatible uses such as farming, but in some areas development has occurred within floodplains.

3.13. In Hertfordshire there are an estimated 1,709 residential addresses that are in areas with a high fluvial flood likelihood (3.3% AEP or greater in any one year) and 4,159 that are in areas of medium fluvial flood likelihood (between 3.3% and 1% AEP in any one year) (2014 figures reported by the EA to the Thames RFCC 24/11/16).There have been intermittent occurrences of fluvial flooding across the county during the past few years, with the most notable events occurring in February 2014

3.14. Map 3 of the LFRMS 2 shows the extent of areas situated within flood zone 3 within the county. It should be noted that fluvial flooding is associated with all watercourses and not just from ‘main rivers’. Not all watercourses have the benefit of modelling and therefore may not have an associated flood zone. This does not mean that they do not flood. Any future development should take this into account as part of a site-specific Flood Risk Assessment (FRA) where the development site contains any watercourse.

3.15. Map 1 of the LFRMS 2 shows the extent of historical floods.

Sewer Flooding

3.16. Sewer flooding is caused when a blockage occurs or by excess surface water entering the drainage network, exceeding available capacity. This generally occurs during periods of heavy rainfall when the drainage network becomes overwhelmed.

3.17. Water Companies keep a record of property flooding called the DG5[19] Flood Risk register. Between 1997 and 2007 there were 291 records of sewer flooding within Hertfordshire, of which 77 were attributed to surface water and 25 to combined sewers.[20] As the records are only referenced to broad areas by postcode district it is not possible to provide a spatial representation of this.

Canal and Other Sources of Flooding

3.18. Canal flooding is caused by overtopping or breach of the canal network. There are a number of canals within Hertfordshire including the Grand Union Canal, the Lee Navigation and the Stort Navigation.

3.19. The Canal and Rivers Trust (formerly British Waterways) has investigated the potential for flooding from the canal network. Current records indicate only two minor breach events on record within Hertfordshire on the Grand Union Canal. Dacorum Borough Council's Level 2 SFRA includes an assessment of potential flood risk associated with a raised section of the Grand Union Canal. It is considered that there are no significant flood risks associated expressly with the canals.

3.20. The Dacorum Level 2 SFRA, published in 2008 (separate from the South West Hertfordshire SFRA Level 1), included breach modelling of the Grand Union Canal (GUC) in Berkhamsted. It should also be noted that there are sections of the GUC embankment through Berkhamsted which are up to 3m higher than the surrounding area. Although this has never failed, there is the potential for significant damage to property, should this embankment ever be breached.

3.21. Reservoir flooding occurs when a reservoir structure is overtopped or fails due to damage or collapse of the reservoir structure.

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[19] The water companies are regulated by OfWAT and have a range of service indicators called DG (Director General) Registers covering all aspects of their activity. DG5 relates to flooding from sewers (as a further example DG6 relates to response to billing queries).

[20] Combined sewers carry both rainwater from roofs and yards and foul sewage.

3.22. The Environment Agency has produced reservoir maps to show the largest area that might be flooded if a reservoir that holds over 25,000 cubic metres of water were to fail. Hertfordshire has 24 reservoirs which hold in excess of 25,000 cubic metres of water. The chance of reservoir failure is very unlikely as reservoirs are regularly inspected and there is an extremely good safety record in the UK with no loss of life due to reservoir flooding since 1925.

The Source-Pathway-Receptor Model

3.23. The risk of flooding occurring can be assessed by looking at a number of factors; the source of the water, the pathway it follows and the receptor it reaches. The source-pathway-receptor model is the basis for assessing the risk of flooding, and is a vital component. The model illustrated in table 5 is specific to Hertfordshire and includes all known sources of flooding, which have been elaborated in this section.

Table 5 - The Source-Pathway-Receptor Model for Hertfordshire

Source	Pathway	Receptor	Comment
Flooding from Infrastructure Failure & Surface Water	Flows exceeding capacity of culverts and /or pipes due to blockages or extreme levels of rainfall	Buildings located next to and adjacent to relevant infrastructure e.g. surface water drains	Surface water flooding is very localised often resulting from a number of factors. The scale, nature and location of any proposed development, will very much depend upon the requirement for a surface water drainage system. This should be discussed at the pre-application stage with the Environment Agency and any applicable Land Drainage Team.[21]
Flooding from Groundwater	Flooding through the raising of groundwater and convergence	Properties and sites that are situated in a low lying area. Can also occur via spring lines	Large numbers of properties could be at risk and there has been a history of such flooding throughout Hertfordshire. Land filling from previous

[21] From 6 April 2015, the county council as Lead Local Flood Authority has been a statutory consultee for all major development in relation to surface water management and surface water flood risk. Anything below this threshold will be the responsibility of the LPA.

	(an impedance of flood flows and reduction in abstraction)	that occur on the sides of valleys	mineral extraction could alter the terrain of the landscape resulting in a possible increase of groundwater flooding. Towns in Hertfordshire that have been affected by groundwater flooding include Potters Bar, Harpenden Kimpton and St Albans.
Flooding from Rivers (fluvial)	Breach, causing an overtopping of any defences	Buildings and critical infrastructure located on a fluvial floodplain	Fluvial flooding is mainly caused when the floodplain is inundated by flows from the river. Depending upon the size of the river and severity of the flood, a large number of properties could be at risk. Many towns in Hertfordshire have been affected by fluvial flooding, including Hertford, Cheshunt and Hitchin.
Flooding from Sewers	Blockages or an over capacity of the network	Properties and sites that are situated in close proximity to a sewer	Hard standing may cause an impact on sewers depending upon the level and type of development proposed.
Flooding from Canal breach	Flooding through the rising of water that is sometimes above natural ground level	Buildings and properties in close proximity to a canal	The Grand Union Canal (GUC) has a significant number of connections between it and the river via large Weir structures. This means that overtopping is unlikely to occur as water levels are controlled. Canal embankments within the study area have a low/medium risk of failure as defined by British Waterways
Flooding from	Flooding	Properties	Water retention above

Reservoir Breach	through the rising of water that is sometimes above natural ground level	located close to a reservoir, which can overflow resulting in an uncontrolled release of water	natural ground level or an increase in flood water depths in redundant or operational quarries may increase the chances of flooding. Potential flooding and damage to property could occur if any reservoir breach happens in the county. Hertfordshire contains a number of reservoirs, four of which are located to the north of Tring (Marswood, Startopsend, Tringford and Wilstone). These are water supply reservoirs and are owned by British Waterways, which actively manage these sites and meet all the required safety legislation. Other reservoirs include Markyate and Hartsbourne Stream Flood Storage Areas and The Pix Brook Flood Storage Flood Reservoir, which is located north of Letchworth in North Herts District. Planning permission was granted by the county council for a 44 million gallon agricultural reservoir at Thorley Hall Farm, Bishop's Stortford in May 2014.
Flooding from Overland flow	Rainfall that is unable to soak into the	Buildings located near to sewers, which	Built form and land topography can influence the direction and flow of

	ground or enter drainage systems, due to intense rainfall (often over short periods)	can surcharge and overflow[22]	surface water. Flooding can be exacerbated if development increases the percentage of impervious area

Climate Change Implications

3.24. As well as looking at flood risk using past events the future risk of flooding needs to be assessed. This is especially relevant because of the need to consider the potentially significant effects arising from climate change.

3.25. Changes in climatic conditions can affect local flood risk in several ways; however, impacts will depend on local conditions and vulnerability. Wetter winters and more intense rainfall may increase river flooding in both rural and urban catchments. More intense rainfall causes greater surface runoff, increasing localised flooding and erosion. In turn, this may increase pressure on drains, sewers and water quality. Storm intensity in summer could increase even in drier summers, so the county needs to be prepared for the risks arising from unexpected flash flooding.

3.26. There is a risk of flooding from groundwater-bearing chalk aquifers across the county. Generally wetter winters would potentially increase levels of ground water but it is difficult to predict in detail as much depends on the nature of the rainfall as, once the ground is saturated or the intensity of rain exceeds the rate of infiltration, water runs off and is not available for groundwater recharge.

3.27. Many drainage systems in the county have been modified to manage water levels and could help in adapting locally to some impacts of future climate on flooding. However changing intensity of weather patterns may mean that these assets may need to be managed differently.

3.28. A range of climate change scenarios have been developed and it seems likely that overall flood risk will increase as flooding may happen more often and/or to a greater depth, depending on the flooding source and mechanism.

[22] Overland flows can flood anything that lies within the flow path as a natural occurrence- sewers may be overwhelmed when an overland flow route flows into a sewer where the capacity may be exceeded which adds to the flooding.

3.29. Climate change flood outlines have been produced by incorporating an additional 20% to the peak river flows expected as a result of our changing climate over the next 100 years. In some locations, this has the effect of increasing the flood extent in the mapping.

3.30. Climate change flood outline maps differ from flood zone maps as they are based on defended modelling conducted by the Environment Agency that reflect residual flood risk. Currently, the main rivers that flow through the county that have been subjected to climate change flood modelling are the rivers: Ash, Beane, Upper Colne, Lee, Rib, Purwell and The Stort.

3.31. The Environment Agency is currently undertaking new modelling studies that investigate some of the Stort Tributaries; Puckeridge, Gade & Bulbourne and the Shonks Mill area of Roding. Once these are completed, 1 in 20 year outlines and climate change outlines will be available for these areas.

Cumulative Impacts of Development

3.32. Development should not be seen just as a receptor of flood waters, but also as a potential impact on flood risk. Development increases the land area with an impermeable surface. If poorly planned, this causes a reduction in the floodplain storage capacity and increases the potential volume and velocity of surface water runoff. These effects will increase the downstream flood risk. Whilst small, standalone developments will not significantly increase this risk, conglomerates or larger developments create cumulative effects which impact the hydrology of the area and heighten flood risk.

3.33. Within Hertfordshire, there are currently no proposed waste developments with planning permission and therefore, the cumulative impacts of specific developments will not be fully assessed.

3.34. District and Borough level 1 SFRAs detail the areas that may experience cumulative impacts of new developments. The assessments detail the locations that are less suitable for development and the measures that should be taken if a proposal comes forward on the land.

3.35. SuDS and other appropriate flood mitigation measures should be incorporated into any arising waste developments in order to reduce and ideally eliminate cumulative impacts on flood risk. Where possible, developments should aim to improve the existing flood risk and include runoff attenuation structures within the design.

The Sequential Approach to Flood Risk Management

3.36. In order to ensure that flood risk is taken into account at all stages of the planning process, a sequential risk-based approach to determine the suitability of land for development, should be carried out in line with the requirements of the NPPF. This is to avoid inappropriate development in areas at risk of flooding, and to direct future development away from areas that have the highest risk of flooding.

3.37. Paragraph 162 of the NPPF provides a clear definition of the Sequential Test, which states:

> *"The aim of the sequential test is to steer new development to areas with the lowest risk of flooding from any source. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower risk of flooding. The strategic flood risk assessment will provide the basis for applying this test. The sequential approach should be used in areas known to be at risk now or in the future from any form of flooding."*

3.38. Only where there are no reasonable sites in areas where there is a lower risk of flooding should consideration be given to the suitability of sites in areas where flooding may occur. The application of the exception test will then need to be applied, which is explained in more detail in paragraphs 3.71 – 3.75.

Flood Zones and the Sequential Test

3.39. The basis for the Sequential Test is the Environment Agency's flood zone categorisation, resulting in all land in England being identified as falling within one of the following four classifications, which are described below. Definitions have been taken from table 1 in Paragraph 065 of the Flood Risk and Coastal Change chapter of the PPG.

Flood Zone 1 (Low Probability of Flooding)

3.40. Land within this flood zone has been assessed as having a less than 1 in 1,000 annual probability of river or sea flooding. The Sequential Test identifies any land use as appropriate within this location. Areas located within flood zone 1 are shown as 'clear' on the Environment Agency flood map and is classed as all land outside of flood zones 2 and 3.

Flood Zone 2 (Medium Probability of Flooding)

3.41. Land within this flood zone has been assessed as having a medium probability of experiencing flooding from rivers and the sea (i.e. having

between a 1 in 100 and 1 in 1000 annual probability of river flooding, or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. Land within this flood zone is shown in light blue on the Environment Agency's flood map.

Flood Zone 3a (High Probability of Flooding)

3.42. Land within this zone has been assessed as having a high probability of experiencing flooding from rivers and the sea (i.e. between 1 in 100 or greater annual probability of river flooding; or between a 1 in 200 or greater annual probability of sea flooding. Land within this flood zone is shown in dark blue on the Environment Agency's flood map.

Flood Zone 3b (The Functional Floodplain)

3.43. Land within this zone is normally classed as having an annual probability of 1 in 20 (5%) or greater in any year of flooding or land that is designed to flood in an extreme flood (0.1%). The primary purpose of the functional flood plain is where water has to flow or be stored in times of flood. The PPG requires local planning authorities to identify within their SFRAs areas of the functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. Land within this zone is not separately distinguished from flood zone 3a on the Environment Agency's flood map.

3.44. Development within flood zones 2, 3a and 3b should seek opportunities to reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage systems.

3.45. The Minerals and Waste Planning Authority is not responsible for identifying land within flood zone 3b. This is the responsibility of the county's ten local planning authorities, who have identified areas of the functional floodplain within their respective SFRAs, in consultation with the Environment Agency.

3.46. Some, but not all, local planning authorities in the county have undertaken hydraulic modelling of areas identified as falling within flood zone 3 in order to identify areas situated within flood zone 3b.

Sequential Test Vulnerability Classes

3.47. In order to apply the sequential test, local planning authorities are required to take into account the flood risk vulnerability of land uses. Table 2 in Paragraph 066 of the Flood Risk and Coastal Change chapter of the PPG categorises different types of uses and development according to their vulnerability to flood risk.

3.48. There are a total of five vulnerability classes which are listed below:

- Essential Infrastructure;
- Highly Vulnerable;
- More Vulnerable;
- Less Vulnerable; and
- Water Compatible-Development.

3.49. All types of infrastructure, development and other land-uses have been categorised as falling within these types of vulnerability classes. Of relevance to Minerals and Waste Local Plan, landfill sites (as defined in Schedule 10 of the Environmental Permitting (England and Wales) Regulations 2010) and hazardous waste facilities have been classed as 'more vulnerable' with all other types of waste treatment classified as less vulnerable. All types of mineral workings (except for sand and gravel) have been classified as 'less vulnerable'. Sand and gravel workings are however classified as 'water-compatible development.' This is shown in the table below, which has been amended from the PPG's Flood Risk Vulnerability Classification table.

Table 6 - Flood Risk Vulnerability and Flood Zone Compatibility for Waste Developments [23]

More Vulnerable: Landfill and sites used for waste management facilities for hazardous waste.
Water-Compatible Development: Sand and gravel working.
Less Vulnerable: Waste treatment (except landfill* and hazardous waste facilities). Minerals working and processing (except for sand and gravel working).

3.50. The PPG contains a table which graphically compares the types of flood zones described previously, with the flood risk vulnerability classes that are listed above. The table shows where developments that fall within the vulnerability classes should or should not be permitted.

3.51. Table 7 and Table 8 below have been amended from table 3 in the PPG [24], in order to highlight the compatibility of waste management facilities and mineral workings within the relevant classes.

[23] Amended from Table 2 in Paragraph 066 of the Flood Risk and Coastal Change chapter of the NPPG.

[24] Table 3 is in Paragraph 067 of the Flood Risk and Coastal Change chapter of the PPG.

Table 7 - Flood Risk Vulnerability and Flood Zone 'Compatibility' for waste developments

Flood Risk Vulnerability classification	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water-Compatible Development	Appropriate for Waste Development?
Flood Zone 1	✓	✓	✓	✓	✓	All waste developments are acceptable in flood zone 1.
Flood Zone 2	✓	Exception Test required	✓	✓	✓	Waste development acceptable if subjected and passed the sequential test.
Flood Zone 3a †	Exception Test required	X	Exception Test required	✓	✓	More vulnerable waste treatment facilities should only be permitted if the exception test is passed. Site specific flood risk assessments needed. Less vulnerable waste treatment facilities acceptable if subjected and passed the sequential test.
Flood Zone 3b	Exception Test required *	X	X	X	✓*	No waste management uses are acceptable.

Table 8 - Flood Risk Vulnerability and Flood Zone 'Compatibility' for minerals workings

Flood Risk Vulnerability classification	Less Vulnerable	Water-Compatible Development	Appropriate for Minerals Development?
Flood Zone 1	✓	✓	All minerals workings and processing facilities are acceptable in flood zone 1.
Flood Zone 2	✓	✓	All minerals workings and processing facilities are acceptable in flood zone 2.
Flood Zone 3a	✓	✓	All minerals workings and processing facilities are acceptable in flood zone 3a.
Flood Zone 3b	**X**	✓*	Only sand and gravel workings are acceptable. Other minerals workings and processing facilities are not acceptable in flood zone 3b.

Key:
✓ Development is appropriate
X Development should not be permitted
* Water-compatible uses that are located in flood zone 3b should be designed and constructed to:

- remain operational and safe for users in times of flood;
- result in no net loss of floodplain storage;
- not impede water flows and not increase flood risk elsewhere.

† In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood.

3.52. The above tables do not show the application of the Sequential Test which should be applied first to guide development to flood zone 1, then flood zones 2 and 3; nor does it reflect the need to avoid flood risk from sources other than rivers and the sea.

Application of the Sequential Test

3.53. In terms of flood risks, waste developments are acceptable in flood zones 1 and 2. Mineral working is acceptable in flood zones 2 and 3a and sand and gravel workings are suitable within flood zones 2, 3a and 3b. However, mineral and waste planning authorities are encouraged to apply the Sequential Test to the allocation of sites for waste management and identifying sites for mineral extraction. This is specifically outlined in paragraph 018 of the Flood Risk and Coastal Change chapter of the PPG:

"Waste and mineral planning authorities should apply the sequential approach to the allocation of sites for waste management and, where possible, mineral extraction and processing. It should also be recognised that mineral deposits have to be worked where they are (and sand and gravel extraction is defined as 'water-compatible development' in table 2, acknowledging that these deposits are often in flood risk areas)."

Waste

3.54. Existing operational waste management facilities within Hertfordshire are dispersed across the county forming a strategic network of waste facilities which enable waste to be dealt with as close as practicable to its source.

3.55. Waste treatment facilities are seen as 'less vulnerable' developments to flood risk however landfills and hazardous waste sites have historically been considered more vulnerable.

3.56. A number of contentious considerations are made in terms of locational criteria for the siting of waste management facilities. There may be other social and economic factors that result in such an arrangement for the location of waste management facilities to meet the needs of communities and businesses, but they should be well designed, appropriately sized and sensitively located so that they reduce the health, environmental and social impacts, and seek enhancement of the locality.

3.57. In testing the suitability of sites and areas in the preparation of Local Plans and in determining planning applications, waste planning authorities are required to consider the protection of water quality and resources and flood risk management:

"Considerations will include the proximity of vulnerable surface and groundwater or aquifers. For landfill or land-raising, geological conditions and the behaviour of surface water and groundwater should be assessed both for the site under consideration and the surrounding area. The suitability of locations subject to flooding, with consequent issues relating

to the management of potential risk posed to water quality from waste contamination, will also need particular care." [25]

3.58. Approximately a quarter of existing operational waste sites in Hertfordshire are within flood zones 2 and 3 and half of all sites are within Green Belt.

3.59. Waste developments have the potential to impact water resources at a specific site or as part of the wider area and national policy states that development should be steered towards areas of lower flood risk. Planning applications must therefore address the likely effects of a development proposal on surface water and groundwater in terms of changes to flow, water table, water temperature and quality.

3.60. Depending upon the specific criteria contained within a future waste site selection methodology, it could be feasible to locate the majority of future waste sites outside of flood zones 2 and 3.

3.61. However, if all potential waste sites cannot be located within flood zone 1, then the Sequential Test must be undertaken. This should take the form of an assessment, which in conjunction with the approved site selection methodology; assesses all reasonably available alternative sites that are located within flood zone 1. If a reasonable alternative site is found and conforms to the overall site selection methodology, then that particular site should take precedence over other sites.

3.62. There may be occasions where, following the application of the Sequential Test, only limited areas within a potential waste site are located within flood zones 2, 3a and 3b. This may not affect the actual waste management operation, but care should be taken to ensure that the site and associated processing facilities are located within the areas of the site that are covered by flood zone 1.

Minerals

3.63. Current sand and gravel workings within Hertfordshire are located within the sand and gravel belt. This is a deposit which is mostly concentrated in a band across the southern part of the county, with a few scattered deposits further north. The extent of the sand and gravel belt has been based upon work undertaken by the British Geological Survey (BGS). Sand and gravel is therefore the predominant type of mineral within Hertfordshire.

3.64. Sand and gravel workings are seen as 'water-compatible development', as traditionally this type of mineral extraction is undertaken in river valleys and

[25] NPPW (2014), Appendix B

flood plains. In Hertfordshire, the sand and gravel belt roughly follows the line of where the River Thames once flowed through the county.

3.65. Whilst the sand and gravel belt within Hertfordshire contains many of the county's main rivers, there are large areas within the deposit that are not situated within flood zones 2 and 3. Depending upon the specific criteria contained within a future mineral site selection methodology, it could be feasible to locate the majority of future sand and gravel sites outside of flood zones 2 and 3.

3.66. However, if all potential sand and gravel sites cannot be located within flood zone 1, then the Sequential Test must be undertaken. This should take the form of an assessment, which in conjunction with the approved site selection methodology; assesses all reasonably available alternative sites that are located within flood zone 1. If a reasonable alternative site is found and conforms to the overall site selection methodology, then that particular site should take precedence over other sites.

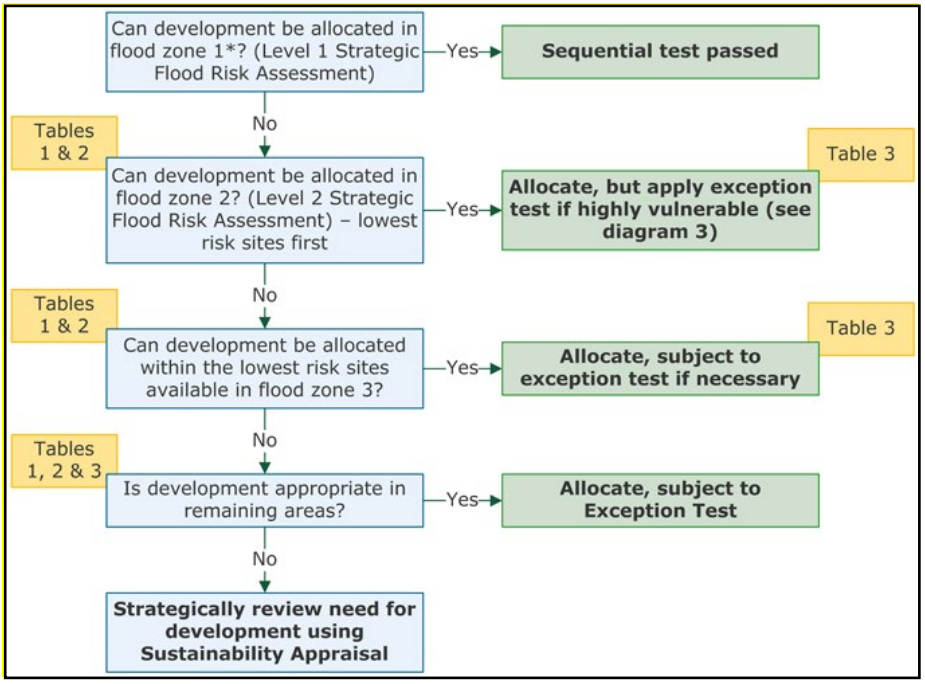
3.67. There may be occasions where, following the application of the Sequential Test, only limited areas within a potential sand and gravel site are located within flood zones 2, 3 and 3b. This may not potentially affect the actual extraction of sand and gravel, but care should be taken to ensure that the plant site and associated processing facilities are located within the areas of the site that are covered by flood zone 1.

3.68. The same principle should be applied when identifying future sites for clay extraction, if the need arises during the production of the Minerals and Waste Local Plan. Whilst clay extraction sites are not deemed suitable developments within flood zone 3b, (in accordance with table 7), the potential layout of the site should avoid the plant site and other infrastructure being located within the areas of the site that may fall within flood zones 2 and 3.

3.69. If a mineral extraction site were to be located within flood zones 2 and 3, or partly outside of flood zone 1, the PPG also encourages minerals planning authorities to take into account at the restoration stage the potential to:

"…explore benefits, such as restoring mineral working located in flood risk areas to increase flood water storage, which can also enhance the natural environment."

3.70. Diagram 2 in Section 6 of the Flood Risk and Coastal Change chapter in the PPG, outlines how local planning authorities should apply the Sequential Test when identifying potential sites through the local plan process. This is replicated below:



* Other sources of flooding also need to be considered.

The Exception Test

3.71. The PPG[26] defines the exception test as:

"…a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available."

3.72. Paragraph 163 of the NPPF provides a definition of when the exception test may have to be applied:

"If it is not possible for development to be located in areas with a lower risk of flooding (taking into account wider sustainable development objectives), the exception test may have to be applied. The need for the exception test will depend on the potential vulnerability of the site and of the development proposed, in line with the Flood Risk Vulnerability Classification set out in Annex 3."

3.73. For the Exception Test to be passed, the Sequential Test should already have been applied. Paragraph 164 of the NPPF goes on to state that the following criteria must therefore be satisfied when applying the Exception Test:

[26] Paragraph 023 of the Flood Risk and Coastal Change chapter of the PPG

a) “the development would provide wider sustainability benefits to the community that outweigh the flood risk; and

b) 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”

3.74. Paragraph 165 of the NPPF makes it clear that both elements of the test will have to be met for development to be allocated or permitted.

3.75. Similarly to the Sequential Test, the PPG outlines how local planning authorities should apply the Exception Test if appropriate, when identifying potential sites through the local plan process. This is replicated below:[27]

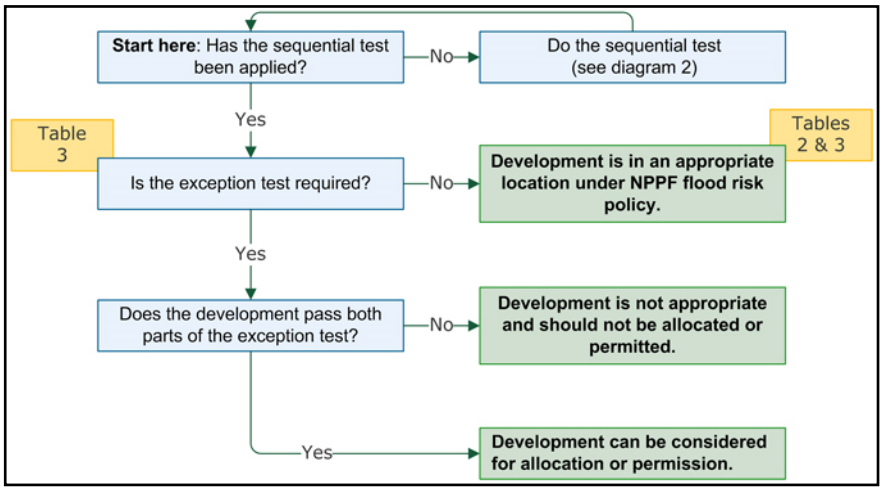


Figure 7 - Exception Test Flowchart

Flood Risk Considerations for Mineral and Waste Sites

3.76. Most mineral extraction sites, due to their size and timescale for extraction, can have a significant impact on flooding over a local and wider area. These can take the form of a reduced floodplain conveyance, an increase in flood storage capacity and effects on surface water and groundwater flows. Impacts from waste sites can take the form of a reduced floodplain conveyance, a decrease in flood storage capacity and effects on surface water and groundwater flows. A description of these potential effects is summarised below:[28]

[27] Diagram 3, Paragraph 028 of the Flood Risk and Coastal Change Chapter of the PPG.

[28] Definitions have been obtained from ‘The Influence of Aggregate Quarrying in River Floodplains and Biodiversity’, produced by Symonds Group Ltd on behalf of RMC Aggregates and Lafarge Aggregates.

3.77. Floodplain conveyance is the ability of the floodplain to transfer water and is dependent upon a number of factors, including hydraulic roughness, flow area and wetted perimeter. As landfilling of waste and mineral extraction impacts on the ground surface, associated impacts on floodplain conveyance are inevitable. Increasing the irregularity of the floodplain surface caused by landfilling and mineral extraction will normally reduce the ability of the floodplain to convey flow and may result in an increase in local flood risk.

3.78. Flood storage capacity refers to the water volume of a flood wave that can be temporarily retained. A decrease in this can result from a working void within active landfilling or active quarry. Some of this potential storage can be preserved after restoration, if the restored surface is below the original floodplain and/or if a site is situated within flood zone 3b. The restoration of mineral sites through landfilling can cause flooding in areas that store or convey water during flood events.

3.79. Surface water and groundwater flows can be exacerbated by mineral extraction and landfills that are constructed in former mineral extraction sites. Surface water run-off may increase by the compaction of soil, if the area of hard surface is increased, by the construction of paved surfaces. It may be necessary to consider the changes in landform over the extended life of the site resulting from settlement which could affect the integrity of drainage systems, gradients, runoff rates and the routes that runoff drains from the site. Groundwater flooding could be influenced where mineral extraction impacts upon local hydro geological characteristics and the interface with the hydrogeological regime, for example through increased transmissivity.

3.80. Mineral and waste sites located within flood zone 3b can also be affected by the inundation of flood water during a flooding event. An event of this nature could potentially affect the integrity of stockpiles of waste located within a waste site rendering them unable to be processed. It could also potentially cause the erosion of stockpiles located within a mineral working site and may also result in the deposit of sediment within a mineral void. Fluvial flooding is normally the most likely cause of these events, but surface water and groundwater flooding can also be a contributing factor.

3.81. It is clear therefore that changes in land use can increase flood risk and indirect flood risk in other locations, by increasing the amount of run-off. This is likely to be less of an issue if new mineral and waste sites are located within flood zone 1, where their location outside of flood zones 2 and 3 do not increase the direct risks of fluvial flooding within the site.

3.82. However, there may still be other flood risk issues that should be taken into account when identifying potential mineral and waste sites within flood zone 1. These are:

- Minor watercourses that could potentially pose a hazard, which may require further investigation through an individual Flood Risk Assessment (FRA);
- The identification of structures (such as a bridge or culvert) that could increase flood risk by restricting water flow and/or be susceptible to blockage.

3.83. This Level 1 SFRA does not currently assess the flood risk potential of new mineral sites being considered for the review of the Hertfordshire Minerals Local Plan. This therefore means that it is not possible to assess whether new mineral sites or the potential location of extensions to existing mineral sites will result in an increase in local or wider flooding.

3.84. The potential effects on local and wider flooding can be reduced by avoiding the identification of new mineral sites and waste management sites within flood zones 2 and 3, even though waste operations, excluding landfill and hazardous waste treatment facilities, are acceptable in flood zone 2 (medium probability of flooding) and mineral workings and processing facilities are acceptable in flood zone 3a (higher probability of flooding) and sand and gravel workings are acceptable in flood zone 3b (the functional floodplain).. Flood Risk Assessments (FRAs) will need to accompany planning applications for new waste developments within the county. Further guidance into the content of an FRA is outlined in paragraphs 3.85 – 3.89 below.

Site Specific Flood Risk Assessment Guidance

3.85. Due to the nature of waste management facilities and size and scale of mineral workings, any new planning application for such sites within the county will likely need to be accompanied by an individual Flood Risk Assessment (FRA), regardless of their location within flood zones 1, 2 and 3. FRAs will assess whether the development will be acceptable in flood risk terms both within the site and on the surrounding area.

3.86. The following guidance from the NPPF can be used in the preparation of site specific FRAs. The conditions where a site specific FRA is required are as follows:

- All development in Flood Zones 2 and 3;
- All proposals in Flood Zone 1 involving:
  - sites of 1 hectare or more;
  - land which has been identified by the Environment Agency as having critical drainage problems;

- land identified in a strategic flood risk assessment as being at increased flood risk in future; or
- land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.[29]

3.87. Site specific FRAs that are submitted at the planning application stage[30] should consider the following during the site's operation:

- Using the Sequential Test to demonstrate that the most vulnerable development is located in areas of lowest flood risk (flood zone 1), unless there are overriding reasons to prefer a different location (this can relate to locating the plant site and other associated infrastructure outside of areas that may be located within flood zones 2 and 3);
- Show that the development is appropriately flood resilient, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning; and that it gives priority to the use of sustainable drainage systems;
- Address the potential impacts of the development on flood storage capacity within the site (including any reduction of capacity in landfill voids following restoration and any scope for the creation of additional capacity in mineral voids following restoration);
- Identify and assess the risks of all forms of flooding to and from the development. It should demonstrate how these flood risks will be managed, taking climate change into account;
- Demonstrate that the development will not impede flow routes and that it will reduce flood risk where applicable;
- A Flood Defence Consent will be required for work to main rivers. This is under the terms of the Water Resources Act 1991, and the Thames Land Drainage Byelaws 1981, whereby the prior consent of the Environment Agency is required for any proposed works or structures, in, under, over or within 8m of the top of the bank of any main river. This is irrespective of planning permission granted.

3.88. Further guidance in the form of a checklist is outlined in the PPG and can be viewed using the following link: http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/site-specific-flood-risk-assessment-checklist/.

3.89. A site specific FRA should be prepared in consultation with the Environment Agency, the county council as LLFA, internal drainage boards, reservoir undertakers and navigation authorities.[31]

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[29] Footnote 55, paragraph 168, National Planning Policy Framework (2021).

[30] Under the terms of the Water Resources Act 1991, and the Thames Land Drainage Byelaws 1981, the prior consent of the Environment Agency is required for any proposed works or structures, in, under, over or within 8m of the top of the bank of any main river. This is irrespective of planning permission granted.

Sustainable Drainage Systems (SuDS)

3.90. Sustainable Drainage Systems (SuDS) is the management of surface water runoff generated by development. The aim of SuDS is to manage surface water as close to its source as possible in order to slow the rate of surface water run-off and improve infiltration through mimicking the natural drainage of both rural and urban areas.

3.91. SuDS are implemented through soft engineering options and should be designed to take into account the surface water run-off quantity, rates and also water quality ensuring their effective operation. The incorporation of SuDS should attempt to contribute to reduce flood risk to the site and surrounding area, reduce pollution and provide landscape and wildlife benefits.

3.92. Where possible, a combination of SuDS techniques should be used and designed into developments at the early planning stages. The 'management train' comprises components at different stages of the overall water drainage system which includes:

- Prevention (good site design and upkeep to prevent runoff and pollution);
- Source control (runoff control at/near to the source);
- Site control (water management from a multitude of catchments);
- Regional control – integrate runoff management systems from a number of sites (for example into a detention pond).

SuDS Techniques

3.93. There are various ways in which SuDS can be incorporated into mineral working and waste management sites. For example, landfill sites could make use of ditches, ponds and vegetation to capture run off and operational quarries install ponds and lagoons to capture run off, for re-use in the associated mineral works. A list of SuDS techniques, which include a range of elements are mentioned below:

3.94. Pervious Surfaces through Porous or Permeable surfaces. Pervious surfaces can be suitable for pedestrian or vehicular traffic while allowing rainwater to infiltrate through the surface areas. Allowing water to infiltrate across the whole surface area is known as porous surfacing. Permeable surfacing allows water to infiltrate between the voids from the surface area.

[31] Paragraph 006 of the Flood Risk and Coastal Change chapter of the PPG.

3.95. Filter strips. A gently sloped area of vegetated ground designed to drain water evenly off impermeable areas and to filter out silt and other particulates.

3.96. Filter and infiltration trenches. Infiltration trenches are shallow troughs which can be filled with a permeable material for example sand or small stones designed to remove pollutants from runoff and allow water to drain into surrounding soils.

3.97. Swales. A shallow vegetated channel that can manage and retain water which may also allow infiltration. Vegetation within the swale helps to filter any particulates.

3.98. Detention Basins, Ponds and Wetlands. Detention basins have a larger surface area to allow water to collect in the basin and allow any pollutants to settle before the water can infiltrate into the soil or be discharged downstream. Ponds can be used when water is stored for longer and allows pollutants to be broken down by natural processes.

3.99. Green Roofs. Green roofs are used to cover buildings or other roof structures with vegetation. Green roofs help to reduce the volume and rate of runoff as they retain precipitation for longer before it reaches the water system.

Requirement for SuDS

3.100. The Flood and Water Management Act 2010 aims to increase the use of sustainable drainage systems in new development. It is compulsory for all new development of 10 homes or more and all major developments to include SuDS as part of the development.

3.101. A Major development is defined under Article 2(1) of Town and Country Planning (Development Management Procedure) (England) Order, which includes minerals and waste development. Therefore, under the proposed changes all applications for mineral working and waste management facilities will need to include SuDS as part of the application.

3.102. The documents of main reference for Hertfordshire are:

- HCC Lead Local Flood Authority SuDS Policy Statement – Meeting Sustainable Drainage System Standards in Hertfordshire March 2017 – https://www.hertfordshire.gov.uk/media-library/documents/environment-and-planning/water/surface-water-drainage/suds-policies-rev1-v2-webpage.pdf

- *HCC SuDS Design Guidance for Hertfordshire March 2015* - https://www.hertfordshire.gov.uk/media-library/documents/environment-and-planning/water/surface-water-drainage/guidance-for-suds-in-hertfordshire.pdf

Flood Management Features

3.103. Hertfordshire and the adjoining authorities benefit from flood management features. These are in place to protect settlements and sensitive areas from the fluvial flood risk. A number of feature types are used in the county, many of which are natural.

3.104. The Environment Agency holds data on flood management features in their Asset Information and Maintenance Programme[32]. This data contains the known condition of the feature and the feature type.

3.105. The majority of flood management features within the county are high ground features (natural banks). These are natural parcels of raised land that direct and channel flood waters. Similar to these are embankments. These have the same function as high ground features but are man-made banks of earth or stone surrounding flood sources. There are also a number of flood walls within Hertfordshire built parallel to river channels to increase the height flood waters must reach to spill into sensitive areas.

3.106. Map 9 within the appendices of this document shows areas benefiting from a large amount of flood management features. The majority of these areas surround the River Lea, particularly from Hertford to Cheshunt, encompassing the Lea Valley area. The appendix maps show this area to have a higher susceptibility to multiple types of flooding including fluvial flooding.

3.107. The area surrounding Croxley Green and Rickmansworth benefits from flood management features also. Here, the River Chess, Gade and Colne converge and present a risk of fluvial flooding.

[32] Environment Agency & Defra (2018). Asset Information and Maintenance Programme. Defra Data Services Platform.

4. Conclusion

4.1. 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.

4.2. This Updated SFRA is an evidence base document that accompanies the Minerals and Waste Local Plan. 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 Hertfordshire County Council.

4.3. This Level 1 SFRA has been written in accordance with the requirements in the NPPF (2021), the PPG and additional guidance published by the Environment Agency. Input into this SFRA has also been received from the Environment Agency and the county council as Lead Local Flood Authority.

4.4. Future proposed mineral and waste developments should refer to this Level 1 SFRA which should be used to direct mineral and waste related development to areas of lower flood risk (flood zone 1), so that development is located in the lowest flood risk areas where possible, and make use of the maps in Appendix 1 to apply the Sequential Test. [33]

4.5. New 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
- 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.

[33] The maps contained within this Level 1 SFRA are correct at time of publication. Maps published on the Environment Agency's website via www.gov.uk should also be consulted.

Appendix 1: County Maps

The following maps illustrate the types of flooding that parts of the county may be susceptible to now and in the future. These maps also identify the sites proposed for allocation within the Plan for mineral extraction within the county. These maps show the following flood data:

Map 1: Location of Main Rivers in Hertfordshire;

Map 2: Location of Flood Zones 2 and 3 in Hertfordshire;

Map 3: Location of Historic Flooding in Hertfordshire;

Map 4: Location of Flood Warning Areas in Hertfordshire;

Map 5: Location of Reservoirs in Hertfordshire;

Map 6: Location of Groundwater Source Protection Zones 1, 2 and 3 in Hertfordshire;

Map 7: Locations Showing Areas Susceptible to Groundwater Flooding in Hertfordshire;

Map 8: Location of Areas at Risk from Surface Water Flooding in Hertfordshire; and

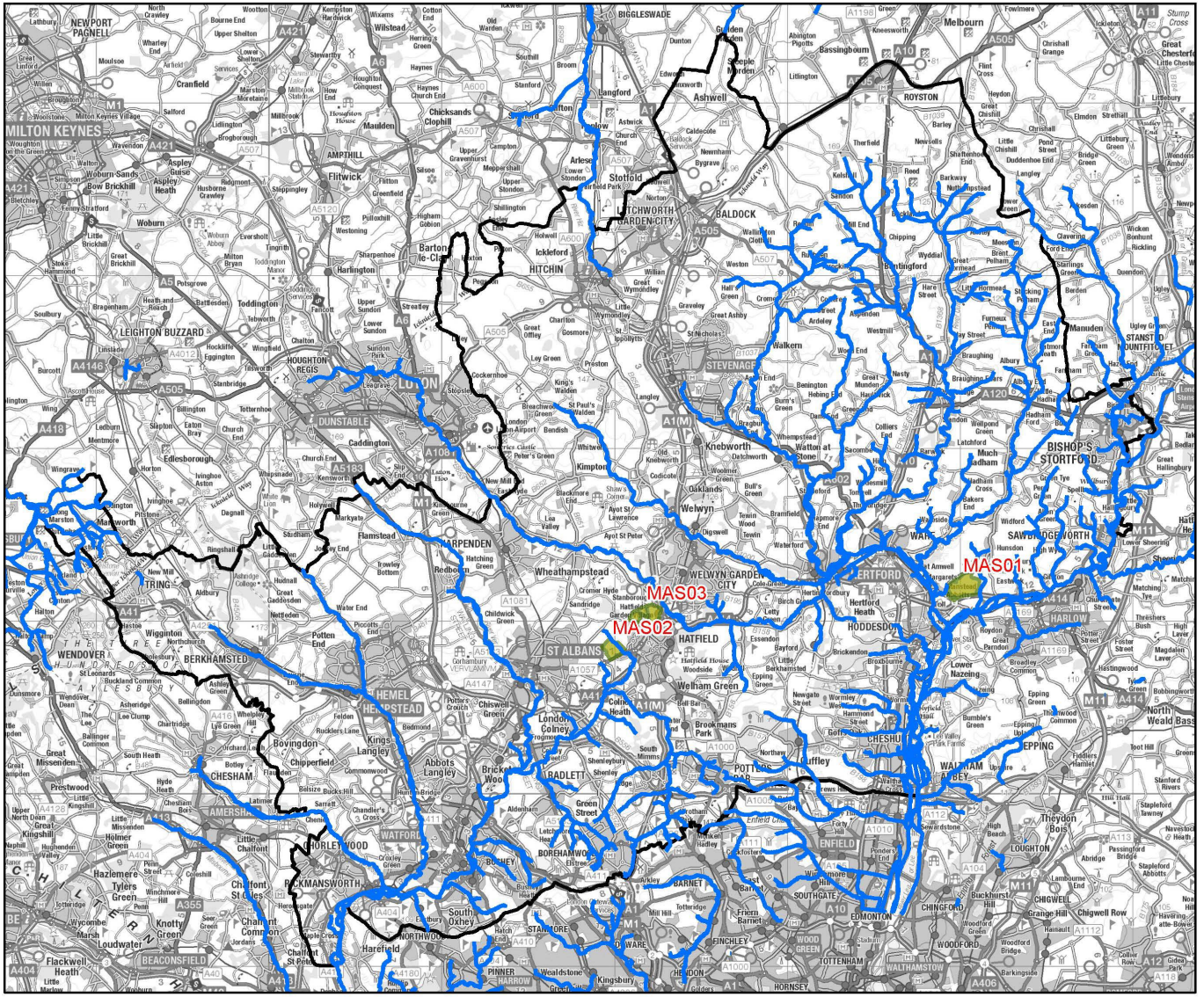
Map 9: Areas Benefiting from Flood Management Features in Hertfordshire

Map 1: Location of Main Rivers in Hertfordshire

Map 1
Main Rivers

Legend

- Main Rivers
- Mineral Allocation Sites
- Plan Area Boundary



N

Scale: 1:300,000

0 3 6 12 Kilometers

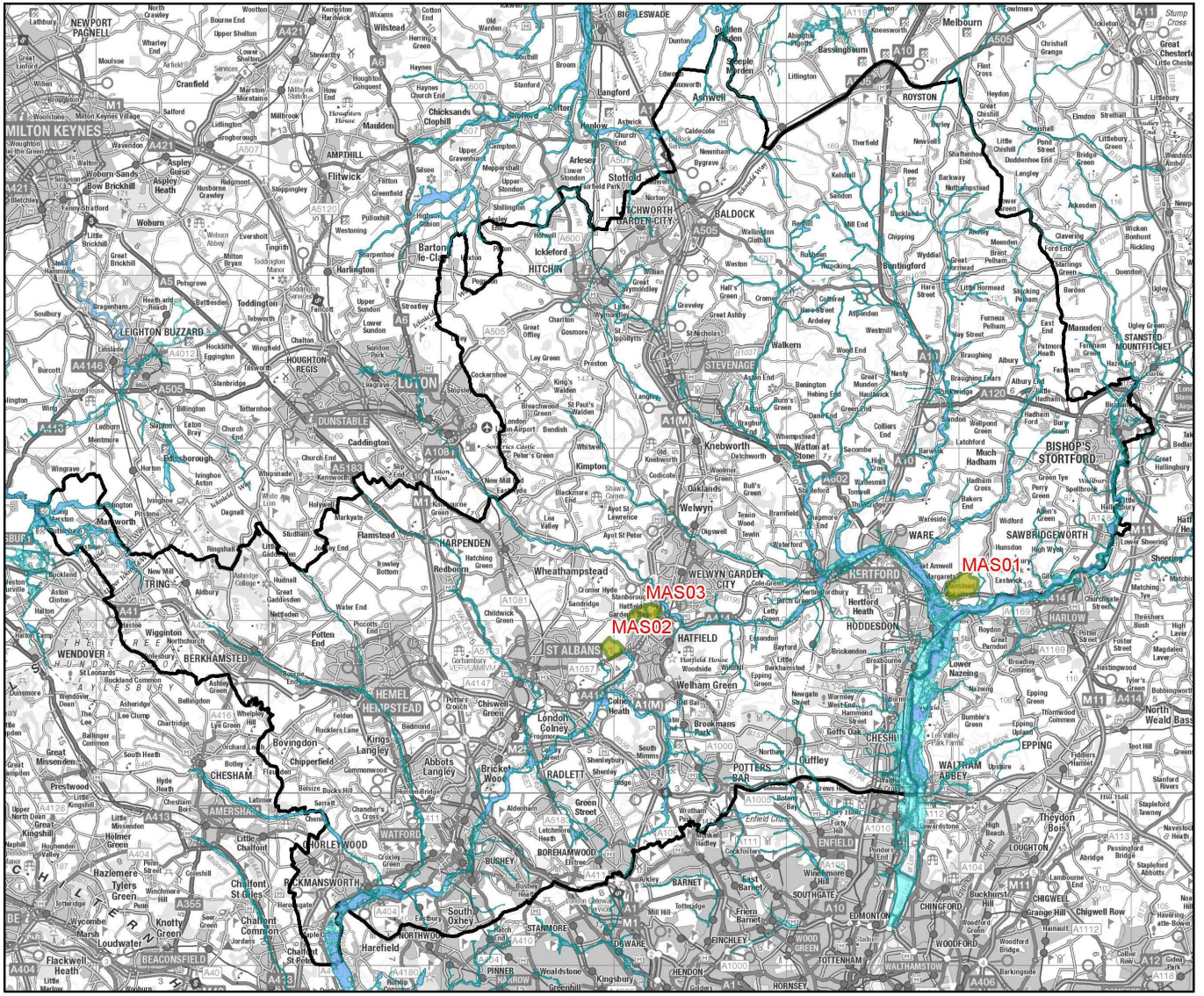
Hertfordshire

Map 2: Location of Flood Zones 2 and 3 in Hertfordshire

Map 2
Flood Zones
2 and 3

Legend

- Flood Zone 3
- Flood Zone 2
- Mineral Allocation Sites
- Plan Area Boundary

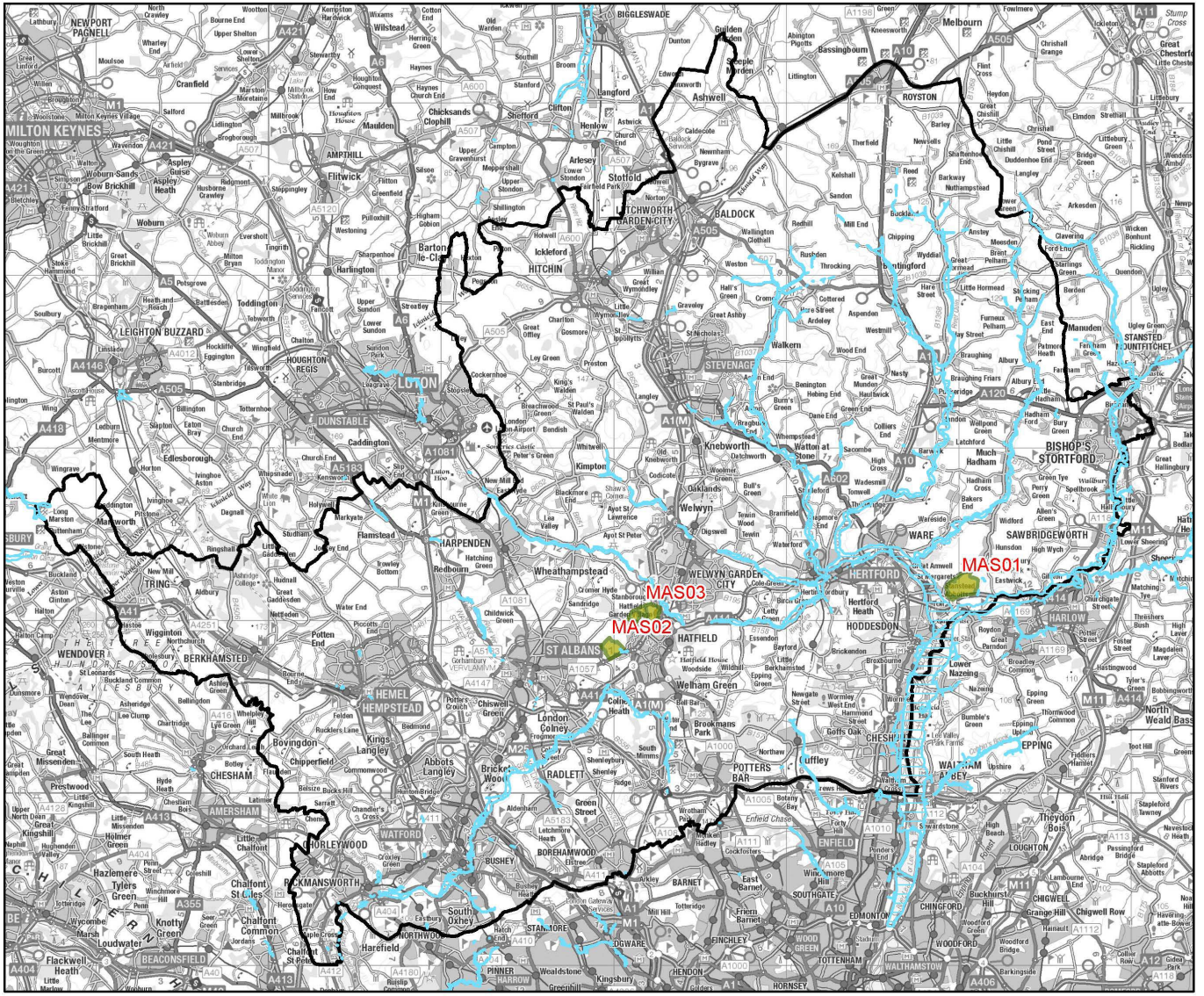


Map 3: Location of Historic Flooding in Hertfordshire

Map 3
Historic Flooding

Legend

- Historic Flooding
- Mineral Allocation Sites
- Plan Area Boundary



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Scale: 1:300,000

0 3 6 12 Kilometers

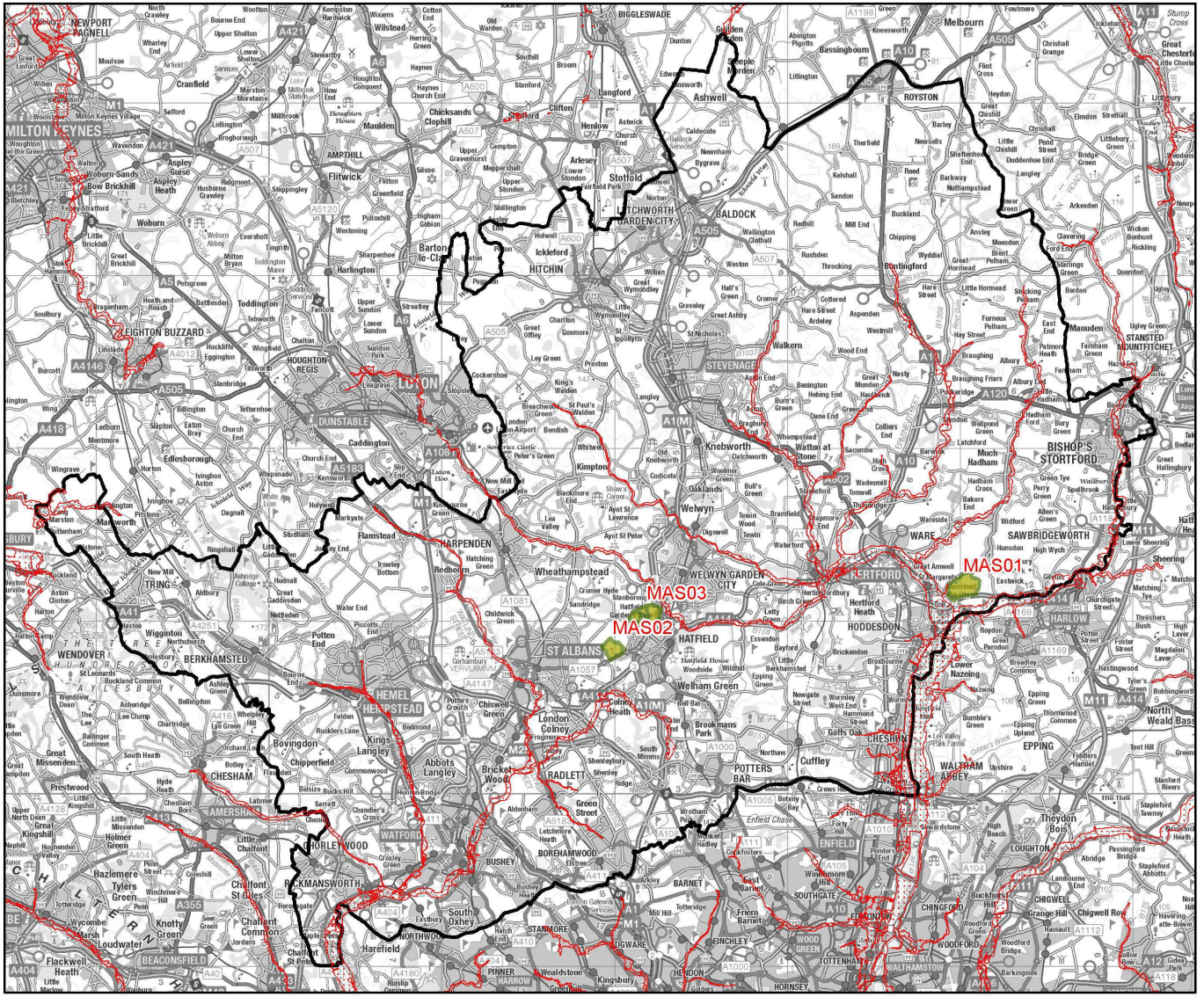
Hertfordshire

Map 4: Location of Flood Warning Areas in Hertfordshire

Map 4
Flood Warning Areas

Legend

- Flood Warning Areas
- Mineral Allocation Sites
- Plan Area Boundary



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Scale: 1:300,000

0 3 6 12 Kilometers

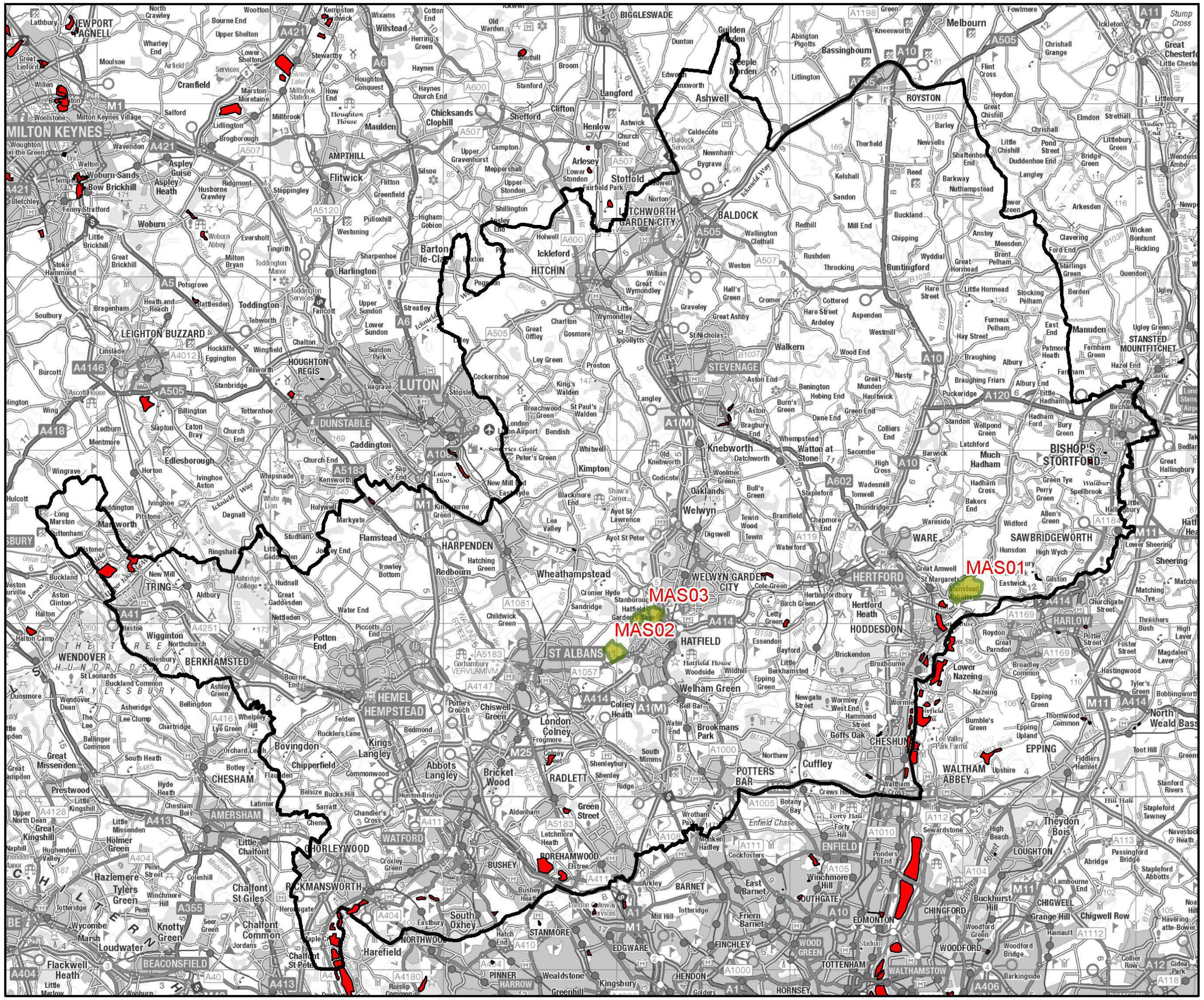
Hertfordshire

Map 5: Location of Reservoirs Flooding in Hertfordshire

Map 5
Lakes, Inland Water and Reservoirs

Legend

- Lakes, Inland Water and Reservoirs
- Mineral Allocation Sites
- Plan Area Boundary



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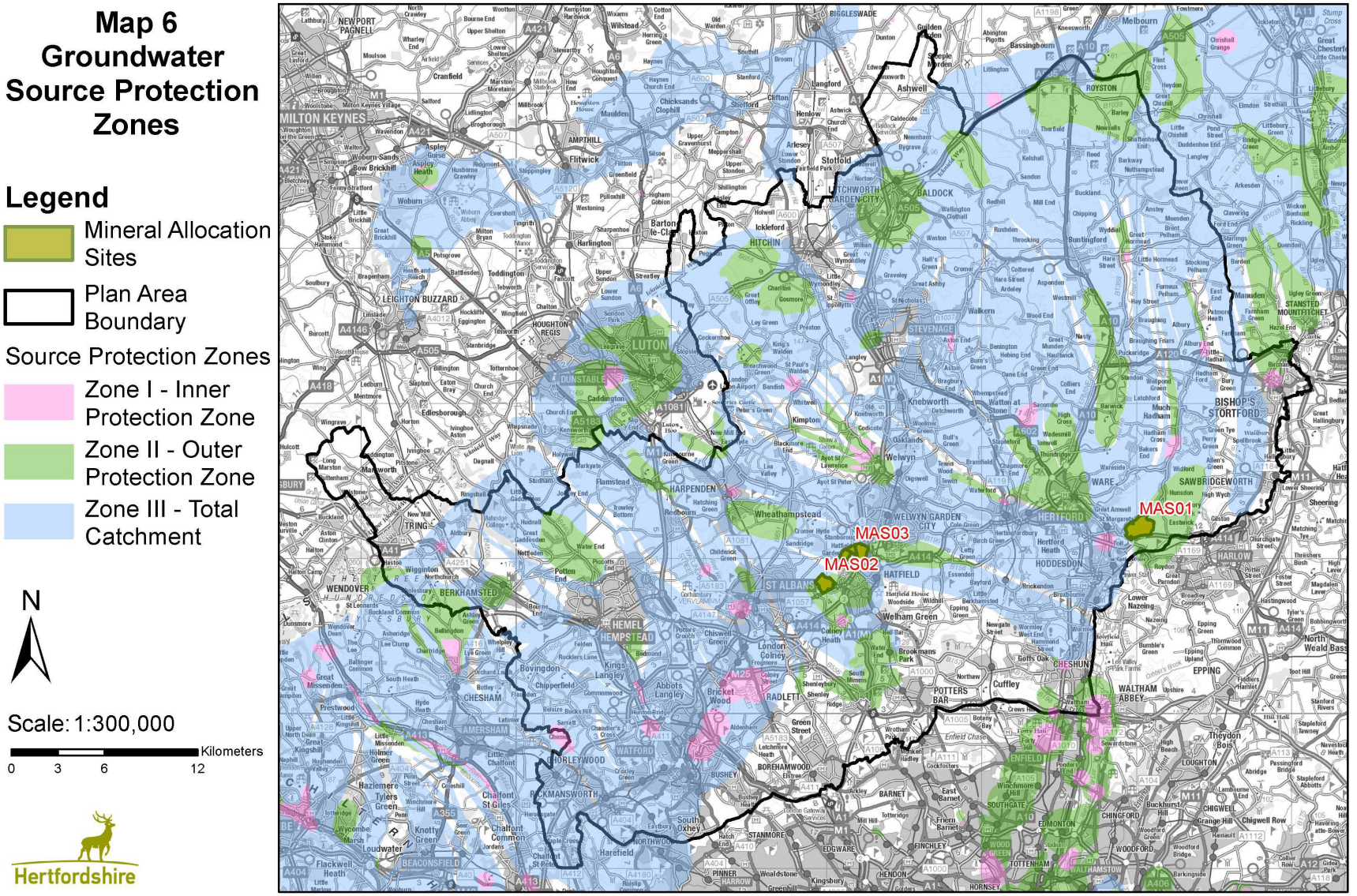
Scale: 1:300,000

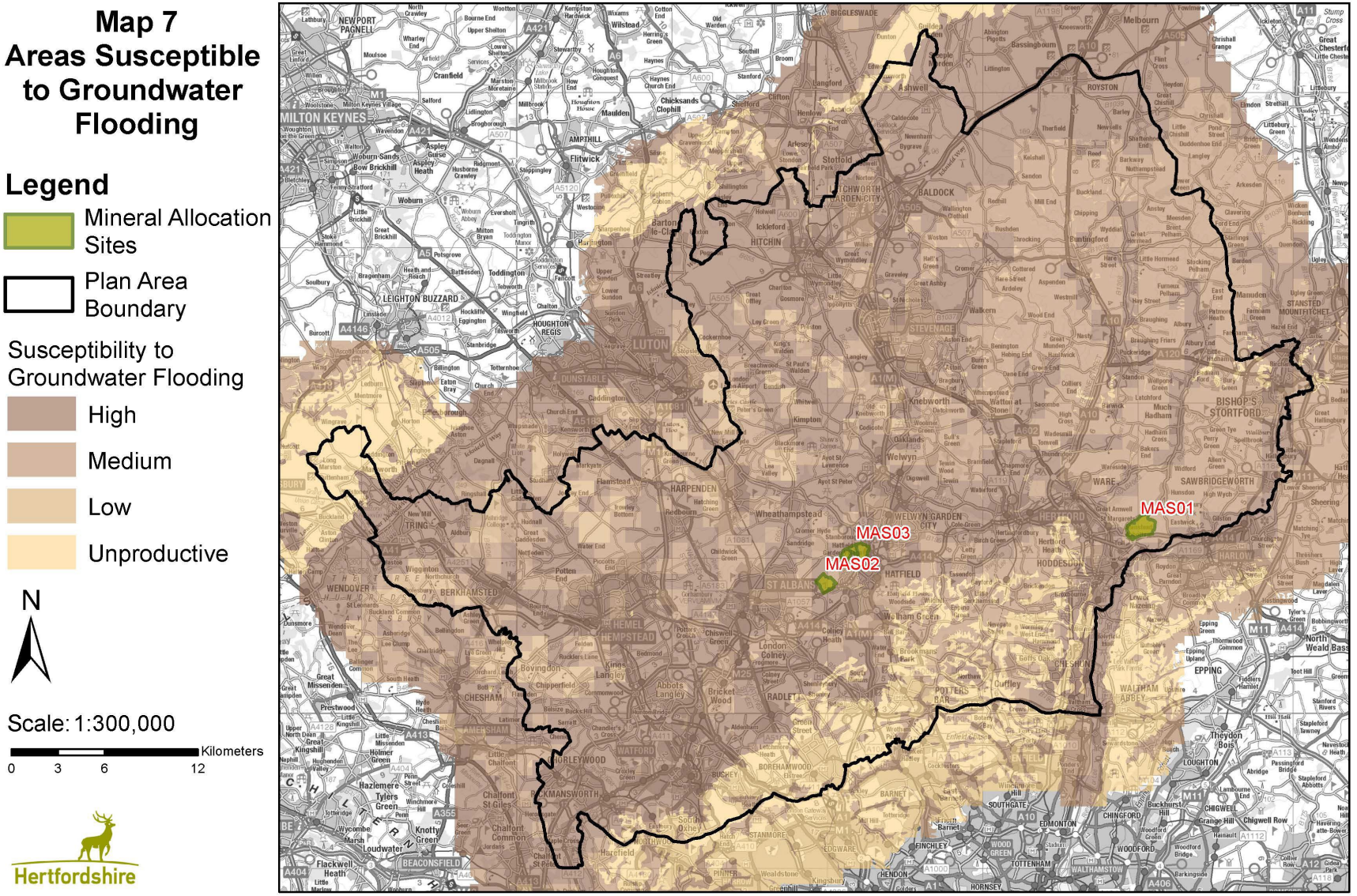
0 3 6 12 Kilometers

Hertfordshire

Map 6: Location of Groundwater Source Protection Zones 1, 2 and 3 in Hertfordshire



Map 7: Locations Showing Areas Susceptible to Groundwater Flooding in Hertfordshire



Map 8: Location of Areas at Risk from Surface Water Flooding in Hertfordshire

Map 8
Areas at Risk of Surface Water Flooding

Legend

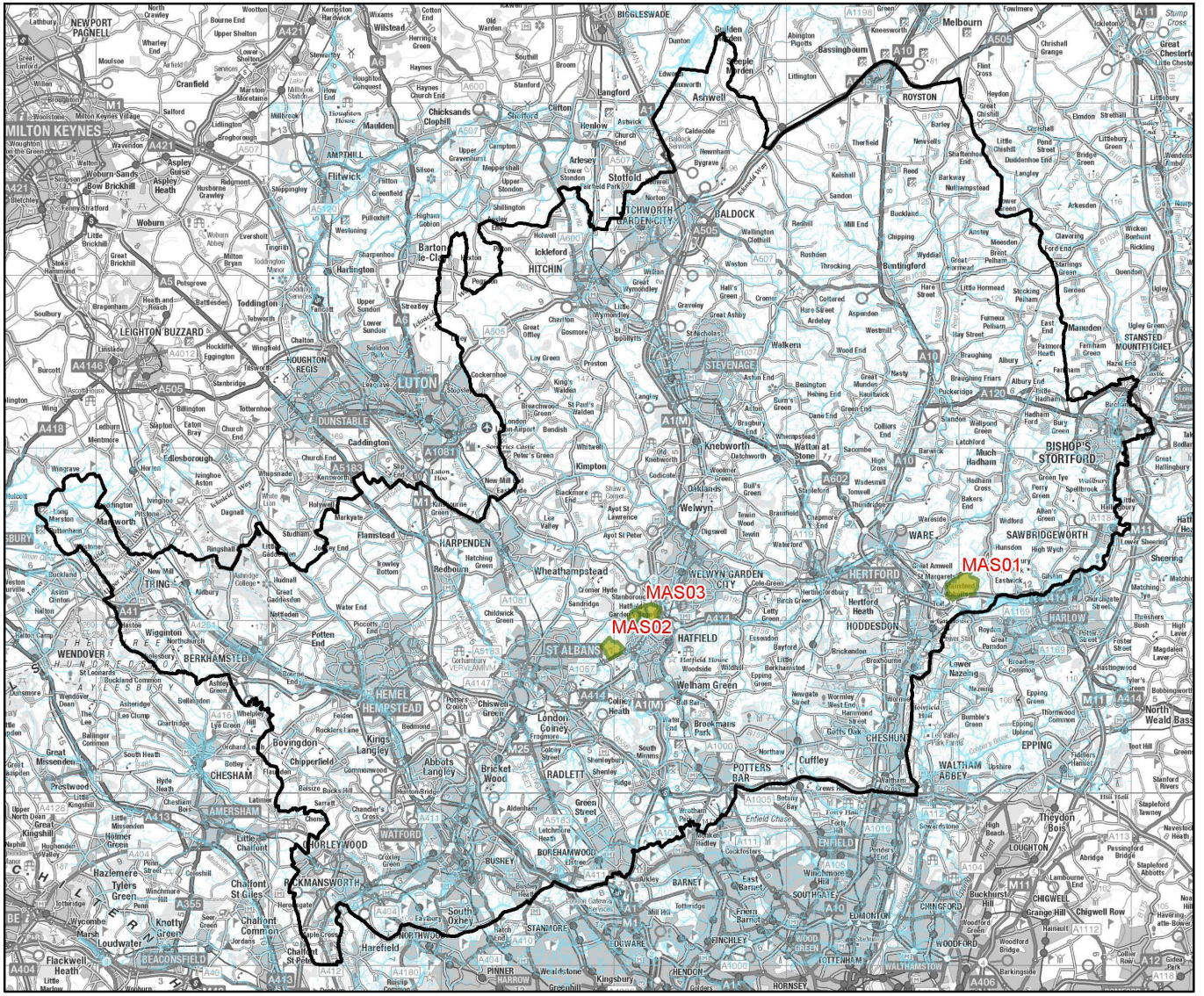
- Mineral Allocation Sites
- Plan Area Boundary
- Surface Water Flooding - Extent (1 in 100 year event)

N

Scale: 1:300,000

0 3 6 12 Kilometers

Hertfordshire



Map 9: Areas Benefiting from Flood Management Features in Hertfordshire

Map 9
Flood Management Features

Legend

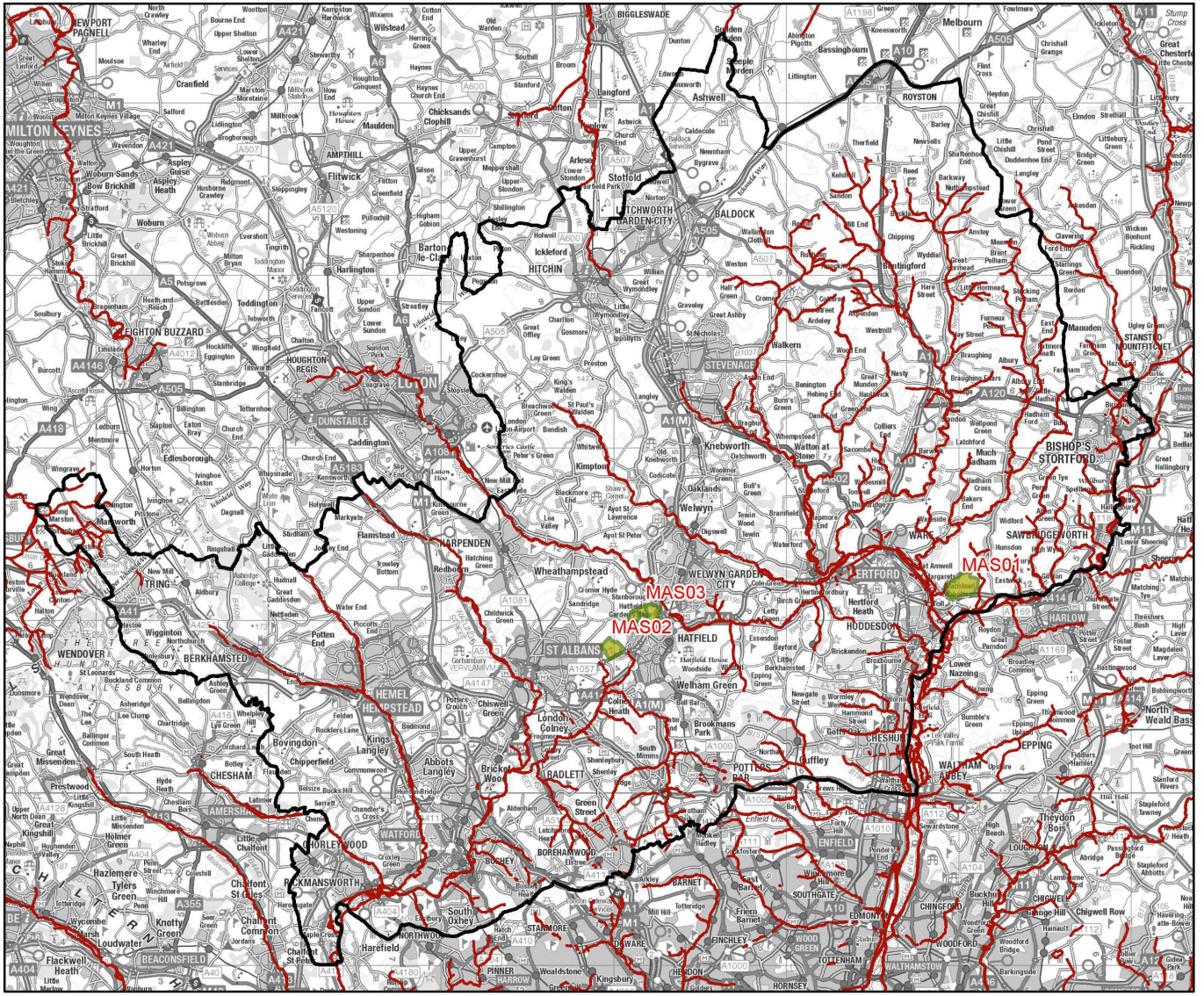
- Mineral Allocation Sites
- Plan Area Boundary
- Flood Management Features

N

Scale: 1:300,000

0 3 6 12 Kilometers

Hertfordshire



Appendix 2: Thames CFMP Policy Unit Messages and Recommendations for Hertfordshire

Thames CFMP Policy Unit Flood Risk Management Approaches for Hertfordshire	
Colne Policy Unit	
Unit Message and Flood Risk Management Approach:	Redevelopment rates in some areas are very high and offer the opportunity to reduce the risk and the current reliance on flood defences. This includes making the urban environment more resilient and with a layout that offers more options for managing future flood risk and the impacts of climate change. Existing river corridors in these areas provide an opportunity to be able to adapt to the impacts of climate change and should be safeguard from inappropriate development. Existing assets should be maintained at least until redevelopment takes place. Existing defences will need to be adapted over time as a result of climate change. A different combination of flood storage, river defences and floodplain attenuation should therefore be sought. Some of these areas are susceptible to rapid flooding from thunderstorms. Emergency response and flood awareness are particularly important.
Policy:	Policy 4: Areas of low, moderate or high flood risk where generally existing flood risk is managed effectively but further action may need to take place to keep pace with climate change.
Policy Unit Recommendation:	Take further action to sustain the current level of flood risk into the future (responding to the potential increases in risk from urban development, land use change and climate change).
Colne Tributaries & Wye Policy Unit	
Unit Message and Flood Risk Management Approach:	The location, layout and design of developments (in that order) are the most vital factors in managing future flood risk so that past mistakes are not repeated. Regeneration and re-development of some areas offers an opportunity to reduce flood risk; for example re-establishing river corridors and more effective management of run-off. Rivers should be part of the urban landscape, as at present, they are often culverted and hidden away, resulting in some flooding where watercourses have been previously modified. Flooding in these locations tends to arise from a number of sources and can be quite localised. Engineering interventions will tend to rely on opportunity; either to increase the conveyance of the watercourses by modifying or removing obstructions to flow or

	attenuating water at a local scale. These areas are susceptible to rapid flooding from thunderstorms.
Policy:	Policy 3: Areas of low to moderate flood risk where generally existing flood risk is managed effectively.
Policy Unit Recommendation:	Continue with existing or alternative actions to manage flood risk at the current level.
Lower Lee Policy Unit	
Unit Message and Flood Risk Management Approach:	Redevelopment rates in some areas are very high and offer the opportunity to reduce the risk and the current reliance on flood defences. This includes making the urban environment more resilient and with a layout that offers more options for managing future flood risk and the impacts of climate change. Generally the existing river corridors in these areas provide an opportunity to be able to adapt to the impacts of climate change . The Environment Agency are seeking to safeguard them from inappropriate development and are also seeking to maintain existing assets at least until redevelopment takes place. Existing defences will need to be adapted over time due to the effects of climate change. Rather than replacing them like for like, a different combination of flood storage, river defences and floodplain attenuation should be sought. Some of these areas are susceptible to rapid flooding from thunderstorms. Emergency response and flood awareness are particularly important.
Policy:	Policy 5: Areas of moderate to high flood risk where the Environment Agency can generally take further action to reduce flood risk.
Policy Unit Recommendation:	Take further action to reduce flood risk. This could mean lowering the probability of exposure to flooding and/or the magnitude of the consequences of a flood, and hence the risk.
Lower Lee Tributaries Policy Unit	
Unit Message and Flood Risk Management Approach:	There are large opportunities to reduce flood risk through redevelopment. In most areas, the character of the urban area in the floodplain should be changed through re-development as it must be resilient and resistant to flooding and result in a layout that re-creates river corridors. The re-creation of river corridors should be sought through re-development so that there is space for the river to flow more naturally

	and space in the floodplain where water can be attenuated. Flood defences should be sought as re-development occurs and as part of an overall catchment plan. This is because more attenuation and more space in the river corridors are needed for defences to be sustainable. This is more complex but represents better value for society in the long-run even if it is more costly for the Environment Agency today. These areas are very susceptible to rapid flooding from thunderstorms. Emergency response and flood awareness are particularly important.
Policy:	Policy 6: Areas of low to moderate flood risk where the Environment Agency will take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits.
Policy Unit Recommendation:	Take action to increase the frequency of flooding to deliver benefits locally or elsewhere (which may constitute an overall flood risk reduction e.g. for habitat inundation).
Middle Lee & Stort Tributaries Policy Unit	
Unit Message and Flood Risk Management Approach:	The floodplain is the most important asset in managing flood risk within this policy unit. The Environment Agency is seeking to maintain the capacity of the natural floodplain to retain water and maintain the conveyance of watercourses in the towns and villages. Together this reduces the impacts of the more frequently experienced floods and has benefits for the natural environment. Redevelopment rates are often quite low. The natural floodplain should be safeguarded from inappropriate development. Refurbishment of buildings and redevelopment of industrial areas in the floodplain offers the opportunity to increase the resilience of these areas. Flood storage schemes will be complementary to wider objectives. However, the scale of intervention is likely to be moderate so other types of scheme can be progressed. There are some places where risk reduction will be possible, but this will not be possible everywhere because of technical and economic constraints. Individual action will play an increasingly important role in these areas.
Policy:	Policy 6: Areas of low to moderate flood risk where the Environment Agency will take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits.

Policy Unit Recommendation:	Take action to increase the frequency of flooding to deliver benefits locally or elsewhere (which may constitute an overall flood risk reduction e.g. habitat inundation).
Thame Policy Unit	
Unit Message and Flood Risk Management Approach:	The floodplain is the most important asset in managing flood risk within this policy unit. The Environment Agency is seeking to maintain the capacity of the natural floodplain to retain water and maintain the conveyance of watercourses in the towns and villages. Together this reduces the impacts of the more frequently experienced floods and has benefits for the natural environment. Redevelopment rates are often quite low. The natural floodplain should be safeguarded from inappropriate development. Refurbishment of buildings and redevelopment of industrial areas in the floodplain offers the opportunity to increase the resilience of these areas. Flood storage schemes will be complementary to wider objectives. However, the scale of intervention is likely to be moderate so other types of scheme can be progressed. There are some places where risk reduction will be possible, but this will not be possible everywhere because of technical and economic constraints. Individual action will play an increasingly important role in these areas.
Policy:	Policy 3: Areas of low to moderate flood risk where generally existing flood risk is managed effectively.
Policy Unit Recommendation:	Continue with existing or alternative actions to manage flood risk at the current level.
Upper Lee Policy Unit	
Unit Message and Flood Risk Management Approach:	The floodplain is the most important asset in managing flood risk within this policy unit. The Environment Agency is seeking to maintain the capacity of the natural floodplain to retain water and maintain the conveyance of watercourses in the towns and villages. Together this reduces the impacts of the more frequently experienced floods and has benefits for the natural environment. Redevelopment rates are often quite low. The natural floodplain should be safeguarded from inappropriate development. Refurbishment of buildings and redevelopment of industrial areas in the floodplain offers the opportunity to increase the resilience of these areas.

	Flood storage schemes will be complementary to wider objectives. However, the scale of intervention is likely to be moderate so other types of scheme can be progressed. There are some places where risk reduction will be possible, but this will not be possible everywhere because of technical and economic constraints. Individual action will play an increasingly important role in these areas.
Policy:	Policy 3: Areas of low to moderate flood risk where generally existing flood risk is managed effectively.
Policy Unit Recommendation:	Continue with existing or alternative actions to manage flood risk at the current level.

Appendix 3: Great Ouse CFMP Policy Unit Messages and Recommendations for Hertfordshire

Great Ouse CFMP Policy Unit Flood Risk Management Approaches for Hertfordshire	
Bedford Ouse Rural & Eastern Rivers Policy Unit	
Unit Message and Flood Risk Management Approach:	Improve integration of flood risk management; partnership between us, relevant local authorities, the Bedford Group of IDBs and private landowners will be important given the policy choice. We will need to work together to ensure we select appropriate areas within the policy unit to reduce our FRM activities without causing significant impacts elsewhere and in particular to downstream communities; Review whether the FWAs that have adopted EDW should remain in the service; Promote to homeowners the idea of individual property protection systems; the objective of which is to prevent flood water entering or damaging the property. Works would consist of a combination of dam boards, flood skirt, waterproof membranes to walls sealing the perimeter of the property; Support and encourage land management that will protect and improve water quality through reduction in diffuse pollution; The CFMP will support land use planning by identifying, and discouraging development in existing and future flood risk areas and directing development to other more suitable areas; Restore the natural appearance and processes of rivers (e.g. promote natural flooding regimes for flood risk and environmental benefit); The GI/WCS/SUDs objectives should be investigated to identify potential ecological enhancements and opportunities to use natural processes to alleviate the flood risk; Fisheries enhancements could be achieved by minor river restoration techniques and installing fish/eel passes at structures; Utilise and extend existing designated sites upstream and downstream of (and within) the Policy Unit e.g. Little Paxton Pits SSSI, Flitwick Moor SSSI, Biggleswade Common CWS; Creating and managing wetland habitats to contribute to BAP targets.
Policy:	Policy 3: Areas of low to moderate flood risk where generally existing flood risk is managed effectively.

Policy Unit Recommendation:	Organisations must work together to continue current levels of flood risk management where flood risk is more concentrated (for example in towns and villages) and seek opportunities to review the approach in areas where the flood risk is lower.
Towcester, Shefford/the Flit Corridor, Alconbury, Alconbury Weston, Huntingdon/Brampton and Hitchin Policy Unit	
Unit Message and Flood Risk Management Approach:	Reduce the risk of harm to life from flooding within the policy unit. This is especially true here given the high number of people at risk in Hitchin in the future; Reduce flood risk through either introducing formal flood defences or increasing channel capacity particularly at Walsworth Common, an area also identified in our pre-feasibility study undertaking in 2004; Improve integration of flood risk management; partnership between the Environment Agency, Bedford Group of IDBs and North Hertfordshire District Council; The CFMP will support land use planning by identifying, and discouraging development in existing and future flood risk areas and directing development to other more suitable areas; Opportunities to enhance the watercourse for fisheries e.g. fish passes at structures, rock riffles, in-stream habitat, along the River Purwell and River Hiz; An existing investigation identified under the WFD i.e. fisheries and water quality, to improve the ecological status (possible river restoration) of the River Purwell (a chalk stream), and also opportunities to restore the River Hiz under the obligations of the WFD; To work with National Rail to upgrade the culvert that runs under the East-Coast mainline; Introduce a flood warning service.
Policy:	Policy 3: Areas of low to moderate flood risk where generally existing flood risk is managed effectively.
Policy Unit Recommendation:	Continue with the current flood risk management activities.

Appendix 4: Glossary of Terms

Catchment Flood Management Plans (CFMPs): Are documents produced by the Environment Agency that cover each river catchment area in England and Wales and are designed to provide a strategic approach to flood risk management for the next 50-100 years.

Catchment Flood Management Plan Policy Units: Catchment areas that have been divided into individual policy units that relate to specific sections of a river. These identify the nature of flood risk and measures that need to be undertaken to reduce flood risk.

Flood Risk Management Strategies: Are documents produced by the Environment Agency that provide a strategic approach to flood risk management that recommend short, medium and long-term actions over the next 100 years.

Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences. The Environment Agency has divided England into three zones; flood zones 1, 2 and 3. Definitions of these zones are contained in Section 5.

Groundwater Source Protection Zones show the risk of contamination from any activities that might cause pollution in the area. The Environment Agency has divided groundwater source catchments into three zones (inner, outer and total catchment). The inner zone (zone 1) is defined as the 50 day travel time from any point below the water table to the source. This zone has a minimum radius of 50m. The outer zone (zone 2) is defined by a 400 day travel time from a point below the water table. This zone has a minimum radius of 250 or 500m around the source, depending on the size of the abstraction. Total catchment (Zone 3) is defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source.

Main rivers are usually larger streams and rivers, but some of them are small watercourses of significance. They include certain structures that control or regulate the flow of water in, into or out of the channel. The Environment Agency decides which watercourses are main rivers after consultation with other risk management authorities and the public.

Ordinary Watercourse includes every river, stream, ditch, drain, cut, dyke, sluice, sewer (other than a public sewer) and passage through which water flows and which does not form part of a main river.

River Basin Management Plans (RBMPs): Are documents produced by the Environment Agency that are drawn up for the 10 river basin districts in England and

Wales, as a requirement of the EU Water Framework Directive. RBMPs are designed to protect and enhance the quality of fresh water, groundwater, estuaries and coastal water.

Surface Water Management Plans (SWMPs): Are plans which promote a coordinated strategic approach to managing surface water drainage and reducing flood risk. They should reflect the future proposals of all key stakeholders and provide a clear delivery plan. They may also provide a way to integrate the requirements of forthcoming River Basin Management Plans into development planning. SWMPs should focus on managing flood risk and optimising the provision of SuDS.

Appendix 5: Sources of Information Used in the Hertfordshire SFRA

1. The Updated Level 1 SFRA for the review of the Hertfordshire Waste Local Plan has drawn on a number of sources of information, all of which are listed below:

2. Strategic Flood Risk Assessment prepared for Broxbourne Borough Council published in May 2016. The SFRA covers the entire area that lies within the administrative boundary of Broxbourne.

3. Strategic Flood Risk Assessment prepared by East Herts Council and published in August 2016. The SFRA covers the entire area that lies within the administrative boundary of East Herts.

4. Strategic Flood Risk Assessment prepared for Hertsmere Borough Council and published in 2018. The SFRA covers the entire area that lies within the administrative boundary of Hertsmere.

5. Strategic Flood Risk Assessment prepared for North Herts District Council published in September 2016. The SFRA covers the entire area that lies within the administrative boundary of North Herts.

6. Strategic Flood Risk Assessment prepared for Stevenage Borough Council published in June 2016. The SFRA covers the entire area that lies within the administrative boundary of Stevenage.

7. Level 1 Strategic Flood Risk Assessment prepared for Three Rivers District Council published in January 2012. The SFRA covers the entire area that lies within the administrative boundary of Three Rivers.

8. Strategic Flood Risk Assessment prepared for Watford Borough Council published in May 2012. The SFRA covers the entire area that lies within the administrative boundary of Watford.

9. Strategic Flood Risk Assessment prepared for Welwyn Hatfield Borough Council published in June 2016. The SFRA covers the entire area that lies within the administrative boundary of Welwyn Hatfield.

10. Level 1 Strategic Flood Risk Assessment prepared for South West Hertfordshire published in October 2018. The SFRA covers the entire area that lies within the administrative boundaries of Dacorum, St Albans, Three Rivers and Watford.

11. The Revised National Planning Policy Framework, published by the Department for Communities and Local Government in 2018 and updated in 2019.

12. The Planning Practice Guidance, published by the Department for Communities and Local Government in March 2014.

13. Hertfordshire Waste Local Plan Framework consisting of: Waste Core Strategies and Development Management Policies Development Plan Document 2011-2026 and Waste Site Allocations Development Plan Document 2011-2026.

14. Employment Land Areas of Search Supplementary Planning Document 2015.

15. Hertfordshire Proposed Submission Minerals Local Plan January 2019.

16. Local Flood Risk Management Strategy 2 for Hertfordshire 2019-2029: A Strategy For The Management Of Local Sources Of Flood Risk, published by Hertfordshire County Council in February 2019.

17. The European Union Water Framework Directive, December 2003.

18. River Basin Management Plan for the Thames River Basin District, published by the Environment Agency in December 2009.

19. River Basin Management Plan for the Anglian River Basin District, published by the Environment Agency in December 2009.

20. Thames Catchment Flood Management Plan, published by the Environment Agency in December 2009. The CFMP covers all of Hertfordshire except for some areas of North Herts District and Stevenage Borough.

21. The Great Ouse Catchment Flood Management Plan, published by the Environment Agency in December 2009. The CFMP covers the remaining parts of Hertfordshire that are not covered by The Thames CFMP.

22. Lower Lee Flood Risk Management Strategy, Consultation Update, published by the Environment Agency in June 2008. The FRM covers all areas situated within the Lower Lee Catchment Area.

23. The Influence of Aggregate Quarrying in River Floodplains on Biodiversity, published by Symonds Group Ltd.

24. Main Rivers GIS shape file, published by the Environment Agency.

25. Flood Zone 2 GIS shape file, published by the Environment Agency. This is the area of land that lies within the extent of the 0.1% chance flood but outside Flood Zone 3.

26. Flood Zone 3 GIS shape file, published by the Environment Agency). This is the area of land that lies within the extent of the 0.1% chance flood but outside Flood Zone 2.

27. Historic Flood Map GIS shape file, published by the Environment Agency. This shows the combined extents of known flooding from rivers, the sea and groundwater.

28. Flood Warning Areas GIS shape file, published by the Environment Agency.

29. Locations of Reservoirs GIS shape file, published by the Environment Agency.

30. Locations of Rivers and Sea Flood Storage Areas GIS shape file, published by the Environment Agency.

31. Groundwater Source Protection Zones GIS shape file, published by the Environment Agency.

32. Areas susceptible to Groundwater Flooding GIS shape file, published by the Environment Agency.

33. Areas at Risk from Surface Water Flooding GIS shape file (1 in 100 year), published by the Environment Agency.

34. Areas Benefiting from Defences GIS shape file, published by the Environment Agency.