3 Current flood risks and management

In this Chapter we have presented a high level overview of the current flood risk and sources of flooding at a regional or basin scale. Where a particular feature of the existing risk as been important in deciding what approaches to adopt to manage future flood risk and select policy, this is drawn out in more detail at a policy unit scale in Chapter Six.

3.1 History of flooding

Extensive, catchment-wide fluvial floods in Thames region tend to happen when heavy and prolonged rainfall occurs when the catchment is either frozen or saturated, between the autumn and spring. The 1894 flood was the highest in terms of recorded flows and happened when 200mm of rain fell across the catchment in 26 days. In 1947, a combination of heavy rain on a frozen catchment causing high run-off rates, followed by a rapid thaw resulted in a flood event with a 2 to 1.3% AEP across the Thames and Lee catchments. These very large scale floods affected more than 10,000 properties across the region. More recently, flooding mainly on the River Thames in autumn / winter 2000 and New Year 2003 was caused by heavy rainfall on a saturated catchment. In 2000, conditions were such that groundwater flooding also occurred across much of the chalk downland. These more recent floods typically had a 10 to 3% AEP and flooded around 1,000 properties, mainly within the Thames basin.

Because of the size of the Thames region, flooding is sometimes confined to sub-catchments as a result of storms and depressions only affecting part of the region. For example, in 1968 large scale flooding occurred in the Wey, Mole and south London catchments and in 1998 in the Cherwell catchment.

Localised storms can lead to flash flooding, particularly in urban areas, which have a faster rate and greater percentage of runoff. Local impacts can be significant and there is a very short time between the start of the rainfall event and the onset of flooding. Urban catchments, especially in London, are particularly vulnerable to river flooding as a result of increased surface water runoff from impermeable surfaces. Pluvial flooding occurs as sewers and drainage systems become overloaded with the high volumes of rainfall. Ponding of floodwater is common, as it has no where to drain to or soak into. These types of floods can happen at any time of year, but particularly in the summer, following intense thunder storms. An intense rainfall event caused flooding in the Ravensbourne catchment in June 1992.

The floodplain of the tidal Thames through London is currently protected to a high standard (greater than 0.1% AEP). The probability of flooding is increasing due to rises in sea-level, long-term subsidence in South East England following the last de-glaciation and expected increases in winter fluvial flows. The highest recorded tide levels in the Thames estuary tend to occur under tidal surge conditions (for example 1953) or when a high tide coincides with a period of high fluvial flows. This occurred in the lower Roding in north London in 2000. A prolonged rainfall event occurred a few days before storm surges forced the Thames Barrier and Barking Barrier to close. Water levels on the Roding were very high and the river was prevented from draining into the River Thames by the Barking Barrier (tide-locking situation).

Hundreds of flood events have been recorded across the Thames region. The impact of different scale and AEP flood events are summarised in table 3.1. More detail about each event is given below and flood outlines from the examples used are shown in Figures 3.1 to 3.3. No further information was available for the event on the Crispey Brook (1992).

	Basin wide event	Sub catchment event	Localised event
10% to 3% AEP	**1,000 properties flooded**	**10 – 100 properties flooded**	**Less than 10 properties flooded**
Example	Thames basin in Autumn 2000	Lower Ravensbourne June 1992	Crispey Brook (Roding) June 1992
3% to 1% AEP	**> 10,000 properties flooded**	**100 to 1000 properties flooded**	**10 to 100 properties flooded**
Example	Thames and Lee basins in 1947	Cherwell, 1998	Groundwater flooding, Winter, 2000
1% to 0.1% AEP	**100,000 properties flooded**	**Up to 10,000 properties flooded**	**Up to 150 properties flooded**
Example	No recorded event	Mole, 1968	Hampstead August 1975

Table 3.1 Historic flood events in the Thames region

Thames basin - Autumn 2000

The Autumn 2000 floods were a nation-wide event caused by heavy rain falling on to a saturated catchment. Autumn 2000 was the wettest autumn on record across England and Wales for 270 years. Recurrent heavy rain in November lead to prolonged flooding. 10,000 properties were flooded across England and Wales, with 1,100 affected in Thames region. Defences were overtopped at Waltham Abbey and Wanstead, and properties that were not protected by flood defences flooded in Weybridge and Woking. The total cost of flooding was estimated to be over £1billion.

Groundwater flooding - 2000

The rainfall of winter 2000/01 and subsequent recharge into the region's aquifers exceeded all previously recorded quantities for a similar period in most areas. As a result, groundwater levels, particularly in the chalk aquifer, rose to the highest recorded levels, and by a considerable margin at many sites. Extensive groundwater flooding occurred, mainly in the upper, normally dry valleys on the dip slope of the chalk escarpment. The flooding did not start until many weeks after the rainfall event. It then persisted for many weeks after as recharge slowly raised groundwater levels.

Cherwell - 1998

This was a sub-catchment event caused by exceptional rain on already very saturated soils. The SMD at the start of the event was zero. At Byfield, 64.2mm rain fell in fourteen hours, more than the April average of 47mm. In Banbury, water levels reached 2.75m and 168 properties were affected. In Kidlington, levels reached 2.1m and 93 properties were affected. At Cropredy bridge (upstream of Banbury), levels reached 2.3m before the logger was submerged. The flood caused £900,000 of damages.

Lower Ravensbourne - June 1992

This was a sub-catchment event caused by intense rainfall over an urban area. The ground was not saturated; the soil moisture deficit (SMD) at the start of the event was 159. At Grove Park 70.2mm rain fell in one hour. At Kelsey Park 41.6mm rain fell in an hour and a half, with 22mm of rain falling in the first fifteen minutes of the storm event. The response time was rapid, with the flood peak occurring within two hours of the onset of rainfall. Flow levels reached 1.2m at Catford Hill. 74 properties were flooded.

Mole - September 1968

The September 1968 River Mole floods were caused by torrential rain falling on saturated soil. The SMD at the start of the event was 34.99. The met office has estimated that 100 – 190mm of rain fell on the Mole catchment over a period of 30 hours, exceeding the September mean total of 72mm. The peak flow was $240m^3s^{-1}$; the highest ever recorded on the Mole. 10,000 properties (mostly houses) were affected. At Gatwick, the peak flow was $22.3m^3s^{-1}$. The peak river levels were 2.84m at Horley, 3.7m at Kinnersley and 3.84m at Dorking. The flood lead to the creation of the Lower Mole Flood Alleviation Scheme.

Hampstead – August 1975

On August 14th 1975, a small area of north London was subjected to an extremely intense rainstorm. At Hampstead Heath, a total of 170.8mm of rainfall was recorded over a period of three hours. Within half an hour of the onset of the storm, the rivers Fleet, Westbourne, Tyburn and Brent flooded locally. The storm caused serious flood damage, estimated at over £1million and disruption to homes, businesses, road and rail communications (including substantial parts of the London Underground), telephones and other public services. The exceptional rainfall total at Hampstead was partly due to the very localised nature of the storm and the apparent absence of storm movement.

Thames and Lee basins - 1947

The 1947 Thames and Lee basin flood was a catchment wide event, caused by heavy rainfall over a frozen catchment creating rapid runoff. This was followed by a rapid thaw. Over 10,000 properties were flooded in Thames region.

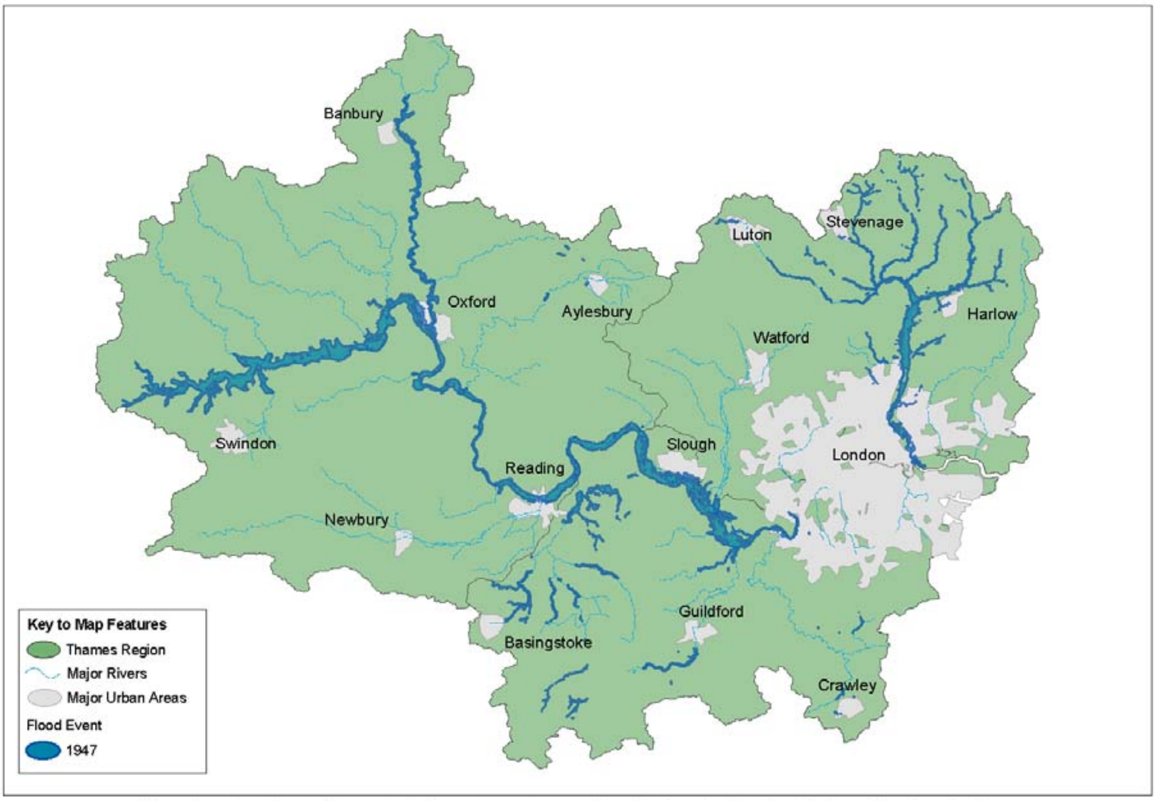


Figure 3.1 Extent of the 1947 flood

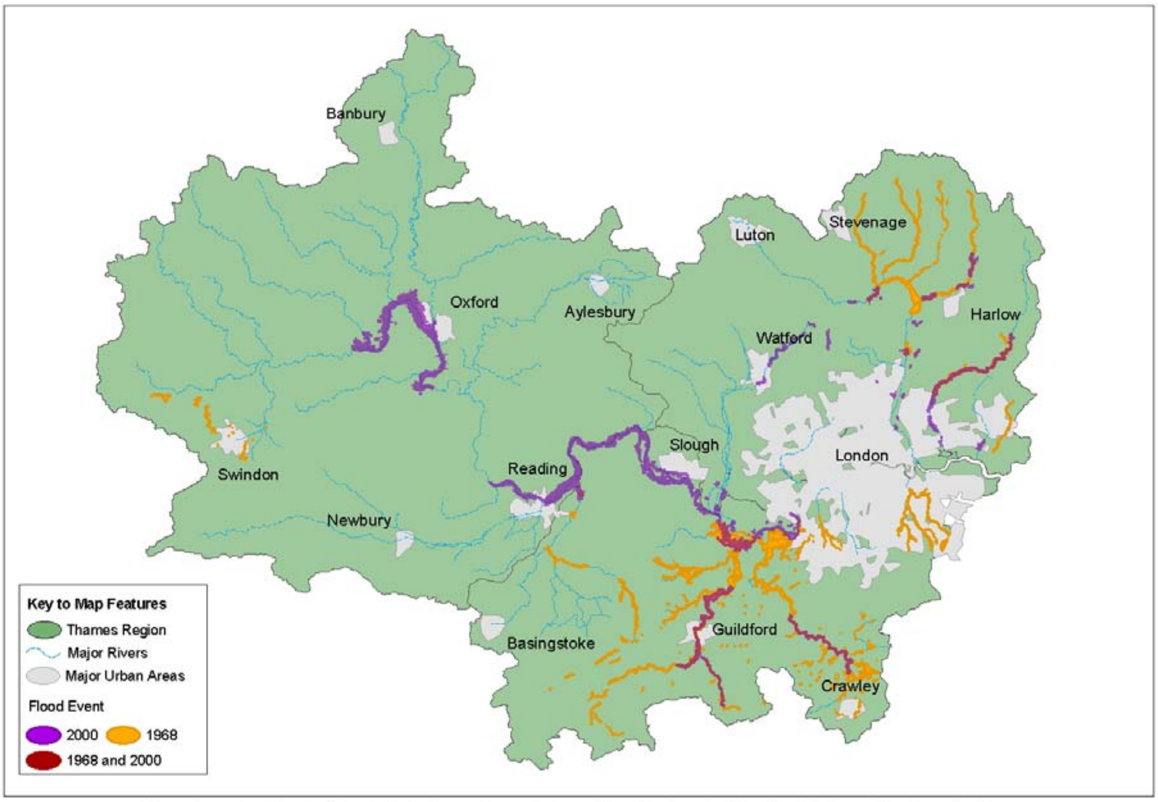


Figure 3.2 Extent of the 1968 and 2000 floods

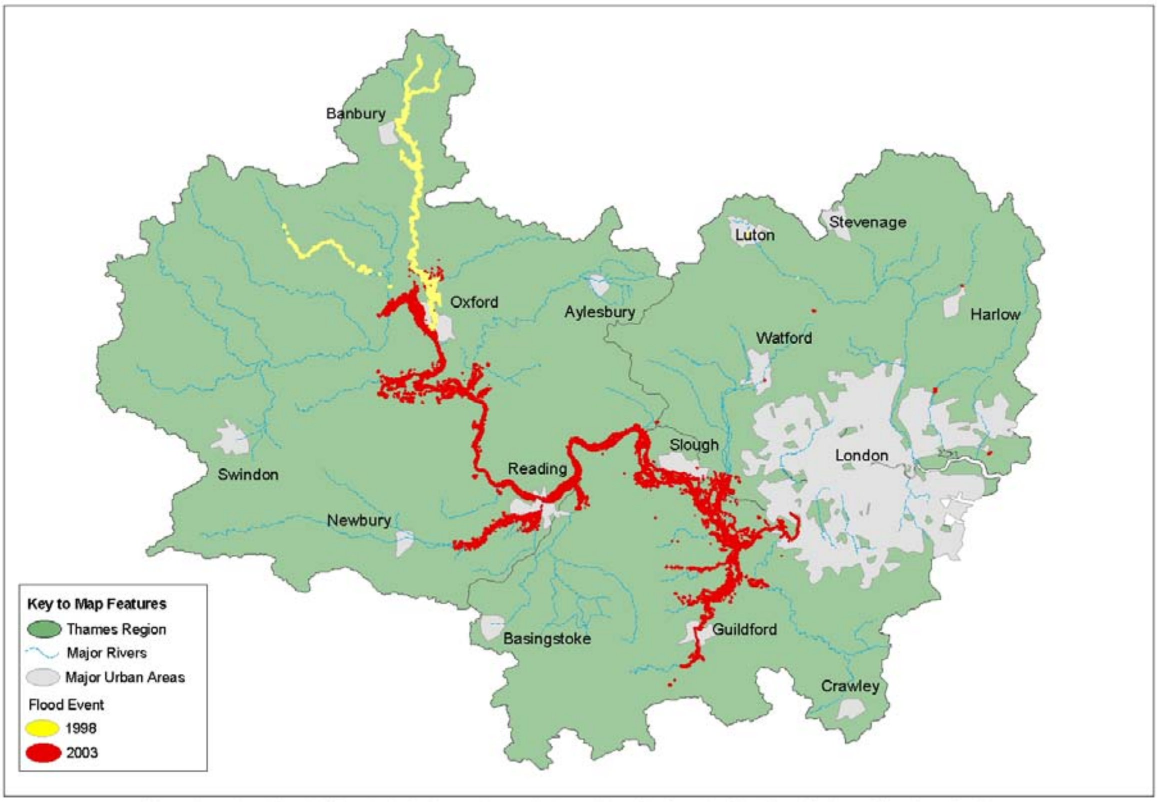


Figure 3.3 Extent of the 1998 and 2003 floods

3.2 Sources and probability of flooding

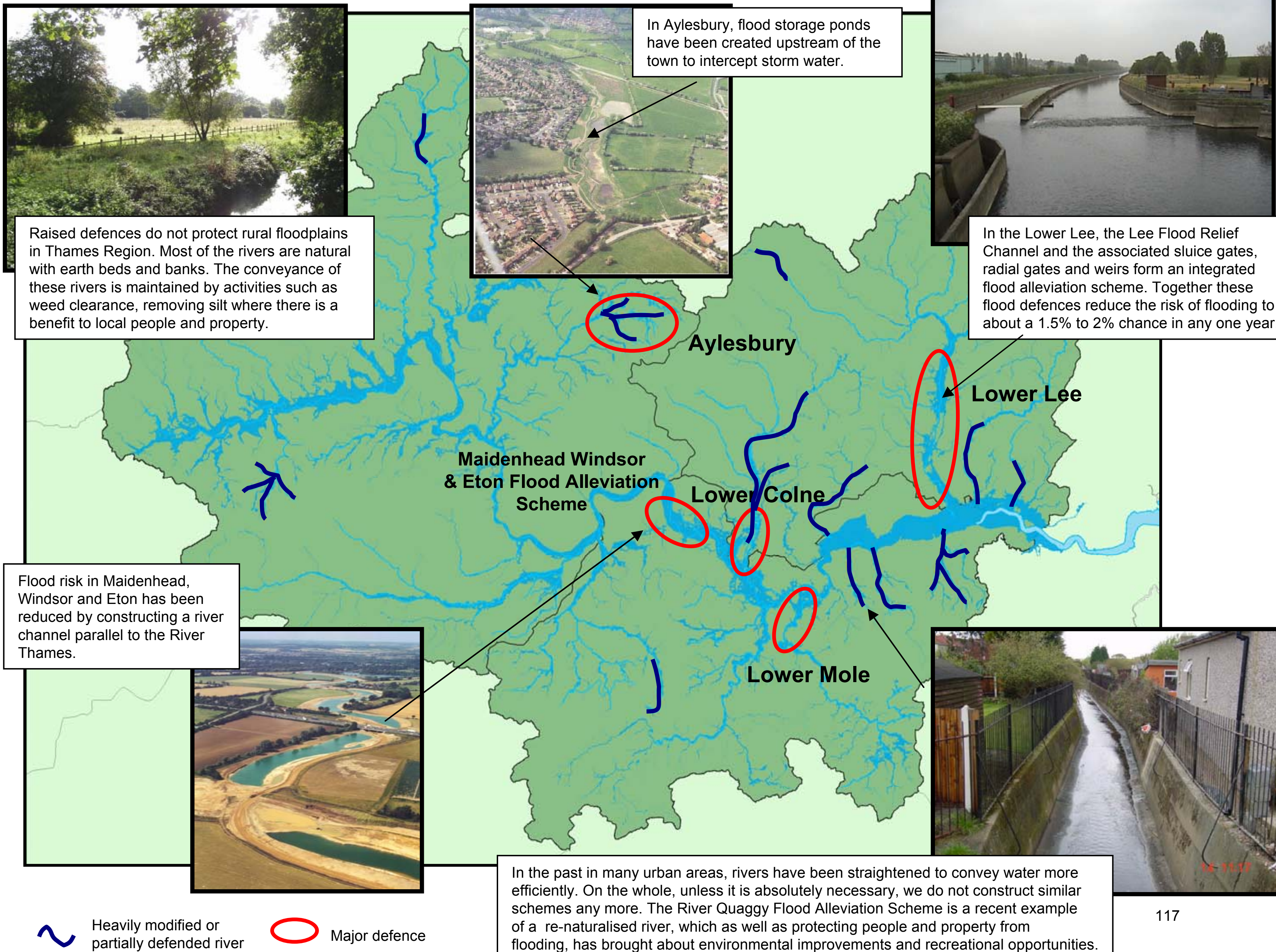
In this section we describe the main sources of flooding in Thames region.

3.2.1 Fluvial flooding

River channels can only carry a limited amount of water. Heavy rain or sudden snowmelt can cause rivers to rise to the point where they overtop their banks. During a flood, the excess water flows onto the low-lying areas on either side of a river – the flood plains. Around 5 million people, in 2 million properties, live in flood risk areas in England and Wales. However, there is an additional risk to property outside of the floodplain from other sources of flooding, especially groundwater flooding.

Figure 3.4 summarises the main pathways for fluvial flooding in the Thames CFMP area:

Figure 3.4 Fluvial flood defences in the Thames CFMP area



The majority of the main rivers across Thames region remain in a natural or semi natural state. They are generally unconstrained, running in an earth channel through relatively flat undefended rural floodplains. The standard of protection is provided by the capacity of the river channels and the natural storage within the floodplains. Maintenance aims to make sure that the channel is free of obstruction and can accommodate high flows. It also makes sure that the condition of the riverbanks is maintained, as these provide a basic standard of flood defence (typically to a 20% AEP) before water enters the floodplain.

In urban areas, especially in London, the rivers are heavily modified for flood risk management purposes. In general, these modifications increase the conveyance of rivers by straightening them, artificially lining the beds and banks and erecting structures to manage blockages and water levels. This has occurred on all the London rivers, especially in south London where almost 50% of the urban watercourses are artificial and over 20% are in culverts. Typically these improvements mean that flooding to property in these catchments occurs in a 20 to 3% AEP flood. In some areas this is occasionally nearer to a 1% AEP flood. Operations, maintenance, emergency response, providing flood warnings and controlling development are carried out with varying success across the London catchments against a backdrop of these previous improvements.

The underlying gravels across much of the floodplain within the region mean that there are very few lengths of raised defences. Instead, as Figure 3.4 shows, defences tend to provide additional storage (for example in Aylesbury), or additional conveyance of water (for example in the Lower Lee, Wandle and Maidenhead).

We will discuss the likelihood, potential depth and extent of fluvial flooding in more detail in the following section on the consequences of flooding.

3.2.2 Tidal flooding

Approximately 478,000 properties in Thames region are at risk from a 0.1% AEP tidal flood event in central London (without taking defences into consideration). This could occur as a result of ‘surges' flowing upstream from the Thames Estuary, caused by the combined effects of atmospheric pressure, high tides and high winds. As well as this, sea levels around the UK are about 10cm higher than they were in 1900.

Tide-locking is the situation when the fluvial river can not drain into the tidal River Thames. This occurs in those fluvial rivers where structures are in place to prevent (temporary) interaction between the fluvial river and the tidal Thames. These structures can be in the form of a barrier, which is closed occasionally during extreme high tides or a fixed impoundment, where the river is permanently separated from the Thames. Where the impoundment is permanent, gravity outfalls have been installed so that the fluvial rivers can discharge at low tide.

When the rivers are unable to discharge into the Thames because of high tides, the water must be stored within the fluvial river system; either within the river channel or in purpose built storage areas. If tide-locking coincides with high fluvial flows and the capacity of the fluvial system is insufficient, fluvial flooding can occur upstream of the barrier or impoundment. As sea level and tides rise, the length of time that the fluvial rivers can discharge under gravity will decrease and the frequency of barrier closure will increase. As climate change is expected to result in more frequent fluvial flooding, the tide-locking situation is likely to get worse.

Thames Estuary 2100 (TE2100) is an initiative by the Thames, Anglian and Southern regions of the Environment Agency to develop a flood risk management plan for the Tidal Thames. The plan will recommend the actions that need to be taken to manage the increasing flood risk in the estuary over the next 100 years. TE2100 has strong links with CFMPs and uses the same national policy options as a basis for defining the level of flood risk management to be provided in different parts of the estuary. A draft Final Plan will be produced in December 2008.

3.2.3 Surface water flooding

Surface water run-off has become a significant issue in urban areas where development has led to more hard paved surfaces. Surface water systems are not designed to handle local, intense rainfall events. Impermeable surfaces (roads, car parks, buildings, pavements) can exacerbate fluvial flooding by increasing the volume of storm run-off, reducing travel times to watercourses and increasing flood peaks. Some 30-50% of rainfall appears as runoff from a paved area (Elliott, 2003, *'Reducing the impacts of flooding*').

Surface water runoff is also a source of pluvial flooding. It can occur in both rural and urban areas, though its effects are more pronounced and damaging in the latter. Urban areas can be inundated by flow from adjacent farmland or parkland after periods of prolonged rainfall when the ground is saturated and natural (undeveloped) areas react to rainfall in a similar way to paved areas.

Pluvial flooding also occurs when the capacity of the local drainage network is exceeded. Most modern systems are designed to cope with rainfall events with a 3% AEP. Older parts of the system may be operating to a lower standard. It is therefore inevitable that the capacities of sewers, covered urban watercourses and other piped systems will sometimes be exceeded. The subsequent flooding often happens very suddenly and there is little time to warn those likely to be affected, for example during the flood event in July 2007.

On 19th and 20th July 2007 widespread intense rainfall after an unusually wet spring and summer led to significant flooding from surface water and subsequent high river levels. Within Thames Region over 5,000 properties were internally flooded. Over 3,000 of these were a result of surface water flooding. Thatcham, Newbury, Reading, Maidenhead and parts of London were particularly badly affected as surface water drainage systems were overwhelmed by the extreme rainfall. Within Thames Region, transport infrastructure including roads and railway lines were flooded causing disruption for commuters for several days. Five water treatment works, fourteen sewerage treatment works and 68 sewerage pumping stations were disrupted. Within Greater London, the local authorities reported 158 schools damaged by flooding to some degree.

A broad indication of the likelihood of surface water flooding in each policy unit in the Thames CFMP is shown in Figure 3.5. This map was compiled using anecdotal evidence from previous flood events and also landuse characteristics and topography. The greatest likelihood is in London particularly but also in other densely urbanised areas that are located in the headwaters, for example Swindon, the Upper Mole and Blackwater Valley which have a steeper topography than other areas including Reading, Oxford and the Lower Thames, where the likelihood of surface water flooding occurring is lower.

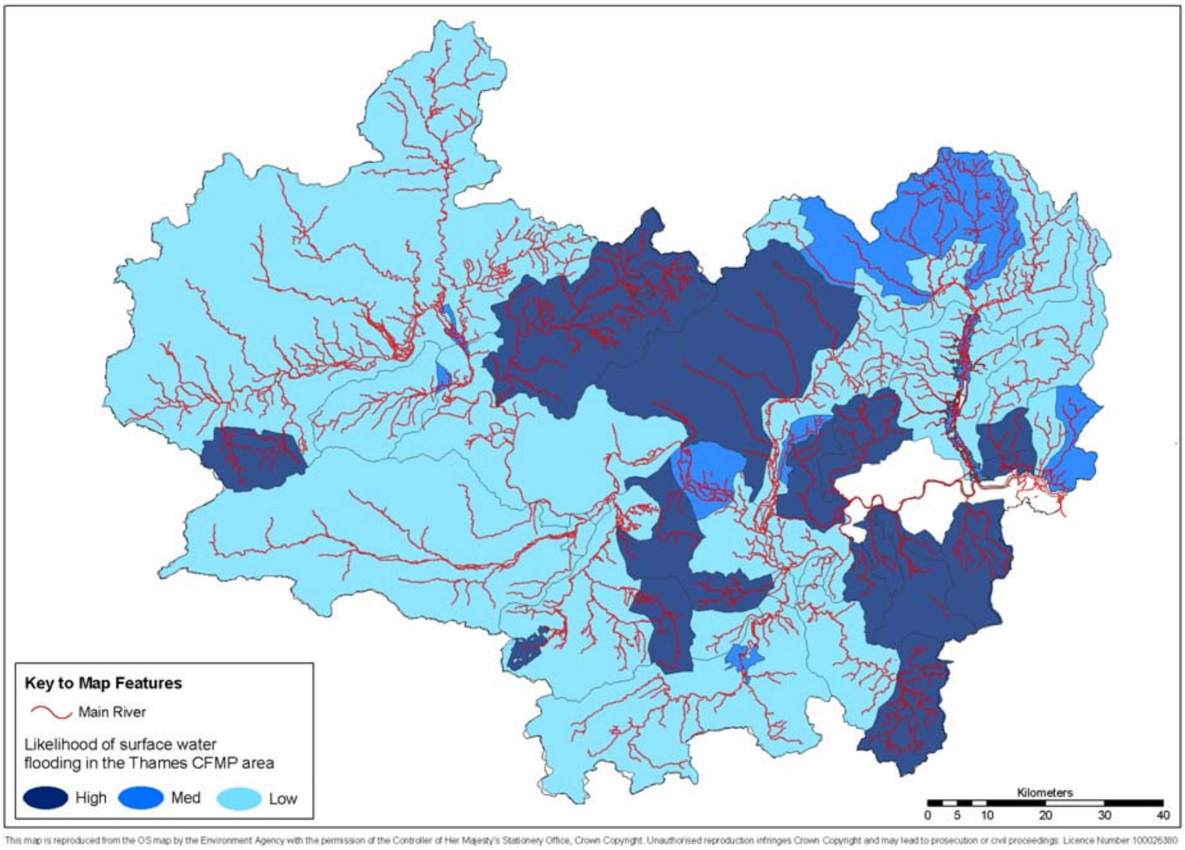


Figure 3.5 Likelihood of surface water flooding occurring in each policy unit in the Thames CFMP

Urban flooding is likely to increase in the future as a result of:

- Ageing drainage infrastructure
- More development covering previously permeable ground
- Increase in paving in existing developments e.g. patios and driveways

- Climate change i.e. wetter winters and heavier summer rainfall

There is broad scope for improving urban drainage in new developments and also in re-development. Planning Policy Statement 25 (PPS25): Development and Flood Risk (December 2006) highlights the important role that sustainable urban drainage systems (SUDS) can play in managing surface water and introduces a general expectation for their use at all sites. It states that regional planning bodies and local planning authorities should '*use opportunities offered by new development to reduce the causes and impacts of flooding e.g. surface water management plans; making the most of the benefits of green infrastructure for flood storage, conveyance and SUDS; re-creating functional floodplain; and setting back defences'.*

Sustainable urban drainage systems (SUDS) mimic natural drainage, with the aim of reducing flooding and improving the quality of water draining from urban surfaces as runoff. SUDS cover a wide range of sustainable approaches to surface water drainage management including areas of vegetation like grassy banks, green roofs and soakaways (to aid infiltration rates), natural water storage features like ponds (for attenuation and controlled drainage of rain water), source control measures (e.g. rainwater recycling), filter drains and porous pavements.

In major urban areas across Thames region, the localised impacts of surface water flooding can be significant and are set to increase in the future due to more frequent and intense rainfall events. National planning policy has an important role to play in helping to reduce these impacts and also in controlling the source of surface water flooding. Flood risk management planning therefore needs to be closely linked with regeneration and redevelopment so that the location and layout of development can help to reduce flood risk.

Sir Michael Pitt is leading the Independent Government Review into the flooding that occurred in July 2007. It has been carried out by the Cabinet Office with support from the Department for Environment, Food and Rural Affairs and the Department for Communities and Local Government. The review has examined both how to reduce the risk and impact of floods, and the emergency response to the floods in June and July. It has sought views from those involved in the floods, including affected residents, the emergency services, business and professional associations. One of the 15 urgent recommendations to come out of the Interim Report (Dec, 2007) is that 'the Environment Agency, supported by local authorities and water companies, should urgently identify areas at highest risk from surface water flooding where known, inform Local Resilience Forums and take steps to identify remaining high risk areas over the coming months'. The information presented in this CFMP regarding surface water flooding is likely to be superseded by the outcomes of this work, when they are available.

3.2.4 Sewer flooding

There are 300,000 km of sewers in the UK operated by the water companies, which form the core of urban drainage systems. Sewers are the main channels for conveying surface-water runoff in the urban areas of the UK.

Sewer flooding is generally a mixture of raw sewage and stormwater and has two main causes:

- Hydraulic overload through lack of system capacity (e.g. sewer size; pumping failure; sewer collapse, etc).
- Impact of wider fluvial flooding from rivers and watercourses, typically by backflow or constraint on flow due to fluvial flood water levels.

Very heavy rain can result in severe, but localised flooding, often made worse by surface run-off over impermeable urban environments. Some sewerage systems, for example London's Victorian system, can be easily overloaded in heavy rain. Properties can be flooded and large amounts of raw sewage released into the water. This often has major consequences for the environment and public health.

In the main sewer network, flooding may happen when rainwater flows entering pipes exceed their carrying capacity. Pipes may then flow full and any excess backs up, resulting in a 'surcharge' of the system. Such surcharges may flood basements or the catchment surfaces from any access point to the sewer system, such as manholes.

London in particular experiences problems with the capacity of its sewage network during periods of high flow. The sewage network in central London is based upon the old Victorian system which takes both surface water and foul sewage. During periods of high and prolonged rainfall, the capacity of the sewers can be exceeded and some sewage is discharged directly to the river via combined sewer overflows (CSO). This happened in August 2004, when heavy rainfall in London caused sewers to overflow, killing thousands of fish, leaving sewage debris and a foul smell along the foreshore of the tidal Thames, and significantly increasing E. coli levels in the river.

We are not responsible for the underground water infrastructure. It is maintained by the relevant water company who are required by the regulator (Ofwat) to make sure that the sewer system operates effectively to limit the impact of sewer flooding. The June 2004 Thames Water Utilities Overview reported that there are 4,477 properties on the Thames Water sewer flooding history database (internal flooding). This is a reduction of 1,000 from 2002/3 and is less than 1% of the connected properties in Thames Water's operational area (which covers the majority of Thames region). 49 properties were flooded as a result of hydraulic overload in 2004 compared to 262 in 2002/03, 223 in 2001/02 and 908 in 2000/1. This large reduction is mainly due to the exceptionally dry year (only 79% of the average annual rainfall fell in Thames region in 2003) and Thames Water's investment programme to reduce risk to properties. The number of properties flooded through other causes (principally blockages in sewers connecting to properties) in 2003/04 fell by 12% from the previous year, to 433.

In the future, demand for more housing is likely to put increased pressure on drainage systems. As a result, the flooding situation will get worse as sewers reach the limits of their capacity and flood more frequently. We currently have a very small role in urban flooding - responsibility for managing the different sources (water from sewers, rivers, groundwater, and intense rainfall run-off) is split between different organisations, including Water Companies, Local Authorities and the Environment Agency. Urban flooding will only be effectively tackled by key stakeholders working together to common standards. Longer term (25 year) strategic planning of drainage infrastructure that takes account of climate change and sets out responses of different organisations involved will be a key mechanism. As part of the Making Space for Water programme, Defra has set up 15 urban drainage pilot projects (including the River Hogsmill in SW London). They will test new approaches to reduce the impact of urban drainage flooding, so that towns and cities are better prepared for the impacts of climate change. Another key output will be establishing partnerships between key organisations to manage surface water and sewer flooding in high risk urban areas through an integrated drainage approach.

3.2.5 Groundwater flooding

Groundwater flooding is associated with fluctuations in the groundwater table. In permeable catchments, significant fluctuations in groundwater can lead to long-duration, small scale flooding. Flooding happens when groundwater levels rise high enough to reach the ground surface and, for whatever reason, the local drainage network cannot cope with the volume of water. These areas are typically in the headwaters of the ephemeral drainage system and, in a typical year, are often a considerable distance from the seasonal watercourses. Groundwater flooding appears to be largely restricted to the surface outcrop of chalk where there are no overlying impermeable drift deposits.

The most extreme and widespread groundwater flooding happened across the country for periods of up to four months between November 2000 and July 2001. Rain in the winter of 2000/01 and subsequent recharge into Thames region’s aquifers exceeded all previously recorded amounts for a similar period in most areas. As a result, groundwater levels, particularly in the chalk aquifer, rose to the highest recorded levels and by a considerable amount at many sites. Extensive groundwater flooding happened mainly in the upper, normally dry valleys on the dip slope of the chalk escarpment, which had not seen stream flow in living memory and also in ephemeral sections where the flows were so large that existing channel size, pipes and culverts were inadequate, e.g. in Henley. Figure 3.6 below shows places where groundwater flooding occurred in the Thames region in January 2001.

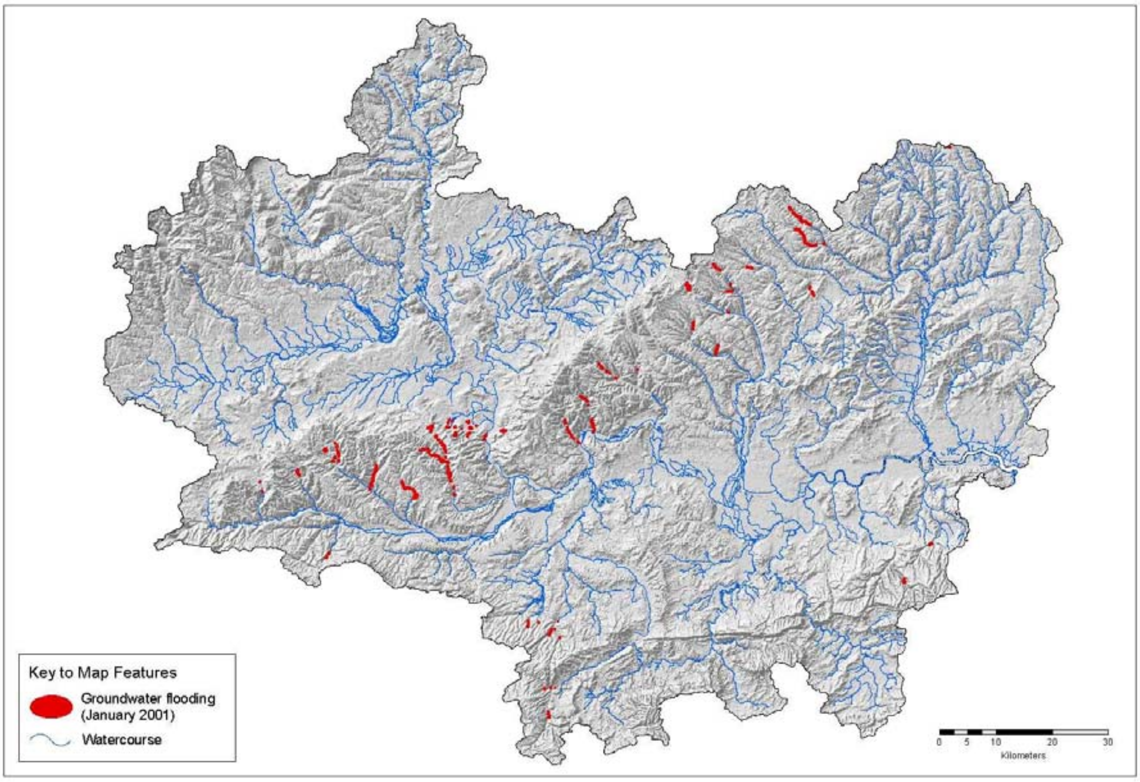


Figure 3.6 Groundwater flooding in Thames region (January 2001).

Groundwater flooding associated with river floodplains happens where groundwater emerges onto the floodplain from the river gravel deposits. When the gravel deposits become fully saturated, the floodplain will often flood before the river goes out of bank. This happened in many floodplains in Thames region during the winter of 2000/01. When rivers did subsequently flood over bank, the floodplain was already flooded by groundwater. The floodwaters stayed for many weeks after the rainfall event as recharge levels slowly raised groundwater levels (Morris, S., Robinson, V., Solomon, J. (2001), *'Groundwater Flooding in the Thames Region Winter 2000/01'*).

From spring 2006 we will assume strategic overview for monitoring groundwater flooding and will work towards better data collection, assessment and monitoring in line with Water Framework Directive and European Legislation objectives.

One of the statements within Defra's Making Space for Water strategy relates to groundwater flooding records collation, monitoring and risk assessment. This statement focuses upon chalk aquifers, which account for the large majority of groundwater flooding incidents, and the rise of high groundwater in response to extreme rainfall. The overall objective of the project is to produce recommendations for effective monitoring and collation of groundwater flooding information, organisation and funding changes required to implement this and the direction of our strategic overview role.

3.3 Consequences of flooding

In developing policy appraisal objectives, the key flood receptors are categorised as economic, environmental or social. Each objective will have clearly defined indicators related to these receptors (for example the number of properties exposed to flooding) to assess the impact of the CFMP across the region and over time.

The indicators will measure whether a particular flood management policy helps achieve policy appraisal objectives or hinders it. So, we need to find out what the current consequences of flooding are for these specific indicators.

We will consider the consequences of flooding on economic, environmental and social assets in the region equally when formulating policy. The results presented here are for fluvial flood risk only, however we recognise that there are also risks from surface water and groundwater flooding. We have been unable to quantify this risk due to the fact that detailed information and modelling is not currently available. By using anecdotal evidence we are able to highlight areas where surface water (e.g. Ravensbourne) and groundwater flooding (e.g. Colne tributaries and Wye) is a major problem and have included actions in the policy unit Action Plans to investigate these sources of flooding further.

Following the recommendations from The Pitt Review, we will be working in the short-term with local authorities and water companies at a National level to produce a map that identifies places at high risk of surface water flooding. However, surface water flooding is hard to predict, model and map as it occurs where water cannot drain away as quickly as it gathers, because drainage systems (both natural and man-made, overland and underground) do not have sufficient capacity to deal with the volume of rainfall. Surface water flooding is a particular problem in urban areas and in intense rainfall events. Prediction and mapping of the risk of flooding from surface water is made more problematic as urban areas generally have complex drainage pathways, and it is difficult to predict exactly where intense rainfall events will occur with any confidence. Very small errors in topography (or changes, such as road resurfacing, a new dropped kerb, or blocked gullies), can have a dramatic effect on where the water would go.

3.3.1 Main receptors

Flooding has a negative impact on people and property, economic and social assets. By definition, floodplain environments require some flooding. The consequences of flooding are, therefore, both positive and negative and we will focus our future policies on maximising the positive impacts on the environment and minimising the negative impacts on the economy and the community.

Generally, the main receptors across the fluvial floodplain in Thames region are;

- **Economy** - £28bn of economic assets;

- **Environment -** Over 1000km of natural or semi-natural floodplain that has the potential to be enhanced or restored;
- **Social -** 640,000 people live in the 0.1% AEP floodplain.

In the following sections, we look in more detail at these receptors, showing where they are located throughout the region, the likelihood of flooding, and specific features of these receptors.

The results presented in this section for people, property, infrastructure and designated environmental sites at risk and economic damages, have all been calculated using outputs from the Modelling and Decision Support Framework (MDSF) tool. MDSF provides an automated process of predicting economic damages and social impacts through the calculation of flood extents and depths based on a digital terrain model (DTM), river centrelines and flood levels. These are all produced externally to MDSF and imported where appropriate. Flood levels for Thames region were obtained from the Thames and Lee Broad Scale Models (BSMs) and S105 mapping work for the London rivers. The national DTM was only used in locations where photogrammetry or LiDAR was unavailable, as it is less accurate. Please see Appendix F for further detail.

However, the MDSF outputs do not cover the entire river network of the region, as we could only calculate damages for river reaches where we have carried out modelling work and where flow data is available. The percentage coverage varies per policy unit as indicated in Table 3.2. For example, in the Sandford to Cookham policy unit, 95% of properties that are within the Flood Zone 3 1% AEP fluvial floodplain are included in the MDSF analysis. However, in the Brent policy unit, this figure is much lower (36%) and the results only cover one of its tributaries, the Silk Stream. This is due to a lack of detailed modelling for the River Brent. Also note that the Lower Mole only considers flooding from the River Thames and not the River Mole.

Due to the incomplete coverage, all the results that have been calculated using MDSF will be underestimated in the majority of policy units and for the region as a whole. We have presented values for projected 1% AEP damages in Table 3.2 and Annual Average Damages (AAD) in Table 3.6 to indicate how the totals would increase if we had complete coverage for every policy unit. In a few cases, the total properties at risk for a 1% AEP have been over-estimated by MDSF compared to Flood Zones and therefore the damages remain the same.

Policy Unit	**Flood Zone 3 properties**	**MDSF Baseline 1% AEP**		**% MDSF coverage per Policy Unit**	**Projected baseline 1% AEP damages**
		Properties	Damages (£M)		
Abingdon	1559	1822	65.55	117	65.55
Addlestone Bourne, Emm Brook, The Cut	1423				
Aylesbury	1926	2019	52.76	105	52.76
Basingstoke	828				
Beam	1759	421	6.80	24	11.98
Beverley Brook	6689	5807	185.22	87	209.64
Brent	7315	2668	96.76	36	158.23

Byfleet and Weybridge	1258	842	35.29	67	46.96
Colne	3563	6891	415.50	193	415.50
Colne tribs & Wye	2316				
Crane	6359	7658	205.63	120	205.63
Graveney	4277	3899	84.11	91	91.55
Guildford	495	826	107.23	167	107.23
Hoe Stream	260				
Hogsmill	3641	1138	29.73	31	50.17
Ingrebourne	398	1095	108.23	275	108.23
Kennet	3338	2615	102.80	78	125.06
Loddon	971	449	14.32	46	22.01
Lower Lee	20010	21490	841.58	107	841.58
Lower Lee tribs	2556	5433	122.17	213	122.17
Lower Mole	1971	467	11.09	24	19.56
Lower Roding	789	371	18.47	47	28.25
Lower Thames	32786	26868	1049.75	82	1239.24
Luton	2104	760	1.51	36	2.48
Middle Lee & Stort	4524	2213	91.59	49	138.38
Middle Mole	705				
Middle Roding	5156	2418	61.87	47	94.72
Ock	451				
Oxford	4674	5433	124.80	116	124.80
Pinn	1416				
Ravensbourne	9461	6575	194.14	69	253.36
Reading	6867	4894	235.96	71	303.75
Rural Wey	2988	597	27.41	20	49.34
Sandford to Cookham	5446	5158	174.05	95	183.25
Swindon	1027				
Thame	1321	109	3.95	8	7.57
Upper & Middle Blackwater	1372				
Upper Lee	1039	505	34.39	49	52.07
Upper Mole	2756				
Upper Roding	2177	1629	48.45	75	60.65
Upper Thames	4810	3735	137.30	78	167.99
Wandle	11698	6215	423.74	53	622.35
Windsor & Maidenhead	11242	8010	122.63	71	157.89
TOTAL	187721	141030	5234.78	70	6139.90

Table 3.2 Percentage coverage of MDSF outputs per policy unit

We know that it would be ideal to have a complete MDSF coverage of the region. However, we have progressed the Thames CFMP with this limitation for the following reasons:

- the MDSF analysis covers most of the areas where there are large numbers of properties at risk (see Figure 3.7);
- obtaining the flow and scenario data for the remaining parts of the catchment now would be costly and time consuming. We will get this information through flood mapping programmes over the next few years. Using the information that is currently available, we have been able to progress this study quickly.

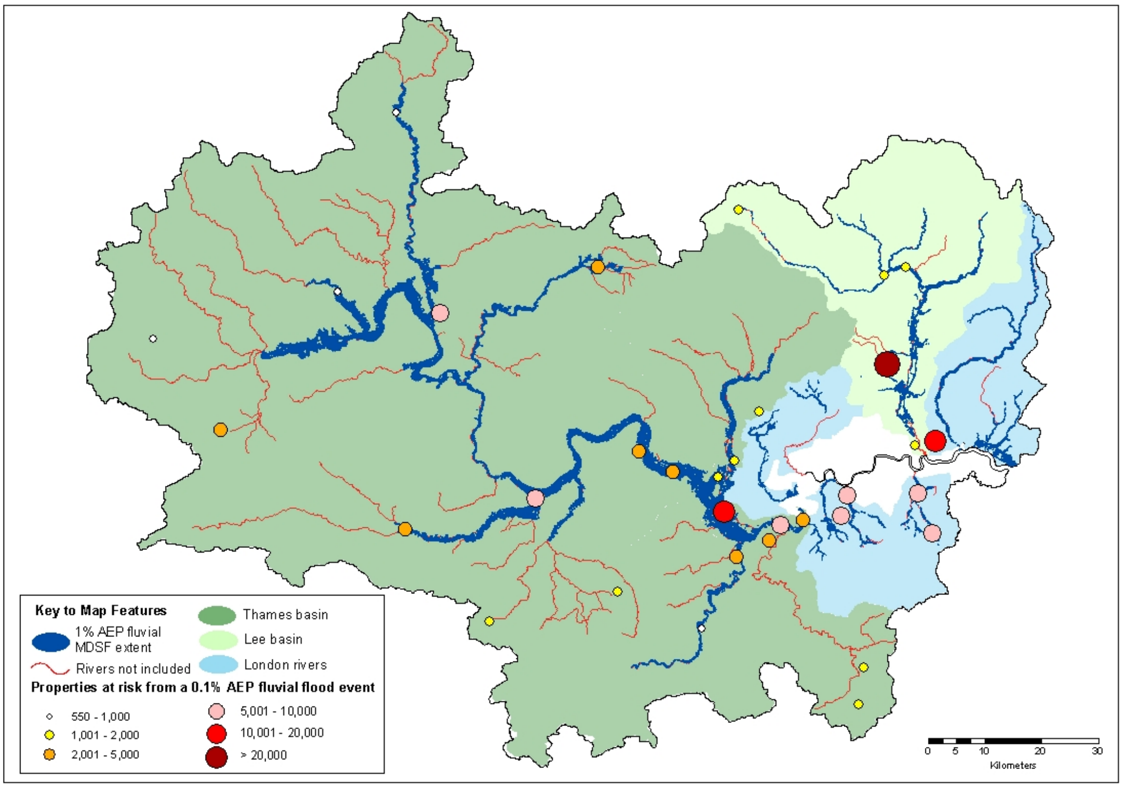


Figure 3.7 Regional coverage of the MDSF analysis work

3.3.2 Risks to people and the community

Approximately 6% of the total population in Thames Region are at risk from fluvial flooding. If we include tidal flooding, this figure increases to 13%.

As Figure 3.8 shows, the highest number of people within the floodplain are located in London, the Lower Lee and Lower Thames. There are some other major concentrations of people at risk from flooding away from London, for example in Oxford, Reading, the Blackwater Valley, the Colne Valley and Upper Mole. Table 3.3 gives the number of people at risk for a range of return periods. These figures have been calculated by multiplying the number of properties by 2.25. Where the people at risk are located has been a major factor in determining our flood risk management policies.

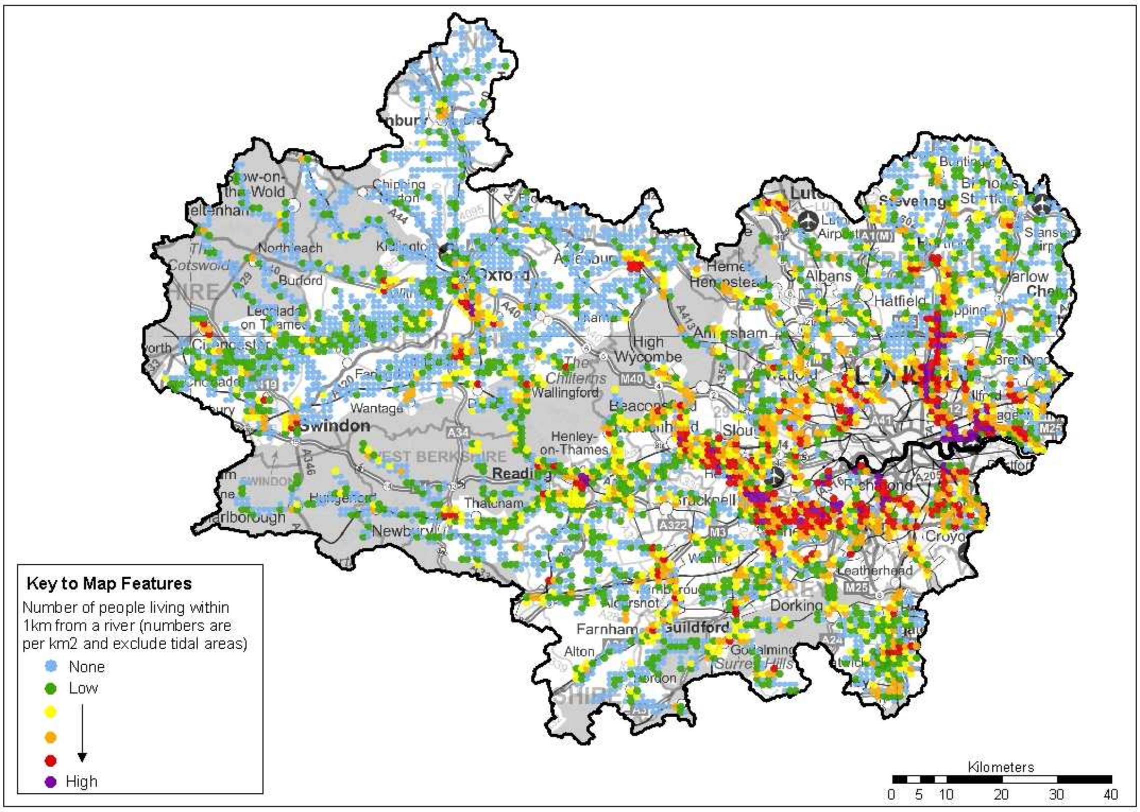


Figure 3.8 Population density within the floodplain

Policy Unit	Flood Zone 3	Flood Zone 2	MDSF				
	1% AEP	0.1% AEP	20% AEP	10% AEP	4% AEP (5% AEP in London)	1% AEP	0.5% AEP
Abingdon	3508	4370	3265	3341	3618	4100	4295
Addlestone Bourne, Emm Brook, The Cut	3202	5148					
Aylesbury	4334	5807	2293	2810	3517	4543	5200
Basingstoke	1863	2432					
Beam	3958	5495	329		623	947	
Beverley Brook	15050	17609	1305		5940	13066	
Brent	16459	20666	2473		4019	6003	
Byfleet and Weybridge	2831	9875	873	979	1195	1895	2237
Colne	8017	16137	8750	9898	11198	15505	17089
Colne tribs & Wye	5211	8696					
Crane	14308	22376	7151		12344	17231	
Graveney	9623	13500	4979		6892	8773	
Guildford	1114	2223	1566	1643	1775	1859	1944
Hoe Stream	585	1114					
Hogsmill	8192	12807	972			2561	
Ingrebourne	896	1559	680		1816	2464	
Kennet	7511	8933	3663	4019	4793	5884	7045
Loddon	2185	4739	673	722	758	1010	1157
Lower Lee	69496	97335	10661	10661	23155	48353	55562
Lower Lee tribs	5751	6923	1638	2261	4226	12224	17440
Lower Mole	4435	20151	142	171	421	1051	1598
Lower Roding	1775	2063	106		414	835	
Lower Thames	73769	100496	25558	32888	43751	60453	69584
Luton	4734	6089	25	349	693	1710	2626
Middle Lee & Stort	10179	14258	2086	2720	3348	4979	6482
Middle Mole	1586	5333					
Middle Roding	11601	13406	23		290	5441	
Ock	1015	1220					
Oxford	10517	11966	2898	4363	8627	12224	13451
Pinn	3186	5915					

Ravensbourne	21287	34720	7787		10528	14794	
Reading	15451	16540	3683	6208	8298	11012	11511
Rural Wey	6723	9929	963	1037	1166	1343	1415
Sandford to Cookham	12254	17534	4514	5378	6995	11606	14578
Swindon	2311	2853					
Thame	2972	4838	155	158	180	245	299
Upper & Middle Blackwater	3087	8998					
Upper Lee	2338	4145	965	965	1024	1136	1193
Upper Mole	6201	11579					
Upper Roding	4898	6343	1348		2700	3665	
Upper Thames	10823	14144	4507	5306	6599	8404	9653
Wandle	26321	27837	7427		10622	13984	
Windsor & Maidenhead	25295	32861	1953	3209	7191	18023	24359
TOTAL	446,846	640,958					

Table 3.3 People at risk per policy unit

Due to certain social factors, some people are more vulnerable to flooding than others. Figure 3.10 (on the next page) shows the properties within the 1% AEP flood extent that are also within enumeration districts that have a high Social Flood Vulnerability Index (SFVI) value. This highlights where the social impacts of floods might be greatest and where the population is likely to suffer most from impacts such as stress, trauma and other health effects. It was compiled by the Flood Hazard Research Centre and is based on three social groups (long-term sick, lone parents and the elderly) and four financial deprivation indicators (unemployed, overcrowding, non-car ownership and non-home ownership). Depending on these factors, an SFVI value between 1 and 5 (with 5 being the highest vulnerability) is given to each enumeration district.

The graph below shows the total numbers of properties in each river basin that are within enumeration districts that have an SFVI of 4 or 5. The percentage of the total population at risk for a 1% AEP flood event that also have a high level of social flood vulnerability, is presented per policy unit in Table 3.4.

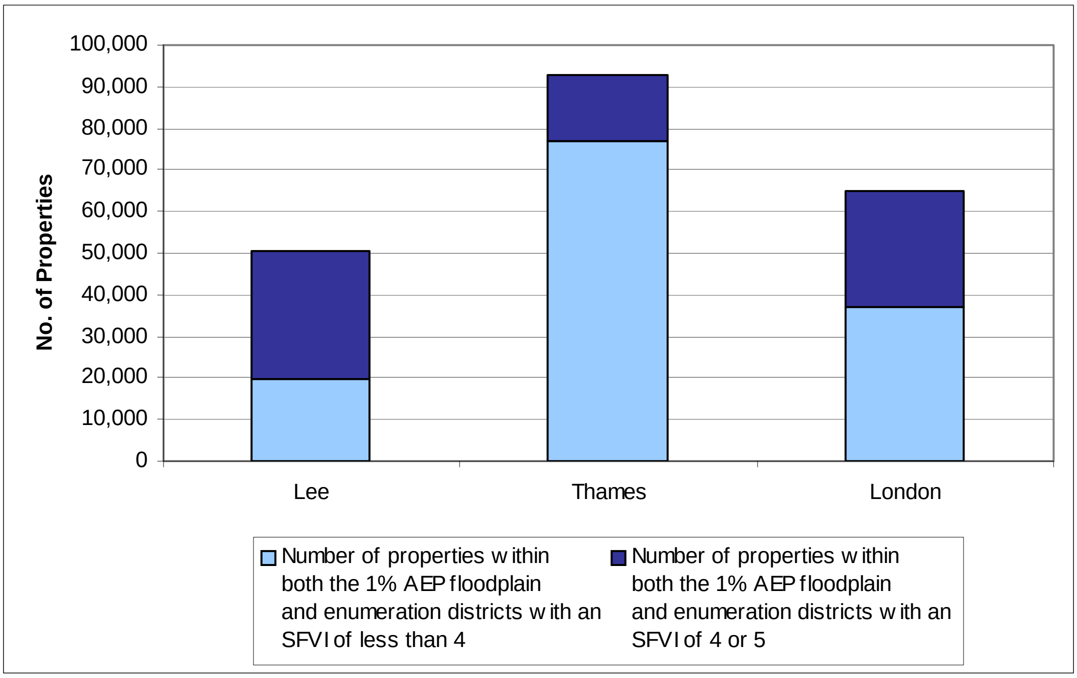


Figure 3.9 Variation in social flood vulnerability within the Thames CFMP area (1% AEP)

In Thames region there are over 136,000 people at risk from a 1% AEP flood event that also live within Enumeration Districts with an SFVI of 4 or 5. This represents just over 30% of the total population at risk. As shown on Figure 3.10, the policy units with the greatest number of people with a high level of social flood vulnerability (over 50% of the total people living within Flood Zone 3) are the Lower Lee, Beam and Lower and Middle Roding and also in major towns and cities outside of London for example in the Oxford and Guildford policy units. For comparison, the percentage of properties in enumeration districts with an SFVI of 4 or 5 in the Sandford to Cookham policy unit is only just over 15%.

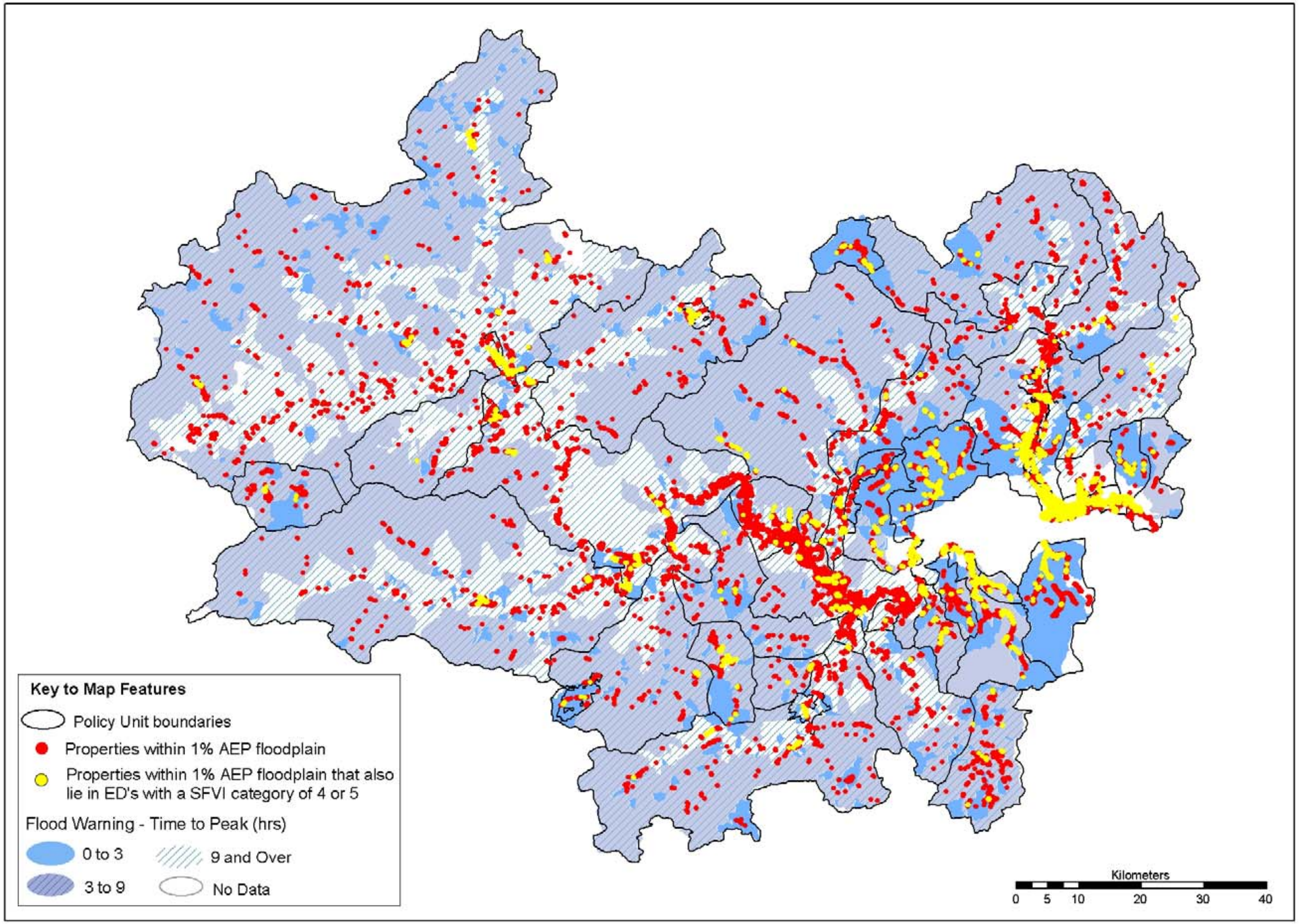


Figure 3.10 Properties within the 1% AEP flood extent that also lie within enumeration districts with an SFVI of 4 or 5

Where vulnerable groups are located and how exposed they are to the risk of flooding, as expressed, for example, by the potential flood warning lead time, has affected how we form policy. Very generally, where people are located has been the main factor in forming the actual policy from a social perspective. The vulnerability will help us decide upon priorities and how we implement the policy.

For example, in parts of London there can be very little time to give people adequate flood warnings. This is because these catchments react very quickly to rainfall. They are highly urbanised and often the rivers have been canalised and straightened in the past. In these areas severe flooding can happen in the summer months from intense thunderstorm rainfall as well as prolonged rainfall more typical of the winter months.

Within the Thames CFMP area, 24% of the properties (63,000) that are within the 0.1% AEP floodplain, have a lead time of less than 3 hours. However, they are not evenly distributed, due to the different characteristics of the catchments. 63% (around 40,000) of all the properties that have a flood warning lead time of 0-3 hours, are within the London river catchments. This is a very high number compared to the Thames and Lee, where there are 14,000 and 9,000 properties respectively, in areas with lead times of less than 3 hours.

Figure 3.11 shows the number of properties that have a flood warning lead- time of less than 3 hours In London, 48% of the properties at risk from a 0.1% AEP flood event have a lead-time of 0-3 hours. By contrast, in the wide, flat floodplain of the Lower Thames, only 2% of properties at risk have a lead-time of less than 3 hours.

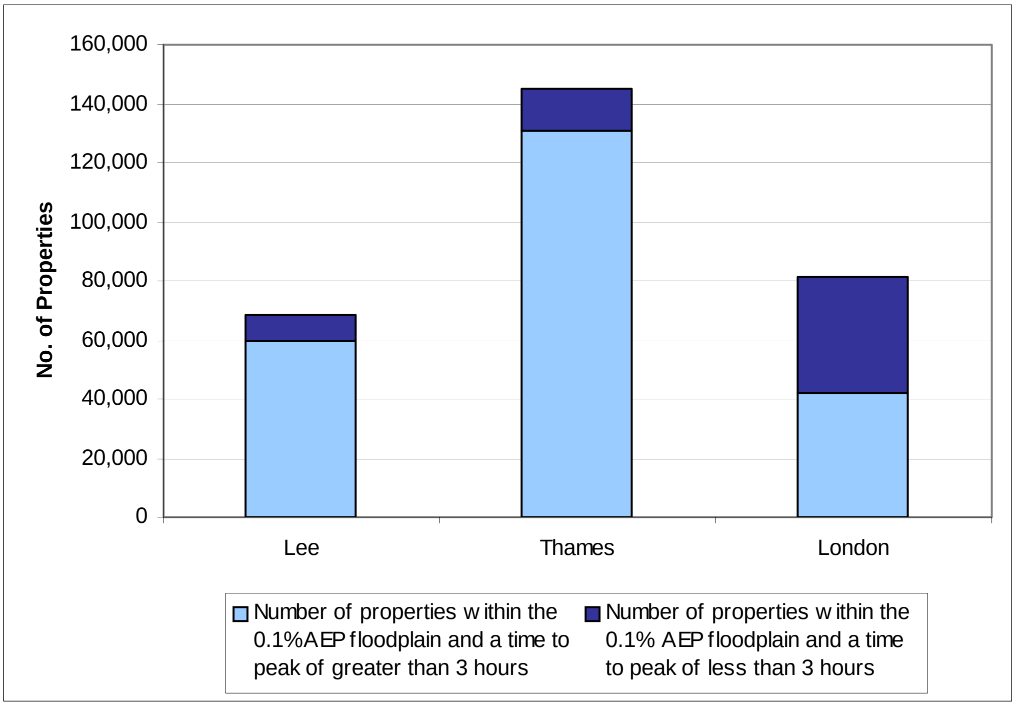


Figure 3.11 Variation in flood warning lead times within the Thames CFMP area

When developments are proposed in areas that could flood, this must be taken into account when they are designed. This includes making sure that people are not exposed to the rapid onset of flooding (less than 2 hours), to floods that extend beyond 12 hours or to deep and fast flowing water (to depths of more than 600mm or that flow more than 1.0m/s).

Figure 3.12 illustrates flood depths for a 1% AEP event. The average depth of flooding for a 1% AEP flood event is 0.09m in the Thames basin, 0.23m in the Lee basin and 0.15m in London. There are concentrations of deeper flooding, but this does not affect large numbers of properties. In the Thames basin, 7% of the total number of properties affected by a 1% AEP flood are in areas with a depth of flooding greater than one metre. It is a similar percentage for both the Lee basin (6%) and London rivers (8%).

On the Thames, this figure is low because most of the deeper flooding occurs in areas of undeveloped floodplain (for example between Oxford and Abingdon and along the Kennet). There is also deeper flooding in areas where there are reservoirs (for example, near Reading and Wraysbury). In other instances, the deeper floodwaters are contained within the channel itself or close to the banks (for example between Abingdon and Reading and on the Thame). In the Lee basin, the areas of deeper flooding are located in the upper reaches, for example at the confluence with the Stort, downstream of the confluence with the Rib. No major urban areas are affected though. The deepest areas are within the channel and near the reservoirs. More analysis on flood depths is presented in section 4.5.1.

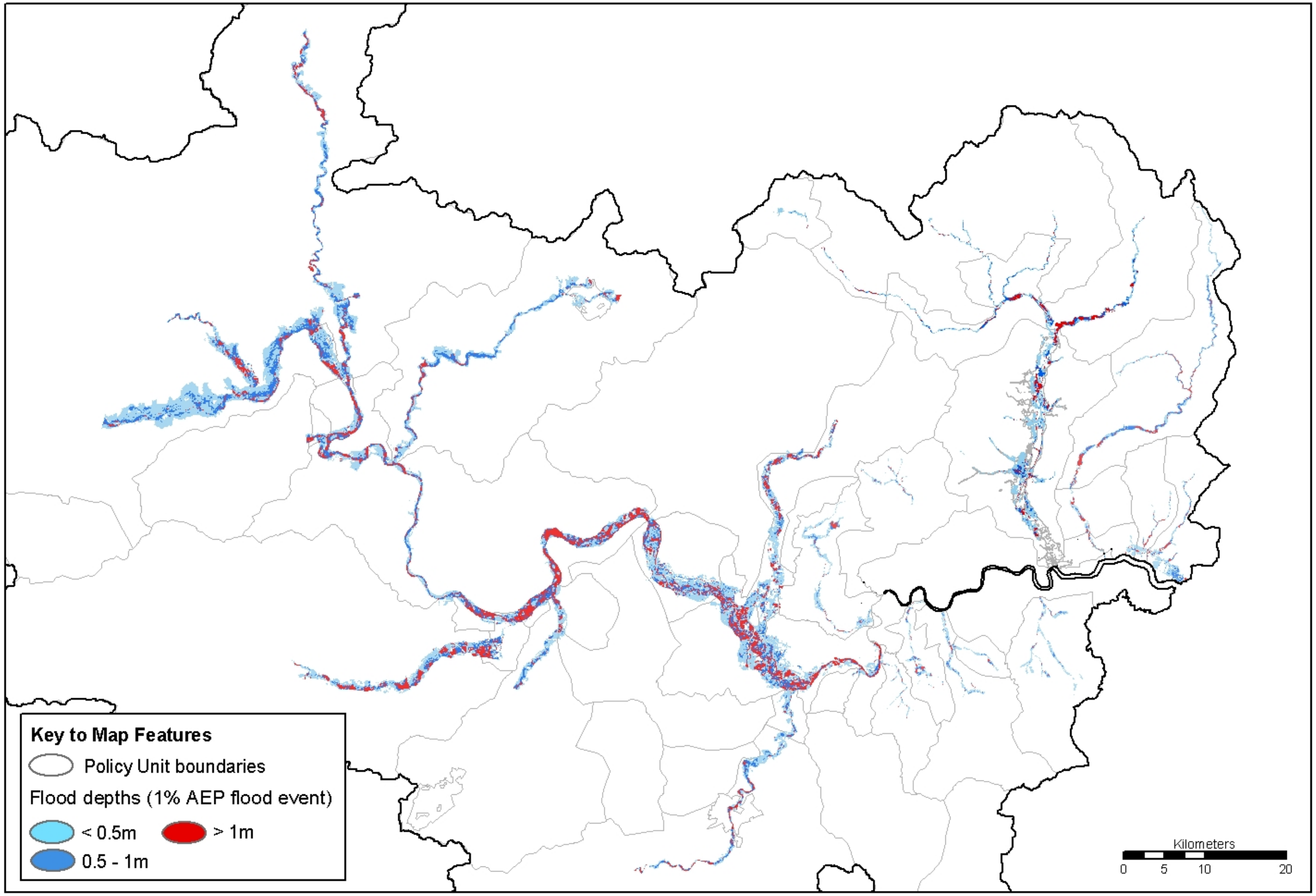


Figure 3.12 Regional depth map for the 1% AEP flood event

In summary, Table 3.4 compares the factors affecting the level of flood risk to people in each policy unit in the Thames CFMP area, drawing on the information above and also from other sections of this document including watercourse slope, geology, catchment size and land use. The entries in red indicate where there are the most people at the greatest risk.

Policy Unit	No. of people at risk (1% AEP fluvial)	% of total people at risk with high social flood vulnerability	Rate of rise	Indicative time available to react (hrs)	Water depth and duration
Abingdon	3,508	48%	Flat floodplain with a rural but relatively small and clay catchment upstream = Medium	9 and over	Medium depth and short duration
Addlestone Bourne, Emm Brook, The Cut	3,202	30%	Mainly rural catchments but urbanised headwaters on The Cut and Emm Brook = Medium overall but Fast in certain urban areas e.g. Bracknell	< 3 to 9	Medium depth and short duration
Aylesbury	4,334	31%	Rapid runoff from urban areas = Fast	over 3	Medium depth and short duration
Basingstoke	1,863	21%	Rapid runoff from urban areas = Fast	< 3 to 9	Medium depth and short duration
Beam	3,958	57%	Rapid urban runoff from development close to river in upper reaches (particularly in Romford) = Fast	< 3	Deep and short duration
Beverley Brook	15,050	23%	Rapid urban runoff into concrete channels = Fast	< 3	Deep and short duration
Brent	16,459	48%	Rapid urban runoff into concrete channels = Fast	< 3	Deep and short duration
Byfleet and Weybridge	2,831	13%	Wide, flat floodplain = Slow	9 and over	Medium depth and medium duration
Colne	8,017	17%	Chalk catchment, influenced by groundwater. Rural in upper reaches with urban areas further downstream = Slow	9 and over	Shallow, widespread and medium duration
Colne tribs & Wye	5,211	38%	Natural river system with steep slopes in the headwaters (Chilterns) = Medium	3 to 9	Deep and short duration
Crane	14,308	4%	Rapid urban runoff into concrete channels in upper reaches (particularly in Yeading) = Fast	< 3	Deep and short duration
Graveney	9,623	37%	Rapid urban runoff into concrete channels = Fast	< 3 to 9	Deep and short duration

Guildford	1,114	54%	Urbanised but with extensive rural floodplain upstream = Slow	9 and over	Medium depth and medium duration
Hoe Stream	585	17%	Urbanised but with extensive rural floodplain upstream = Medium	3 to 9	Medium depth and short duration
Hogsmill	8,192	21%	Rapid urban runoff into concrete channels. Steep slopes in the headwaters = Fast	< 3 to 9	Deep and short duration
Ingrebourne	896	34%	Rapid rurban runoff and steep slopes in the headwaters = Fast	< 3	Deep and short duration
Kennet	7,511	32%	Chalk catchment, influenced by groundwater. Steep slopes at headwaters of tribs = Slow overall, but Medium in the headwaters	over 3	Shallow and long duration
Loddon	2,185	14%	Generally flat, clay, rural catchment = Medium	over 3	Shallow and long duration
Lower Lee	69,496	74%	When the source of flooding is the Lower Lee tributaries = Fast When the source of flooding is the more extensive rural catchments of the Upper Lee and Stort = Medium	9 and over	Medium depth with variable duration
Lower Lee tribs	5,751	45%	Urbanised clay catchments, often with steep slopes in the headwaters = Fast	< 3 to 9	Medium depth and short duration
Lower Mole	4,435	0.1%	Wide, flat floodplain = Slow	9 and over	Shallow and long duration
Lower Roding	1,775	77%	Rapid runoff from major urban expansion = Fast	< 3	Deep and short duration
Lower Thames	73,769	16%	Wide, flat floodplain = Slow	9 and over	Shallow and long duration
Luton	4,734	6%	Rapid urban runoff into concrete channels = Fast	< 3	Deep and short duration
Middle Lee & Stort	10,179	16%	Rapid urban runoff in the Middle Lee but the tributaries are predominately rural with steep slopes in the headwaters = Medium to Slow	9 and over	Shallow and medium duration
Middle Mole	1,586	11%	Rural, fairly flat floodplain = Slow	9 and over	Shallow and medium duration
Middle Roding	11,601	65%	Rapid runoff from the local urban area, but upstream the catchment is extensive and largely rural = Medium overall but locally Fast	over 3	Medium depth and medium duration

Ock	1,015	24%	Rural clay catchment with flat floodplain = Medium	over 3	Medium depth and medium duration
Oxford	10,517	75%	Wide, flat floodplain, with flood storage available = Slow	9 and over	Shallow and long duration
Pinn	3,186	23%	Rapid runoff from major urban areas in the upper reaches (e.g. in Pinner) = Fast	< 3	Medium depth and short duration
Ravensbourne	21,287	37%	Rapid urban runoff into concrete channels = Fast	< 3	Deep and short duration
Reading	15,451	17%	Wide, flat floodplain = Slow	9 and over	Shallow and long duration
Rural Wey	6,723	24%	Predominately rural catchment with steep slopes in the headwaters (North Downs) = Slow overall but locally Fast (e.g. Cranleigh Waters)	over 3	Medium depth and medium duration
Sandford to Cookham	12,254	17%	Wide, mainly rural, flat floodplain = Slow	9 and over	Shallow and long duration
Swindon	2,311	17%	Rapid runoff from major urban expansion = Fast	< 3 to 9	Medium depth and short duration
Thame	2,972	52%	Predominately rural, clay catchment = Medium	over 3	Shallow and medium duration
Upper & Middle Blackwater	3,087	17%	Rapid runoff from urban areas = Fast	< 3	Medium depth and short duration
Upper Lee	2,338	26%	Predominately rural catchment, but with steep slopes in the headwaters and some large urban areas (e.g. Stevenage) = Medium	3 to 9	Medium depth and short duration
Upper Mole	6,201	24%	Runoff from urban development and steep headwaters = Fast	3 to 9	Medium depth and short duration
Upper Roding	4,898	33%	Natural river system with impermeable clay soils = Medium	over 3	Medium depth and medium duration
Upper Thames	10,823	39%	Natural river system with steep slopes in the headwaters (Cotswolds) = Medium	< 3 to over 9	Shallow and long duration on the Thames but deeper and shorter duration on the tributaries
Wandle	26,321	32%	Rapid urban runoff, clay catchment = Fast	< 3 to 9	Deep and short duration
Windsor & Maidenhead	25,295	18%	Wide, flat floodplain = Slow	9 and over	Shallow and long duration

Table 3.4 Levels of flood risk and hazard across the Thames CFMP area (not considering the impact of flood defences)

3.3.3 Risks to property and infrastructure

Properties at risk

There are over 280,000 properties within the 0.1% AEP fluvial flood event outline (Flood Zone 2) in Thames region. Approximately 60% of these properties at risk are located in the London, Lower Thames, Lower Lee and Lower Lee tributaries policy units (170,000 properties). These three areas make up 15% of the total area covered by the Thames CFMP and contain 17% of the 0.1% AEP floodplain. There are 188,00 properties at risk from a 1% AEP event (Flood Zone 3). Figure 3.13 shows the total number of properties at risk within the Thames, Lee and London basins.

Apart from London, the majority of properties at risk from fluvial flooding are located in cities and towns along the River Thames, mainly in the Lower Thames, Maidenhead, Reading and Oxford. Figure 3.15 shows areas where there are more than 500 properties at risk of flooding.

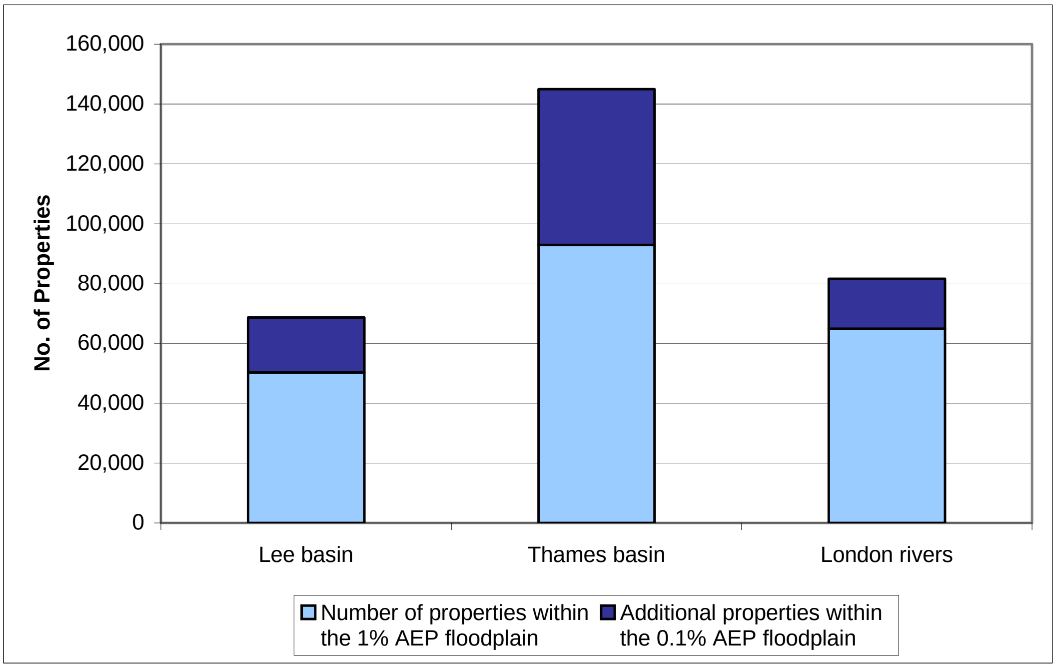


Figure 3.13 Properties at risk from flooding within the Thames CFMP area

Table 3.5 shows how many properties are at risk in each policy unit at different return periods, including the split between residential and commercial properties. The significance of these figures is explored in more detail in the policy appraisal in Chapter Six.

In terms of the type of properties affected, there are many more residential than commercial properties in the floodplain, as Figure 3.14 shows. In the Thames basin, 86% of properties within the 1% AEP flood extent are residential. It is a similar figure for the Lee (87%). Within the London river catchments, 90% of the properties within the 1% AEP flood extent are residential.

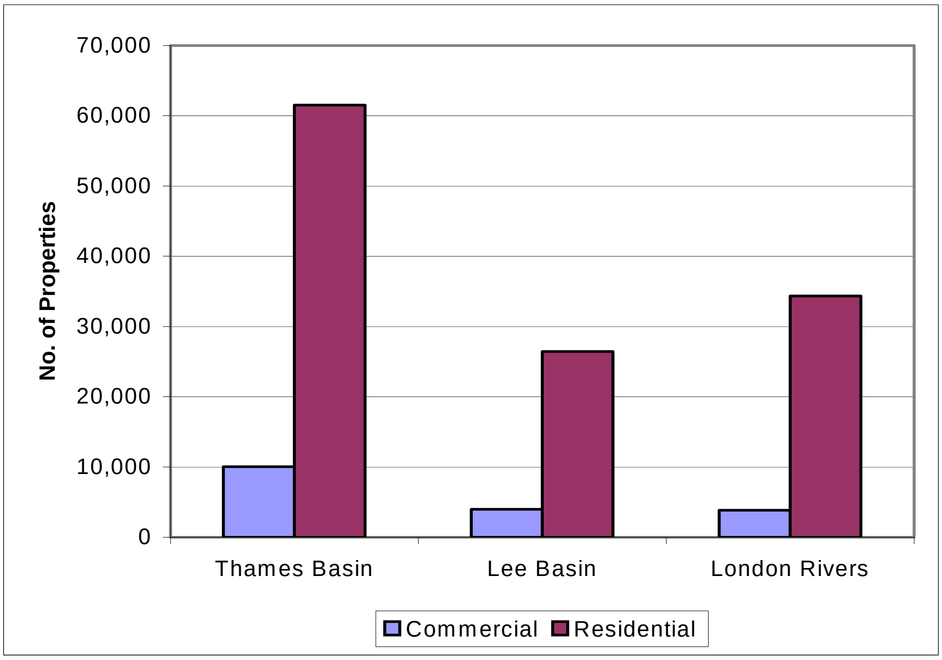


Figure 3.14 Total properties within the 1% AEP flood event outline, split between commercial and residential (based on MDSF results)

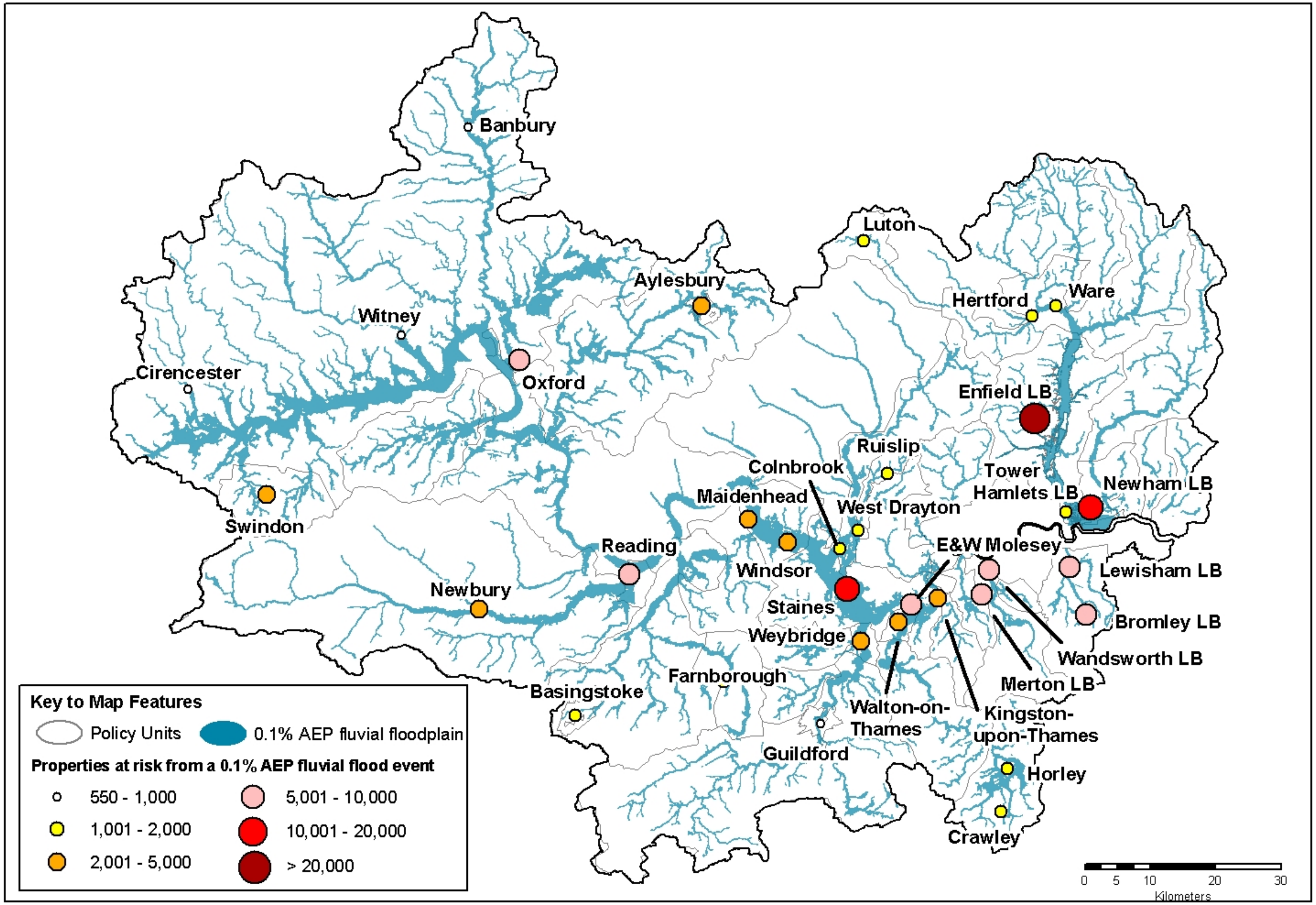


Figure 3.15 Concentrations of properties at risk (greater than 500) from a 0.1% AEP fluvial flood event

Policy Unit	Flood Zone 3	Flood Zone 2	MDSF									
	1% AEP	0.1% AEP	20% AEP		10% AEP		4% AEP (5% AEP in London)		1% AEP		0.5% AEP	
			Res	Comm	Res	Comm	Res	Comm	Res	Comm	Res	Comm
Abingdon	1559	1942	1377	74	1403	82	1517	91	1714	108	1792	117
Addlestone Bourne, Emm Brook, The Cut	1423	2288										
Aylesbury	1926	2581	856	163	1058	191	1340	223	1766	253	2047	264
Basingstoke	828	1081										
Beam	1759	2442	135	11			259	18	390	31		
Beverley Brook	6689	7826	570	10			2456	184	4801	286		
Brent	7315	9185	913	186			1525	261	2318	350		
Byfleet and Weybridge	1258	4389	313	75	353	82	447	84	747	95	885	109
Colne	3563	7172	3039	850	3479	920	3971	1006	5680	1211	6259	1336
Colne tribs & Wye	2316	3865										
Crane	6359	9945	2924	254			5138	348	7190	468		
Graveney	4277	6000	2024	189			2837	226	3631	268		
Guildford	495	988	374	322	394	336	440	349	462	364	489	375
Hoe Stream	260	495										
Hogsmill	3641	5692	376	56					887	251		
Ingrebourne	398	693	195	107			609	198	827	268		
Kennet	3338	3970	1052	576	1158	628	1417	713	1723	892	2143	988
Loddon	971	2106	230	69	249	72	261	76	359	90	421	93
Lower Lee	20010	39231	2044	631	3778	960	8658	1633	18922	2568	21683	3011
Lower Lee tribs	2556	5433	627	101	872	133	1636	242	4833	600	6973	778
Lower Mole	1971	8956	41	22	48	28	153	34	392	75	537	173
Lower Roding	789	917	20	27			148	36	321	50		
Lower Thames	32786	44665	10145	1214	13215	1402	17374	2071	24059	2809	27652	3274
Luton	2104	2706	9	2	153	2	300	8	749	11	1148	19
Middle Lee & Stort	4524	6337	600	327	825	384	1020	468	1587	626	2111	770
Middle Mole	705	2370										
Middle Roding	5156	5958	6	4			123	6	2365	53		
Ock	451	542										
Oxford	4674	5318	1038	250	1630	309	3429	405	4884	549	5364	614

Pinn	1416	2629									
Ravensbourne	9461	15431	2928	533			4035	644	5772	803		
Reading	6867	7351	1326	311	2332	427	3128	560	4121	773	4279	837
Rural Wey	2988	4413	290	138	318	143	368	150	433	164	460	169
Sandford to Cookham	5446	7793	1790	216	2109	281	2750	359	4540	618	5645	834
Swindon	1027	1268										
Thame	1321	2150	35	34	35	35	41	39	64	45	85	48
Upper & Middle Blackwater	1372	3999										
Upper Lee	1039	1842	318	81	344	85	365	90	408	97	425	105
Upper Mole	2756	5146										
Upper Roding	2177	2819	545	54			1123	77	1533	96		
Upper Thames	4810	6286	1553	450	1859	499	2361	572	3058	677	3546	744
Wandle	11698	12372	2443	858			3636	1085	4873	1342		
Windsor & Maidenhead	11242	14605	745	123	1165	261	2794	402	7225	785	9825	1001
TOTAL	187,721	283,197										

Table 3.5 Properties at risk per policy unit

Flood damages

Based upon the MDSF results (which do not account for the presence of defences), the total Annual Average Damage (AAD) for the Thames CFMP area is approximately £390 million. Damages in the Thames basin account for 60% of the total, whilst the Lee contributes 13% and London 27%. However, these damage calculations are underestimated due to incomplete coverage of the MDSF work (see Table 3.2). If all properties within the 1% AEP fluvial floodplain had been included in the modelling, the AAD damages in London are likely to account for a slightly higher percentage of the total (30%) and the Thames, a lower percentage (56%). AAD for the Lee basin increase by only 2%.

Figure 3.16 shows how the damages increase as the scale of the flood event increases. It is noted that the difference between the 20% AEP and 10% AEP flood events in the Thames and Lee is not that great but there is a marked increase between the more extreme probability events.

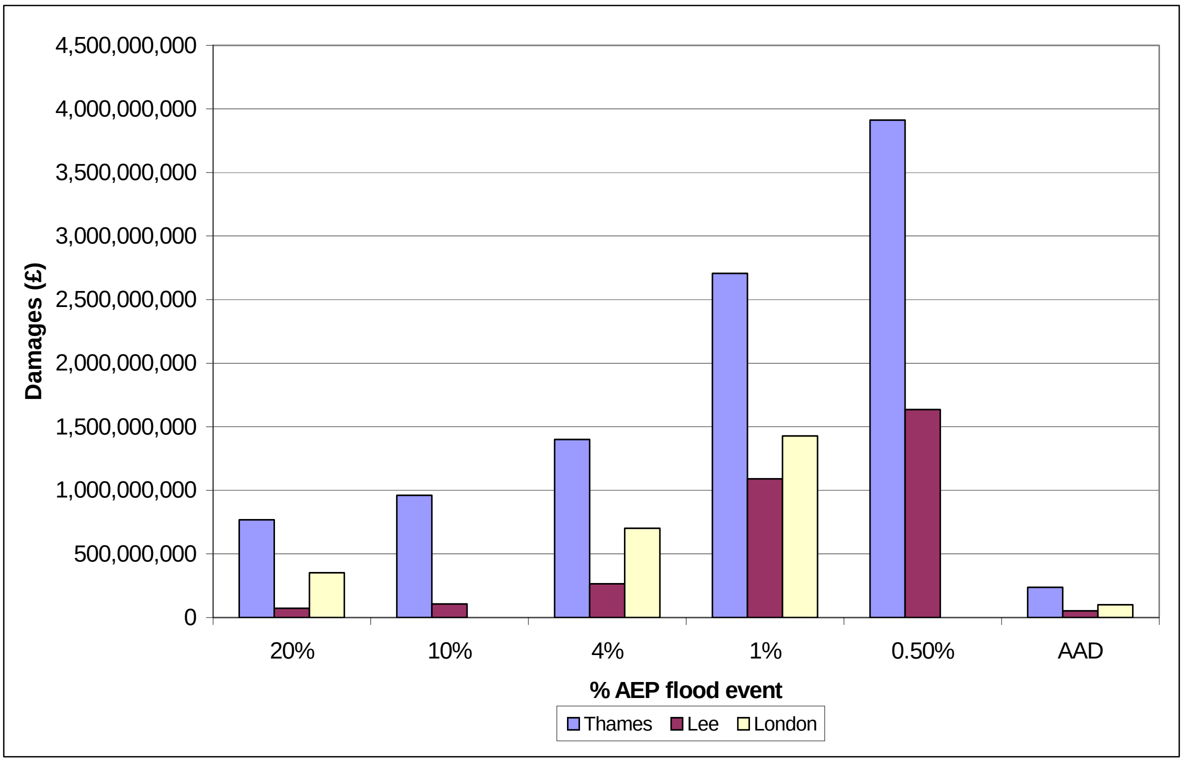


Figure 3.16 Damages for the Thames and Lee basins and the London rivers[1] for a range of % AEP

In the Lee basin, the top 10% of properties (in terms of AAD) account for 78% of the economic damages (AAD). In the Thames basin, this figure falls to 73% and for London it is 60%. In all areas, the top few properties, in terms of individual damages, are all commercial. As Figure 3.17 shows, commercial properties also make up the majority of the AAD, although the percentage varies between areas. In the Thames basin, 61% of the AAD comes from commercial properties. In the Lee, this figure is 66% and in London, it is 55%. This has important implications for flood warning.

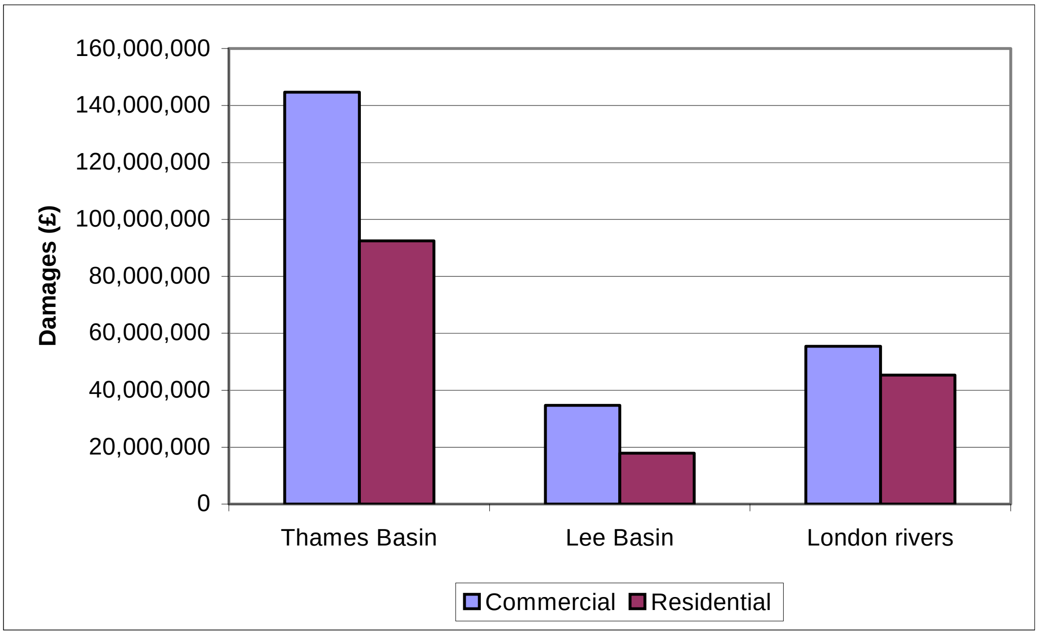


Figure 3.17 AAD split between commercial and residential properties

The policy unit with the highest 1% AEP damages is the Lower Thames (£1,050 million) closely followed by the Lower Lee (£842 million). These figures represent 20% and 16% of the total damages for the region respectively. Of the policy units that represent large urban areas, Reading has the greatest 1% AEP damages (£236 million) which is 9% of the total for the Thames basin (excluding Lee and London policy units). The smallest damages occur in the more rural policy units including the Loddon (£14 million) and Rural Wey (£27 million).

In the Thames basin, in the Oxford, Reading, Lower Thames and Windsor and Maidenhead policy units, there is a large increase in damages between the 4% and 1% AEP flood events and also between the 1% and 0.5% AEP. With regard to properties affected in these three places, the largest increase is between the 4% and 1% AEP flood events.

In other urban areas such as Aylesbury, Abingdon and Guildford, the increases in both damages and properties are more gradual across the return periods. Between 860 and 2,300 properties in each of these policy units are affected by the 0.5% AEP event, compared to over 5,000 in both Oxford and Reading.

In the Lee basin, approximately 85% of the 1% AEP damages occur in the Lower Lee and Lower Lee tributaries policy units. Specific locations at risk include Waltham Abbey, Hertford and Harlow. In the Lower Lee and Lower Lee tributaries, the AAD is £39.8 million, whilst in the Upper Lee the figure is £4.0 million and in the Middle Lee and Stort policy unit the total is £8.6 million. This is a result of the highly urbanised nature of the Lower Lee catchment and the higher numbers of properties within the

[1] Damages for the London rivers could only be calculated for the 20%, 5% and 1% AEP events as these catchments are not covered by a BSM

floodplain. For example, for a 0.5% AEP flood event, there are 26,900 properties at risk in the Lower Lee, 500 in the Upper Lee and 2,900 in the Middle Lee and Stort.

In the London basin, approximately 70% of the annual average damages occur in the South London policy units. The policy units with the highest economic damages are the Wandle (£28.0 million AAD) and Ravensbourne (£17.4 million AAD). This is a result of the highly urbanised nature of the south London catchments and the high number of properties within the floodplain. Only 7% of the annual average damages in the London basin occur in the East London policy units (Beam and Ingrebourne), which are more rural.

Table 3.6 shows the economic damages for the 20% AEP, 10% AEP, 4% AEP (5% AEP in London), 1% AEP and 0.5% AEP and AAD for each policy unit (where available). A figure for the projected AAD has been provided as an estimate of the total if 100% coverage was available.

Policy Unit	MDSF Damages (£M)													
	20% AEP		10% AEP		4% AEP (5% AEP in London)		1% AEP		0.5% AEP		AAD			Projected AAD
	Res	Comm	Res	Comm	Res	Comm	Res	Comm	Res	Comm	Res	Comm	Total	
Abingdon	16.31	8.77	21.81	12.05	28.18	16.62	41.30	24.26	46.72	26.85	4.90	2.45	7.35	7.35
Addlestone Bourne, Emm Brook, The Cut														
Aylesbury	6.87	26.14	8.46	28.42	11.66	30.56	17.36	35.40	20.80	38.21	2.01	4.21	6.21	6.21
Basingstoke														
Beam	1.89	0.02			3.62	0.06	6.27	0.53			0.67	0.03	0.70	1.23
Beverley Brook	12.35	0.76			57.03	22.89	125.53	59.69			10.11	3.90	14.01	15.86
Brent	14.76	5.48			22.32	16.51	46.81	49.95			2.62	2.13	4.75	7.77
Byfleet and Weybridge	3.81	16.14	4.24	19.52	4.72	23.52	5.85	29.44	10.09	34.70	0.92	3.72	4.64	6.18
Colne	19.94	215.25	24.92	241.54	32.90	278.99	63.71	351.78	90.31	408.85	6.26	46.46	52.72	52.72
Colne tribs & Wye														
Crane	14.58	6.04			55.08	34.16	133.65	71.98			10.13	5.45	15.58	15.58
Graveney	12.24	6.82			29.41	16.33	53.60	30.51			5.32	2.52	7.84	8.53
Guildford	6.87	78.24	7.27	83.68	7.78	90.08	8.83	98.40	9.44	104.60	1.50	14.91	16.41	16.41
Hoe Stream														
Hogsmill	10.30	4.37					18.28	11.45			2.52	1.29	3.81	6.47
Ingrebourne	0.78	4.99			5.47	33.39	11.86	96.37			0.76	5.21	5.97	5.97
Kennet	14.09	25.71	15.69	30.31	18.11	40.77	25.11	77.69	28.32	92.97	3.43	7.22	10.65	12.95
Loddon	1.99	6.58	2.30	7.67	2.55	9.04	3.16	11.16	3.72	12.81	0.48	1.64	2.12	3.26
Lower Lee	3.76	6.05	11.42	11.63	63.93	78.01	267.43	574.14	372.93	853.55	11.46	20.45	31.90	31.90
Lower Lee tribs	3.51	9.47	7.38	15.13	17.42	25.61	52.96	69.21	90.45	134.36	3.15	4.76	7.91	7.91
Lower Mole	0.56	0.09	0.65	0.16	1.32	1.24	3.86	7.23	9.56	14.79	0.28	0.30	0.58	1.02
Lower Roding	0.01	2.82			0.34	3.27	6.26	12.20			0.22	0.85	1.07	1.64
Lower Thames	86.95	85.87	141.50	116.10	269.27	208.33	542.08	507.67	730.93	770.27	42.75	34.08	76.83	90.70
Luton	0.00	0.00	0.02	0.01	0.18	0.06	1.21	0.30	9.00	1.24	0.10	0.02	0.12	0.19
Middle Lee & Stort	6.97	28.89	7.85	34.43	10.17	45.85	16.03	75.56	28.88	106.00	1.93	6.64	8.57	12.95
Middle Mole														
Middle Roding	0.00	0.35			0.11	0.72	54.68	7.19			1.65	0.30	1.95	2.99
Ock														
Oxford	3.62	3.65	4.90	6.40	18.20	16.86	69.72	55.08	119.05	116.68	3.50	3.27	6.78	6.78

Pinn														
Ravensbourne	23.19	29.88			43.07	59.56	94.37	99.77			8.66	8.75	17.41	22.72
Reading	6.74	13.60	11.34	19.69	29.53	40.65	94.75	141.20	122.86	222.73	5.15	7.98	13.14	16.91
Rural Wey	2.06	18.34	2.48	19.77	2.86	21.31	3.52	23.89	3.94	25.85	0.52	3.29	3.81	6.86
Sandford to Cookham	25.08	10.48	31.75	16.53	43.16	27.49	91.31	82.74	137.67	164.78	8.37	4.78	13.14	13.84
Swindon														
Thame	0.30	1.38	0.36	1.54	0.42	1.81	0.56	3.39	0.67	5.35	0.08	0.24	0.32	0.61
Upper & Middle Blackwater														
Upper Lee	4.71	9.88	5.02	13.81	5.45	19.75	6.60	27.80	7.34	32.17	1.05	2.97	4.02	6.09
Upper Mole														
Upper Roding	4.59	2.75			14.31	5.71	30.39	18.06			2.62	0.81	3.43	4.29
Upper Thames	12.54	24.49	16.68	29.85	25.60	46.78	48.07	89.23	66.73	113.48	4.46	6.75	11.21	13.71
Wandle	18.00	190.34			28.96	250.98	61.53	362.22			5.95	22.02	27.96	41.07
Windsor & Maidenhead	6.25	4.81	8.92	8.00	14.57	16.03	74.98	47.65	186.50	138.92	4.39	3.09	7.48	9.64
TOTAL	345.6	848.4	335.0	716.2	867.7	1483.0	2081.7	3153.1	2095.9	3419.2	157.9	232.5	390.4	482.19

Table 3.6 Flood damages per policy unit

Infrastructure

As well as people living within the floodplain, there is also social infrastructure that has been built within flood risk areas. Some of this infrastructure is highly vulnerable for example police stations and hospitals. Table 3.8 below shows the number of vulnerable infrastructure within the 1% AEP floodplain (using Flood Zone 3 for complete coverage). Table 3.9 details the vulnerable infrastructure for the 10% AEP floodplain and also the 1% AEP floodplain using MDSF data where available.

The distribution of the most critical infrastructure that it is important to keep operational during a flood event, but is also within the 1% AEP floodplain, has been mapped in Figure 3.18 to show the distribution across the region. There is a concentration of emergency response centres and sewage treatment works at risk in urban areas including Abingdon and Reading, the Lower Thames and Lower Lee. In more rural areas, there are higher numbers of telephone exchanges at risk (five in the Upper Thames). The only electricity generating station and gas works at risk are in London.

Within the Thames CFMP there are significant lengths of road and railway that are shown to be within the floodplain. Many roads and railways are located within the floodplain out of necessity. This means that many transport routes face disruption as a result of flood risk with an impact at the local and wider regional and national level. Within our analysis of flood risk to roads we have only considered the main roads. We have defined this as meaning Motorways and A-Roads.

Details of the risk to transport routes at a regional level are provided in table 3.7 below. The actual surface height of these railway lines and roads maybe above the water level in times of flooding. We have not determined this within the CFMP due to data limitations. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time that the route could expected to be closed or suffer travel restrictions.

Transport Infrastructure	Total Length (km)	Flood Zone 3 (1% AEP)		Flood Zone 2 (0.1% AEP)	
		Length (km)	As a % of the total	Length (km)	As a % of the total
Motorway	605	47	8%	60	10%
A Class Roads	3178	281	9%	349	11%
Main Railway	2105	268	13%	329	16%

Table 3.7 Transport infrastructure at risk

Policy Unit	High Vulnerability									Lower Vulnerability				
	Hospital	School	Care Home	Prison	Mobile Home Park	Camp/Caravan site	Emergency Response[2]	Power & Gas Stations	Telephone Exchange	Airport	Railway Station	IPPC Sites[3]	Radioactive Substances[4]	Sewage & Water Treatment
Abingdon	0	0	5	0	0	0	2	2	0	0	0	0	0	0
Addlestone Bourne, Emm Brook, The Cut	0	1	0	0	0	0	1	4	0	0	0	0	0	4
Aylesbury	0	2	0	0	0	0	0	2	0	0	1	0	0	0
Basingstoke	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Beam	0	2	0	0	0	0	0	11	0	0	0	0	0	0
Beverley Brook	1	7	1	0	0	0	2	25	1	0	2	0	0	0
Brent	0	1	0	0	0	0	1	11	0	0	0	0	0	0
Byfleet and Weybridge	0	0	0	0	0	0	0	4	0	0	0	1	0	1
Colne	1	1	1	0	0	0	0	21	0	0	1	0	0	2
Colne tribs & Wye	0	2	1	0	0	0	5	20	0	0	0	2	0	3
Crane	0	3	2	0	0	0	1	11	0	0	2	0	0	0
Graveney	0	3	1	0	0	0	2	8	0	0	0	0	0	0
Guildford	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Hoe Stream	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Hogsmill	0	2	0	0	0	0	3	5	0	0	0	0	0	0
Ingrebourne	0	1	0	0	0	0	2	10	1	0	1	2	0	2
Kennet	0	2	1	0	0	0	1	17	0	0	1	0	0	8
Loddon	0	1	0	0	0	0	0	4	0	0	2	0	1	3
Lower Lee	0	20	3	0	0	2	1	110	0	0	3	1	0	0
Lower Lee tributaries	0	12	3	0	0	2	1	36	0	0	0	1	0	0
Lower Mole	0	1	1	0	0	1	2	3	0	0	1	0	0	1
Lower Roding	0	8	1	0	0	0	1	111	0	0	2	2	0	0
Lower Thames	0	9	0	0	0	3	3	51	1	0	1	2	1	2
Luton	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Middle Lee & Stort	0	0	1	0	0	1	0	8	1	0	5	1	0	2
Middle Mole	0	1	0	0	0	0	1	2	0	0	3	0	0	1
Middle Roding	0	3	2	0	0	0	1	27	0	0	0	0	0	0
Ock	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Oxford	0	3	0	0	0	1	0	7	0	0	0	0	0	0

[2] This includes ambulance stations, fire stations and police stations
[3] Integrated Pollution Prevention and Control (IPPC) sites includes major landfill, hazardous waste treatment and incineration plants
[4] Sites with radioactive substances (RAS)

Pinn	0	2	0	0	0	0	0	2	0	0	1	0	0	0
Ravensbourne	0	8	4	0	0	0	6	40	0	0	4	0	2	0
Reading	0	3	0	0	0	0	1	15	0	0	0	0	0	0
Rural Wey	0	1	2	0	0	0	3	5	1	0	0	1	0	10
Sandford to Cookham	0	2	5	0	0	1	0	7	0	0	3	0	1	6
Swindon	0	0	0	0	0	0	0	5	0	0	0	0	0	1
Thame	0	1	1	0	0	0	2	4	0	0	0	0	0	5
Upper & Middle Blackwater	0	2	2	0	0	0	0	5	0	0	2	0	0	3
Upper Lee	0	2	0	0	0	0	0	4	0	0	0	0	0	3
Upper Mole	0	1	4	0	0	1	0	9	0	1	0	0	0	3
Upper Roding	0	1	0	0	0	0	0	5	0	0	0	0	0	5
Upper Thames	0	1	2	0	0	6	1	10	5	0	3	3	1	18
Wandle	0	5	6	0	0	0	1	34	0	0	0	1	1	0
Windsor & Maidenhead	1	6	7	0	0	2	3	16	0	0	0	0	0	2
TOTAL	**3**	**121**	**56**	**0**	**0**	**20**	**50**	**673**	**10**	**1**	**38**	**17**	**7**	**86**

Table 3.8 Vulnerable infrastructure within the 1% AEP fluvial floodplain (Flood Zone 3)

Policy Unit	High Vulnerability																	
	Hospital		School		Care Home		Prison		Mobile or Chalet Home Park		Camping/ Caravan Site		Emergency Response		Power & Gas Stations		Telephone Exchange	
	10% AEP	1% AEP	10% AEP	1% AEP	10% AEP	1% AEP	10% AEP	1% AEP	10% AEP	1% AEP	10% AEP	1% AEP	10% AEP	1% AEP	10% AEP	1% AEP	10% AEP	1% AEP
Abingdon	0	0	1	1	1	1	0	0	0	0	0	0	1	2	2	3	0	0
Addlestone Bourne, Emm Brook and The Cut																		
Aylesbury	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0
Basingstoke																		
Beam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Beverley Brook	0	0	0	7	0	0	0	0	0	0	0	0	0	1	0	19	0	0
Brent	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	7	0	0
Byfleet and Weybridge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0
Colne	0	0	0	1	0	1	0	0	0	0	0	0	0	0	10	19	0	0
Colne tribs & Wye																		
Crane	0	0	0	3	0	1	0	0	0	0	0	0	0	0	0	6	0	0
Graveney	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3	0	0
Guildford	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0
Hoe Stream																		
Hogsmill	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Ingrebourne	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	0	1
Kennet	0	0	0	0	0	0	0	0	0	0	0	0	1	1	6	9	0	0
Loddon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0
Lower Lee	0	0	1	7	0	2	0	0	0	0	0	0	0	0	2	47	0	0
Lower Lee tribs	0	0	1	3	0	0	0	0	0	0	0	1	0	3	1	9	0	0
Lower Mole	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0
Lower Roding	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0
Lower Thames	0	0	1	16	0	3	0	0	0	0	3	3	0	5	14	40	1	2
Luton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Middle Lee & Stort	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	1	0	0
Middle Mole																		
Middle Roding	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	10	0	0
Ock																		
Oxford	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	7	0	0
Pinn																		
Ravensbourne	0	0	0	4	0	1	0	0	0	0	0	0	0	1	0	15	0	0
Reading	0	1	0	0	0	0	0	0	0	0	0	0	0	2	4	12	0	0

Rural Wey	0	0	0	0	1	1	0	0	0	0	0	0	1	1	1	1	0	0
Sandford to Cookham	0	0	1	1	1	3	0	0	0	0	0	1	0	0	1	4	0	0
Swindon																		
Thame	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper & Middle Blackwater																		
Upper Lee	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Upper Mole																		
Upper Roding	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Upper Thames	0	0	1	1	0	0	0	0	0	0	2	2	1	1	3	5	0	0
Wandle	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	14	0	0
Windsor & Maidenhead	0	0	0	2	1	3	0	0	0	0	0	1	0	0	1	6	0	0
TOTAL	**0**	**2**	**6**	**53**	**6**	**18**	**0**	**0**	**0**	**0**	**6**	**9**	**4**	**23**	**50**	**248**	**1**	**3**

Table 3.9 Highly vulnerable infrastructure within the 10% and 1% AEP fluvial floodplain (MDSF)

Policy Unit	Lower Vulnerability									
	Airport		Railway Station		IPPC Sites		Radioactive		Sewage & Water Treatment	
	10% AEP	1% AEP	10% AEP	1% AEP	10% AEP	1% AEP	10% AEP	1% AEP	10% AEP	1% AEP
Abingdon	0	0	0	0	0	0	0	0	0	0
Addlestone Bourne,										
Aylesbury	0	0	1	1	0	0	0	0	0	1
Basingstoke										
Beam	0	0	0	0	0	0	0	0	0	0
Beverley Brook	0	0	0	1	0	0	0	0	0	0
Brent	0	0	0	0	0	0	0	0	0	0
Byfleet and Weybridge	0	0	0	0	0	0	0	0	0	0
Colne	0	0	0	0	0	0	0	0	0	0
Colne tribs & Wye										
Crane	0	0	0	1	0	0	0	0	0	0
Graveney	0	0	0	0	0	0	0	0	0	0
Guildford	0	0	0	0	0	0	0	0	0	0
Hoe Stream										
Hogsmill	0	0	0	0	0	0	0	0	0	0
Ingrebourne	0	0	0	0	0	0	0	0	0	2
Kennet	0	0	0	1	1	1	0	1	0	1
Loddon	0	0	0	1	1	1	0	1	1	1
Lower Lee	0	0	0	2	0	3	0	0	0	1
Lower Lee tribs	0	0	0	0	0	0	0	0	0	0
Lower Mole	0	0	1	1	0	0	0	0	0	0
Lower Roding	0	0	0	1	0	0	0	0	0	0
Lower Thames	0	0	0	2	1	3	0	1	1	1
Luton	0	0	0	0	0	0	0	0	0	0
Middle Lee & Stort	0	0	4	4	0	0	0	0	0	0
Middle Mole										
Middle Roding	0	0	0	0	0	0	0	0	0	0
Ock										
Oxford	0	0	0	0	0	0	0	0	0	0
Pinn										
Ravensbourne	0	0	0	1	0	0	0	2	0	0
Reading	0	0	0	0	0	0	0	0	0	0
Rural Wey	0	0	0	0	0	0	0	0	4	4
Sandford to Cookham	0	0	1	2	0	1	0	0	3	5
Swindon										
Thame	0	0	0	0	0	0	0	0	1	1
Upper & Middle Blackwater										
Upper Lee	0	0	0	0	0	0	0	0	1	1
Upper Mole										
Upper Roding	0	0	0	0	0	0	0	0	0	2
Upper Thames	0	0	1	1	1	1	0	0	3	3
Wandle	0	0	0	0	0	0	0	1	0	0
Windsor & Maidenhead	0	0	0	0	0	0	0	0	1	2
TOTAL	**0**	**0**	**8**	**19**	**4**	**10**	**0**	**6**	**15**	**25**

Table 3.10 Less vulnerable infrastructure within the 10% and 1% AEP fluvial floodplain (MDSF)

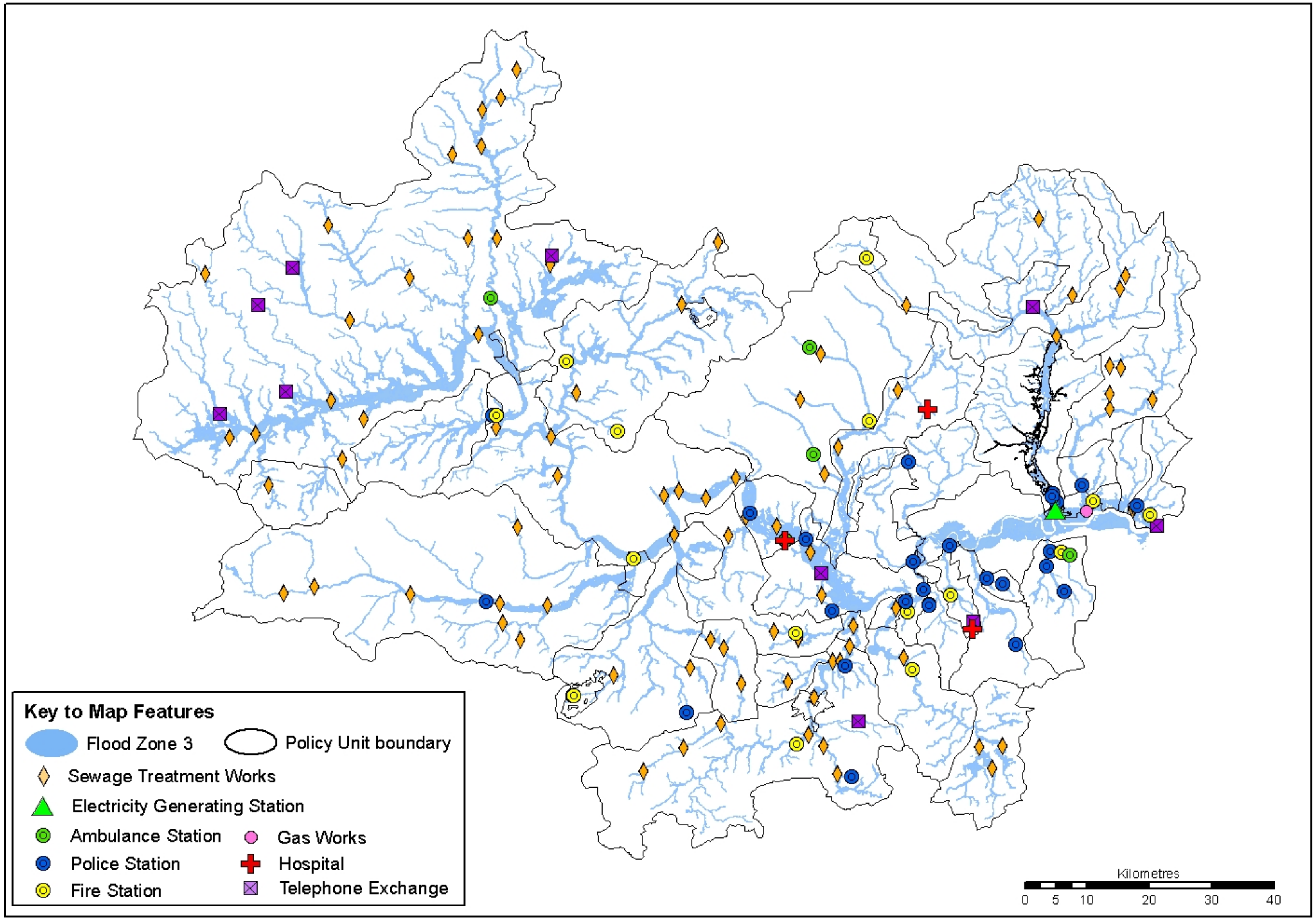


Figure 3.18 Critical infrastructure within fluvial Flood Zone 3 (1% AEP)

- **There are 187,700 properties within the 1% AEP fluvial floodplain in Thames region**
- **There are 283,200 properties at risk from a 0.1% AEP fluvial flood event. This equates to over half a million people.**
- **Total AAD is £390 million, of which 61% comes from commercial properties.**
- **60% of properties at risk from fluvial flooding in the Thames CFMP area are located in the London, Lower Thames, Lower Lee and Lower Lee tributaries policy units.**
- **24% of properties within the 0.1% AEP fluvial floodplain have a flood warning lead time of less than three hours. The majority of these are in London.**
- **88% of properties within the floodplain for a 1% AEP flood event are residential**
- **There are 136,500 people at risk from a 1% AEP fluvial flood and within Enumeration Districts with an SFVI value of 4 or 5. This represents 30% of the total population at risk.**
- **6% of properties that are affected by a 1% AEP fluvial flood are in areas where flooding can exceed 1 metre in depth.**

3.3.4 Risk to the natural environment

The biggest risk to the environment is not using the opportunity provided by CFMPs to integrate flood risk management and environmental enhancement.

We have concluded that when forming future flood risk management policies at a river basin scale, we will best improve the quality of the environment by doing the analysis at a comparable scale. This way we can identify where there may be large-scale opportunities to restore and enhance the floodplain and river environments.

In this section, we will first look at the particular constraints of some designated sites before looking at the bigger risk of not using the CFMPs to balance how we manage flood risk with the needs of the environment. There are very few cases where the constraints have influenced policy at a large scale and these have been identified.

3.3.4.a Designated sites

All of the SPAs and Ramsar sites are at least partially inside the 1% AEP fluvial floodplain. 8 of the 21 SACs may also be affected by a 1% AEP flood event. In some cases, it is only a small proportion of the site that is actually within the floodplain. Approximately 40% of all of the SSSIs in Thames Region lie at least partially within the 1% AEP floodplain.

Table 3.11 identifies the number and area of SPAs, SACs and SSSIs within the 10% and 1% AEP floodplains in each policy unit (where MDSF data is available). In some cases it is only a small percentage of the total area of designated site within each policy unit, whereas in the Lower Lee for example, over 60% of the Lee Valley SPA is within the 1% AEP floodplain.

Policy Unit	SSSIs						SACs						SPAs					
	10% AEP			1% AEP			10% AEP			1% AEP			10% AEP			1% AEP		
	Count	Area	% of total area	Count	Area	% of total area	Count	Area	% of total area	Count	Area	% of total area	Count	Area	% of total area	Count	Area	% of total area
Abingdon	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%
Addlestone Bourne, Emm Brook, The Cut																		
Aylesbury	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%
Basingstoke																		
Beam				0	0	0.00%				0	0	0.00%				0	0	0.00%
Beverley Brook				2	0.37	4.98%				0	0	0.00%				0	0	0.00%
Brent				2	0.022	1.72%				0	0	0.00%				0	0	0.00%
Byfleet and Weybridge	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%
Colne	5	1.547	26.90%	5	2.213	38.49%	0	0	0.00%	0	0	0.00%	1	0.003	0.46%	0	0.014	2.15%
Colne tribs & Wye																		
Crane				0	0	0.00%				0	0	0.00%				0	0	0.00%
Graveney				0	0	0.00%				0	0	0.00%				0	0	0.00%
Guildford	1	0.013	32.50%	1	0.019	47.50%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%
Hoe Stream																		
Hogsmill	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%
Ingrebourne				3	2.766	50.75%				0	0	0.00%				0	0	0.00%
Kennet	5	0.595	1.90%	6	0.886	2.83%	2	0.193	9.37%	2	0.298	14.47%	0	0	0.00%	0	0	0.00%
Loddon	1	0.004	0.02%	1	0.005	0.02%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%
Lower Lee	6	1.577	43.81%	6	2.211	61.42%	0	0	0.00%	0	0	0.00%	1	0.891	40.32%	1	1.336	60.45%
Lower Lee tribs	6	0.003	0.02%	6	0.017	0.09%	1	0.002	0.02%	1	0.012	0.10%	0	0	0.00%	1	0.002	0.11%
Lower Mole	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%
Lower Roding				0	0	0.00%				0	0	0.00%				0	0	0.00%
Lower Thames	7	2.434	8.23%	7	2.662	9.00%	0	0	0.00%	0	0	0.00%	1	1.492	14.40%	1	1.598	15.42%
Luton	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%
Middle Lee & Stort	6	0.692	8.84%	6	1.019	13.01%	0	0	0.00%	0	0	0.00%	1	0.243	31.15%	1	0.491	62.95%
Middle Mole																		
Middle Roding				0	0	0.00%				0	0	0.00%				0	0	0.00%
Ock																		
Oxford	5	0.678	56.97%	5	1.065	89.50%	1	0.374	54.20%	1	0.609	88.26%	0	0	0.00%	0	0	0.00%

Pinn																		
Ravensbourne				0	0	0.00%				0	0	0.00%				0	0	0.00%
Reading	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%
Rural Wey	5	1.038	1.96%	5	1.166	2.20%	1	0.001	0.00%	1	0.001	0.00%	1	0.001	0.00%	1	0.001	0.00%
Sandford to Cookham	7	0.268	2.88%	7	0.299	3.21%	3	0.037	1.59%	3	0.060	2.58%	0	0	0.00%	0	0	0.00%
Swindon																		
Thame	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%
Upper & Middle Blackwater																		
Upper Lee	1	0.017	0.92%	1	0.030	1.63%	0	0	0.00%	0	0	0.00%	1	0.017	42.50%	1	0.030	75.00%
Upper Mole																		
Upper Roding	0	0	0.00%	1	0.174	1.74%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%
Upper Thames	13	2.311	6.82%	13	3.104	9.16%	1	1.161	38.19%	1	1.866	61.38%	0	0	0.00%	0	0	0.00%
Wandle				0	0	0.00%				0	0	0.00%				0	0	0.00%
Windsor & Maidenhead	2	0.027	0.44%	2	0.102	1.66%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%
TOTAL		11.204	2.91%		18.130	4.70%		1.768	1.26%		2.846	2.03%		2.647	2.00%		3.472	2.63%

Table 3.11 The number and area of SSSIs, SACs and SPAs within the 10% and 1% AEP floodplain (MDSF) and the percentage of the total area this represents

All of the SPAs and just over half of all SACs in Thames region are water dependent conservation areas (see Section 2.8 for more detail). We have evaluated those where flood risk management policy could have either a positive or negative impact on the site. We carried out this exercise by referring to Water Level Management Plans and consulting conservation experts. The results of this analysis are in Table 3.12. From this information we have not been able to conclude whether flooding would have a positive or negative effect on each individual site as it would depend on a number of factors such as the time, depth and the duration of the flooding.

As Table 3.12 shows, in some cases, we have been able to determine that regular flooding is beneficial or even essential to the conservation status of the site. For example at Oxford Meadows SAC, the special interest of the site critically depends on groundwater levels and annual flooding. Prolonged spring flooding is important, if not essential, to the survival of the creeping marshwort population, which is known to only exist on one other site in the whole of the UK. Oxford Meadows is also important for flood storage and attenuation. On other sites, changes to the hydrological regime that affect water quality or levels can have a detrimental effect on the wildlife. This issue has been identified at a number of sites including Amwell Quarry (part of the Lee SPA) and the SW London Waterbodies SPA.

We have also made a broad assessment on the desired hydrological management regimes of the water-dependent SSSIs that are within the 1% AEP floodplain in Thames region, depending on their habitat types and in some cases, the presence of certain rare species. Again it is not possible to determine the consequences of flooding at these sites, however we can identify those where more flooding would be beneficial and also where flood risk management activities would not have any impact, for example if the site is fed by groundwater e.g. Weston Fen or is dependent on water quality e.g. Kennet Valley Alderwoods. For many sites, it is the micro-management that is important as each site has very different requirements regardless of the broad habitat type it contains. Information has been gathered using the Views About Management (VAM) documents for each site that are available on the Natural England website. A summary of our assessment is presented in Table 3.13 and further detail can be found in Appendix E.

SPA / SAC	Name	Relevant SSSI WLMP	Policy Unit	Within 10% AEP Floodplain?	Within 1% AEP Floodplain?	Current condition	Favourable condition	Action
SPA	Lee Valley	Rye Meads	Middle Lee and Stort	Yes	Yes	No significant hydrological problems or needs	Achieve winter flooding to minimise or prevent flooding in the bird breeding season	If justified, achieve more regular winter flooding on the meadows
		Amwell Quarry	Middle Lee and Stort	Yes	Yes	Hydrological conditions satisfactory	As per current conditions. Water depth is critical in relation to migratory birds	Maintain current water level regime
		Turnford and Cheshunt Pits	Lower Lee	Yes	Yes	Water level condition is satisfactory	As per current conditions. Water depth is critical in relation to migratory birds	Maintain current water level regime
SPA	South West London Waterbodies	Kempton East (no water level management takes place on any other waterbody)	Lower Thames	Yes	Yes	Favourable condition	As per current conditions	Maintain *status quo* on all waterbodies
SAC	Kennet and Lambourn Floodplain	River Kennet	Kennet	Yes	Yes	Largely currently satisfactory. Concern over low flows, abstraction and siltation	Better control of water levels needed so there is enough water to feed the River Kennet, water meadows and adjacent channels	Maintain flow of the Kennet every year with natural flow variations
		Chiltern Foliat Meadows	Kennet	No data	Yes	Water management is satisfactory	Would be desirable to increase the length of flooding on the water meadows and to allow some areas of damp ground to remain longer	Flood the meadows to the NW of the site from Sept to April (two months longer)

		Thatcham Reedbeds	Kennet	Yes	Yes	Area north of the canal is perceived to be too dry. The condition of the area to the south is generally satisfactory.	Enhance the tall-herb fen. Extend and improve the area of wet reedbed	Excavate new ditches within reedbed area and install sluices to control water levels
		Kennet and Lambourn Floodplain	Kennet	Yes	Yes	Hydrological regime is variable	Some of the grassland areas would benefit from regular flooding	Maintain humid conditions in the vegetation with water at ground level with some areas of standing or slow flowing water
SAC	Kennet Valley Alderwoods	Kennet Valley Alderwoods	Kennet	No data	Yes	Satisfactory	Maintain water levels, including winter flooding	No change to current hydrological regime
SAC	Oxford Meadows	Port Meadow	Upper Thames	Yes	Yes	Unsatisfactory. It is thought that overall changes in plant life are happening and that these are due to drier conditions in summer and winter	More frequent winter flooding and longer spring flooding. Generally wetter conditions to maintain the special interest of the site	Make flooding happen more often and last longer. If this is not possible but de-silting of ditches and hollows is found to be desirable, it may be necessary to install structures to retain winter floods
		Cassington Meadows	Upper Thames	Yes	Yes	Satisfactory	As per current regime of winter flooding and a high summer water table	Maintain existing regime
		Pixey, Oxey and Yarnton Meads	Upper Thames	Yes	Yes	Satisfactory	As per current conditions. Land remains important for flood attenuation and storage	Maintain existing regime
		Wolvercote Meadows	Oxford	Yes	Yes	Satisfactory	As per current conditions. Land remains important for flood attenuation and storage	Maintain existing regime
SAC	North Meadow and Clattinger Farm	North Meadow	Upper Thames	No data	Yes	Satisfactory, although deposition of dredgings has disrupted flooding patterns	Increased winter flooding to maintain the hay meadows	Maintain the varied conditions on site and current maintenance regime
		Clattinger Farm	Upper Thames	No data	Yes	Satisfactory	Few changes are proposed to the hydrological regime	Monitor height of water table. Maintain existing regime

SAC	Shortheath Common	Shortheath Common	Rural Wey	No data	No data	Satisfactory	No artificial disturbance to the hydrological regime	Maintain the high and stable water levels
SAC	Thursley, Ash, Pirbright and Chobham	Thursley, Hankley and Frensham Commons	Rural Wey	No data	No data	Largely satisfactory although concern over low water levels and neglect/lack of appropriate management	Maintain water levels to prevent any negative effects to the wet heath and bog	Review abstraction licences and management regime.

Table 3.12 Hydrological regimes of water dependent internationally designated sites in Thames region

SSSI Name	Policy Unit	Within 10% AEP flood event outline?	Within 1% AEP flood event outline?	Condition	Relevant Feature, Habitat or Species Type	Summary of hydrological management requirements
Aldermaston Gravel Pits	Kennet	Y	Y	100% unfavourable recovering	Artificial waterbodies	Maintain optimum water depths
Alvescot Meadows	Upper Thames	No Data	Y	92% favourable	Neutral grassland	Maintain surface drainage and avoid deepening drainage channels
Amwell Quarry	Middle Lee and Stort	Y	Y	100% favourable	Artificial waterbodies	Maintain water levels
Arncott Bridge Meadows	Upper Thames	No Data	Y	72% unfavourable recovering	Neutral hay meadows	Maintain surface drainage and avoid deepening drainage channels
Ash to Brookwood Heaths	Hoe Stream	No Data	Y	83% unfavourable recovering	Valley mire	Drainage schemes should not intercept the site and water levels should not be raised artificially
Ashford Hill Woods and Meadows	Kennet	No Data	Y	73% unfavourable recovering	Neutral hay meadow and neutral pastures	Maintain surface drainage and avoid deepening drainage channels
					Flush and spring fen	Drainage schemes should not intercept groundwater
Barrow Farm Fen	Ock	No Data	Y	100% unfavourable recovering	Flush and spring fen	Maintain groundwater quality and quantity
Basingstoke Canal	Loddon, Upper and Middle Blackwater, Hoe Stream	No Data	Y	83% unfavourable declining	Canals	Maintain water levels
Bentley Priory	Brent	Y	Y	70% unfavourable recovering	Natural waterbodies	Maintain optimum water depths
					Flushes and Springs	Drainage schemes should not intercept groundwater
Bestmoor	Upper Thames	Y	Y	100% favourable	Neutral hay meadows	Maintain surface drainage and avoid deepening drainage channels
Blackwater Valley	Upper and Middle Blackwater	No Data	Y	72% Favourable	Neutral hay meadow, neutral pasture and marshy grassland	Maintain surface drainage and avoid deepening drainage channels
					Lowland wet woodland	Avoid intervention

Blenheim Park	Upper Thames	No Data	Y	100% favourable	Artificial standing waterbodies	Maintain optimum water depths
Bourley and Long Valley	Loddon	No Data	Y	85% unfavourable recovering	Valley Mire	Drainage schemes should not intercept the site and water levels should not be raised artificially
Boxford Water Meadows	Kennet	No data	Y	100% favourable	Floodplain grazing marsh	Winter flooding is important and avoid the deepening of drainage channels
Brent Reservoir	Brent	No Data	Y	100% favourable	Artificial waterbodies	Maintain optimum water depths
Broadmoor to Bagshot Woods and Heaths	Addlestone Bourne, Emm Brook	No Data	Y	81% unfavourable recovering	Dry and wet lowland heath	Restore natural drainage and maintain water levels
Cassington Meadows	Upper Thames	Y	Y	100% favourable	Neutral hay meadows	Maintain surface drainage and avoid deepening drainage channels
Charleshill	Rural Wey	Y	Y	100% unfavourable no change	Valley Mire	Avoid abstraction of local groundwater and ensure that drainage does not intercept groundwater
Charterhouse to Eashing	Rural Wey	Y	Y	39% favourable	Ditches	Maintain water levels and restore natural drainage
					Floodplain fen	Winter flooding is important at this site
Chilton Foliat Meadows	Kennet	No Data	Y	45% unfavourable recovering	Wet grassland with breeding and wintering bird interest	Partial winter flooding is important, including retaining flood water on the site into the spring. There are many finer aspects of water level and flood management needed at this site.
					Rivers and streams	Maintain natural physical features
					Ditches	Maintain water levels within the ditch systems
Chimney Meadows	Upper Thames	Y	Y	100% favourable	Neutral hay meadows	Maintain surface drainage and avoid deepening drainage channels
Chingford Reservoirs	Lower Lee tributaries	Y	Y	100% unfavourable recovering	Artificial waterbodies	Maintain water levels
Cock Marsh	Sandford to Cookham	Y	Y	100% favourable	Floodplain grazing marsh	Maintain winter flooding and avoid deepening drainage channels
Colony Bog and Bagshot Heath	Addlestone Bourne, Emm Brook	No Data	Y	69% unfavourable declining	Dry and wet lowland heath	Restore natural drainage and maintain water levels
					Valley mire	Drainage schemes should not intercept the site and water levels should not be raised artificially

					Lowland raised bog	Restore a high and stable water table
					Neutral pasture and marshy grassland	Maintain surface drainage and avoid deepening drainage channels
Cornmill Stream and Old River Lea	Lower Lee	Y	Y	100% favourable	Rivers and streams	Maintain the natural processes
Cothill Fen	Ock	No Data	Y	65% favourable	Flush and spring fen	Maintain groundwater quality and quantity
					Swamp	Water quality dependent
Cotswold Water Park	Upper Thames	No Data	Y	51% favourable	Artificial waterbodies	Maintain optimum water depths
Croxley Common Moor	Colne tributaries and Wye	Y	Y	100% unfavourable recovering	Wet grassland	Maintain surface drainage and avoid deepening drainage channels
Decoy Pit, Pools and Woods	Kennet	No Data	Y	52% favourable	Ponds	Avoid abstraction of local groundwater
Denham Lock Wood	Colne	Y	Y	100% favourable	Floodplain fen	Winter flooding is important
Ducklington Mead	Upper Thames	Y	Y	100% favourable	Neutral hay meadow	Maintain surface drainage and avoid deepening drainage channels
Dumsey Meadow	Lower Thames	Y	Y	100% unfavourable recovering	Neutral pasture	Maintain surface drainage and avoid deepening drainage channels
Easton Farm Meadow	Kennet	No Data	Y	100% favourable	Neutral pasture	Maintain surface drainage and avoid deepening drainage channels
Epping Forest	Upper Roding / Lower Lee tributaries	Y	Y	34% unfavourable recovering	Dry and wet lowland heath	Maintain surface drainage and avoid deepening drainage channels
Fernham Meadows	Ock	No Data	Y	87% favourable	Broadleaved, semi-natural woodland with ponds	Avoid abstraction of local groundwater
Fleet Pond	Loddon	No Data	Y	94% unfavourable declining	Ponds	Avoid abstraction of local groundwater
					Dry and wet lowland heath	Maintain water levels and restore natural drainage
Forest Mere	Rural Wey	No Data	Y	100% unfavourable recovering	Natural waterbodies	Maintain optimum water depths

					Wet lowland heath	Maintain water levels and restore natural drainage and avoid the deepening of drainage channels
Fray's Farm Meadows	Colne	Y	Y	100% unfavourable recovering	Wet grassland with breeding and wintering bird interest	Partial winter flooding is important, including retaining flood water on the site into the spring
Freeman's Marsh	Kennet	No Data	Y	100% unfavourable recovering	Neutral pasture	Maintain surface drainage and avoid deepening drainage channels
Frilford Heath, Ponds and Fens	Ock	No Data	Y	92% unfavourable no change	Flush and spring fen	Avoid abstraction of local groundwater
					Ponds	Avoid abstraction of local groundwater
Frogmore Meadows	Colne tributaries and Wye	No Data	Y	100% unfavourable no change	Neutral pasture	Maintain surface drainage and avoid deepening drainage channels
Grafton Lock Meadow	Upper Thames	Y	Y	100% favourable	Neutral hay meadows	Maintain surface drainage and avoid deepening drainage channels
Greywell Fen	Loddon	No Data	Y	46% favourable	Valley Mire	Drainage schemes should not intercept the site and water levels should not be raised artificially
					Neutral Hay Meadow	Maintain surface drainage and avoid deepening drainage channels
Hazeley Heath	Loddon	No Data	Y	97% unfavourable declining	Dry and wet lowland heath	Maintain water levels and restore natural drainage
Hook Meadow and the Trap Grounds	Oxford	Y	Y	68% unfavourable recovering	Neutral grassland	Maintain surface drainage and avoid deepening drainage channels
Horsell Common	Addlestone Bourne, Emm Brook	No Data	Y	61% unfavourable recovering	Heathlands	Restore natural drainage and maintain water levels and avoid deepening drainage channels
Hunsdon Mead	Middle Lee and Stort	Y	Y	78% unfavourable no change	Neutral hay meadows	Maintain surface drainage and avoid deepening drainage channels
Ingrebourne Marshes	Ingrebourne	Y	Y	100% favourable	Neutral pasture and marshy grassland	Maintain surface drainage and avoid deepening drainage channels
					Swamp	Water quality dependent
Inner Thames Marshes	Ingrebourne	Y	Y	72% unfavourable recovering	Wet grassland with breeding and wintering bird interest	Partial winter flooding is important, including retaining flood water on the site into the spring

					Floodplain grazing marsh with breeding and wintering bird interest	A mosaic of unflooded, partially flooded and fully flooded areas needs to be maintained. Deepening of ditches should be avoided. Some areas should be flooded into the spring.
Kennet and Lambourn Floodplain	Kennet	No Data	Y	88% favourable	Floodplain grazing marsh	Maintain winter flooding and avoid deepening drainage channels
Kennet Valley Alderwoods	Kennet	No Data	Y	100% favourable	Lowland wet woodland	Minimum intervention
					Swamp	Water quality dependent
Kingcup Meadows and Oldhouse Wood	Colne tribs and Wye	No Data	Y	48% favourable	Neutral hay meadow, neutral pasture and marshy grassland	Maintain surface drainage and avoid deepening drainage channels
Langham Pond	Lower Thames	Y	Y	63% favourable	Natural waterbodies	Maintain water levels
					Floodplain grazing marsh	Maintain winter flooding and avoid deepening drainage channels
Langley's Lane Meadow	Upper Thames	Y	Y	100% favourable	Neutral hay meadow	Maintain surface drainage and avoid deepening drainage channels
Little Hallingbury Marsh	Middle Lee and Stort	Y	Y	100% unfavourable declining	Floodplain fen	Winter flooding is important to the site
					Swamp	Water quality dependent
Little Tew Meadows	Upper Thames	No Data	Y	100% favourable	Neutral grassland	Maintain surface drainage and avoid deepening drainage channels
Little Wittenham	Sandford to Cookham	Y	Y	100% favourable	Ponds / Great Crested Newt	Avoid abstraction of local groundwater
Long Herdon Meadow	Upper Thames	No Data	Y	100% favourable	Neutral hay meadows	Maintain surface drainage and avoid deepening drainage channels
Mapledurwell Fen	Loddon	No Data	Y	100% unfavourable declining	Floodplain fen	Winter flooding is important
Mid Colne Valley	Colne	Y	Y	55% favourable	Artificial standing waterbodies	Maintain optimum water depths
New Marston Meadows	Upper Thames	Y	Y	100% favourable	Neutral grassland	Maintain surface drainage and avoid deepening drainage channels

North Meadow, Cricklade	Upper Thames	No Data	Y	100% unfavourable recovering	Neutral hay meadows	Maintain surface drainage and avoid deepening drainage channels
Odiham Common with Bagwell Green and Shaw	Loddon	No Data	Y	93% unfavourable recovering	Neutral hay meadow	Maintain surface drainage and avoid deepening drainage channels
					Ponds	Avoid abstraction of local groundwater
Old Rectory Meadows	Colne tributaries and Wye	No Data	Y	83% unfavourable recovering	Neutral pasture	Maintain surface drainage and avoid deepening drainage channels
Otmoor	Upper Thames	No Data	Y	79% unfavourable recovering	Floodplain grazing marsh with breeding and wintering bird interest	A mosaic of unflooded, partially flooded and fully flooded areas needs to be maintained. Deepening of ditches should be avoided. Some areas should be flooded into the spring.
					Hay meadow, neutral pasture and marshy grassland	Maintain surface drainage and avoid deepening drainage channels
					Ditches	Maintain optimum water depths
					Ponds	Avoid abstraction of groundwater
Pamber Forest and Silchester Common	Kennet	Y	Y	89% unfavourable recovering	Dry and wet lowland heath	Maintain water levels
					Neutral hay meadow	Maintain surface drainage and avoid deepening drainage channels
Papercourt	Rural Wey	Y	Y	48% unfavourable recovering	Artificial standing waterbodies	Maintain optimum water depths
					Rivers and streams	Maintain natural processes
					Swamp	Water quality dependent
Pike Corner	Upper Thames	No Data	Y	100% unfavourable recovering	Neutral grassland	Maintain surface drainage and avoid deepening drainage channels
Pixey and Yarnton Meads	Upper Thames	Y	Y	100% favourable	Neutral hay meadows	Maintain surface drainage and avoid deepening drainage channels
Port Meadow with Wolvercote	Upper Thames	Y	Y	99% favourable	Neutral pasture	Deepening of drainage channels should be avoided. Flooding for short periods in the winter when water levels are

Common and Green						high are beneficial
River Kennet	Kennet	Y	Y	100% unfavourable no change	Rivers and streams	Maintain natural physical features
River Lambourn	Kennet	Y	Y	82% unfavourable no change	Rivers and streams	Maintain natural physical features
Roding Valley Meadows	Upper Roding	Y	Y	53% unfavourable no change	Neutral hay meadows	Maintain surface drainage and avoid deepening drainage channels
Rushy Meadows	Upper Thames	N	Y	100% unfavourable recovering	Neutral pasture	Maintain surface drainage and avoid deepening drainage channels
Rye Meads	Middle Lee and Stort	Y	Y	68% favourable	Artificial standing waterbodies	Maintain optimum water depths
					Swamp	Water quality dependent
					Wet grassland with breeding and wintering bird interest	Partial winter flooding is important, including retaining flood water on the site into the spring. There are many finer aspects of water level and flood management needed at this site.
Salmonsbury Meadows	Upper Thames	No Data	Y	100% unfavourable recovering	Neutral grassland	Maintain surface drainage and avoid deepening drainage channels
Sandhurst to Owlsmoor Bogs and Heaths	Upper and Middle Blackwater	No Data	Y	100% unfavourable recovering	Dry and wet lowland heath	Maintain water levels.
					Valley mire	Avoid intercepting surface water and groundwater drainage.
Sarratt Bottom	Colne tributaries and Wye	No Data	Y	100% unfavourable no change	Neutral pasture	Maintain surface drainage and avoid deepening drainage channels
Sawbridgeworth Marsh	Middle Lee and Stort	Y	Y	100% favourable	Floodplain fen	Partial winter flooding is important, including retaining flood water on the site into the spring. There are many finer aspects of water level and flood management needed at this site.
					Swamp	Water quality dependent
Shortheath Common	Rural Wey	No Data	Y	88% unfavourable recovering	Valley mire	Avoid abstraction of local groundwater and ensure that drainage does not intercept groundwater
					Basin fen	Maintain water supply

Spartum Fen	Thame	No Data	Y	100% unfavourable recovering	Flush and spring fen	Groundwater dependent
					Ponds	Groundwater dependent
Staines Moor	Lower Thames	Y	Y	73% favourable	Rivers and streams	Maintain natural processes and flow regime and re-connect the river with the floodplain
					Artificial standing waterbodies	Maintain water levels
					Floodplain grazing marsh	Maintain winter flooding and avoid deepening drainage channels
Stanford End Mill and River Loddon	Loddon	No Data	Y	100% favourable	Rivers and streams	Maintain natural physical features and avoid over-abstraction
					Neutral hay meadow	Maintain surface drainage and avoid deepening drainage channels
Sulham and Tidmarsh Woods and Meadows	Kennet	No Data	Y	100% favourable	Neutral hay meadows	Maintain surface drainage and avoid deepening drainage channels
Syon Park	Crane	Y	Y	85% favourable	Floodplain grazing marsh	Maintain surface drainage and avoid deepening drainage channels
Taynton Quarries	Upper Thames	No Data	Y	76% favourable	Flush and spring fen	Groundwater dependent
Tewinbury	Upper Lee	No Data	Y	100% unfavourable recovering	Artificial standing waterbodies	Maintain optimum water depths
					Swamp	Water quality dependent
Thatcham Reed Beds	Kennet	Y	Y	80% favourable	Desmoulin's Whorl Snail	Maintain damp conditions all year round.
					Reedbed	Need flowing water to the site
					Fen	Maintain a high water table
Thorley Flood Pound	Middle Lee and Stort	Y	Y	100% unfavourable declining	Floodplain fen	Partial winter flooding is important, including retaining flood water on the site into the spring. There are many finer aspects of water level and flood management needed at this site.
					Swamp	Water quality dependent

Thorpe Hay Meadow	Lower Thames	Y	Y	100% unfavourable recovering	Neutral hay meadow	Maintain surface drainage and avoid deepening drainage channels
Thorpe Park No. 1 Gravel Pit	Lower Thames	Y	Y	100% favourable	Artificial waterbodies	Maintain water levels
					Swamp	Water quality dependent
Thursley, Hankley and Frensham Commons	Rural Wey	Y	Y	47% favourable	Dry and Wet Lowland Heath	Maintain water levels and restore natural drainage and avoid the deepening of drainage channels
					Valley Mire	Avoid abstraction of local groundwater and ensure that drainage does not intercept groundwater
					Ditches	Maintain water levels in ditches
					Ponds	Avoid abstraction of groundwater
Tring Reservoirs	Thame	No Data	Y	98% favourable	Artificial standing waterbodies	Maintain water levels
Tuckmill Meadows	Upper Thames	No Data	Y	100% unfavourable recovering	Floodplain fen	Winter flooding is important for the site
					Neutral pasture	Maintain surface drainage and avoid deepening drainage channels
Turnford and Cheshunt Pits	Lower Lee	Y	Y	100% favourable	Artificial waterbodies	Maintain water levels
					Neutral grassland	Maintain surface drainage and avoid deepening drainage channels
Waltham Abbey	Lower Lee	Y	Y	100% unfavourable declining	Heronry	Maintain areas of open water
Walthamstow Marshes	Lower Lee	Y	Y	63% unfavourable recovering	Swamp	Water quality dependent
Walthamstow Reservoirs	Lower Lee	Y	Y	100% unfavourable recovering	Artificial waterbodies	Maintain water levels
Water End Swallow Holes	Colne	No Data	Y	100% favourable	Geological site	Maintain the natural processes
Wendlebury Meads	Upper Thames	No Data	Y	86% favourable	Neutral hay	Maintain surface drainage and avoid deepening drainage

and Mansmoor Closes					meadows	channels
Weston Fen	Upper Thames	No Data	Y	100% favourable	Flush and spring fen	Groundwater dependent
					Swamp	Water quality dependent
Weston Turville Reservoir	Thame	No Data	Y	100% favourable	Artificial waterbodies	Maintain water levels
Whelford Meadow	Upper Thames	No Data	Y		Floodplain fen	Winter flooding is important for the site
Whitmoor Common	Hoe Stream	No Data	Y	69% unfavourable no change	Dry and wet lowland heath	Maintain optimum water depths
					Ponds	Avoid abstraction of local groundwater
Wildmoorway Meadows	Upper Thames	No Data	Y	100% unfavourable declining	Neutral grassland	Maintain surface drainage and avoid deepening drainage channels
Windsor Forest and Great Park	Lower Thames	No	Y	48% favourable	Artificial standing waterbodies	Maintain water levels
Wolvercote Meadows	Oxford	Y	Y	100% favourable	Neutral hay meadows	Maintain surface drainage and avoid deepening drainage channels
Woolhampton Reed Bed	Kennet	No	Y	100% unfavourable recovering	Swamp	Water quality dependent
Woolmer Forest	Rural Wey	No Data	Y	77% unfavourable recovering	Dry and wet lowland heath	Maintain water levels and restore natural drainage
					Valley mire	Avoid abstraction of local groundwater and ensure that drainage does not intercept groundwater
					Natural standing waterbodies	Maintain optimum water depths
					Great Crested Newt	Maintain optimum water levels
Wraysbury and Hythe End Gravel Pits	Lower Thames	Y	Y	85% favourable	Artificial standing waterbodies	Maintain water levels
Wraysbury No. 1 Gravel Pit	Lower Thames	Y	Y	100% unfavourable declining	Artificial waterbodies	Maintain water levels
Wychwood	Upper Thames	No Data	Y	100% unfavourable recovering	Artificial standing waterbodies	Maintain optimum water depths

Wytham Ditches and Flushes	Upper Thames	Y	Y	100% favourable	Flush and spring fen	Groundwater dependent
					Ditches	Maintain optimum water depths in ditches

Table 3.13 Summary of hydrological management requirements for water-dependent SSSIs in Thames region

3.4 Summary of flood risk

Figure 3.19 shows the variation in the 1% AEP damages per policy unit. It uses the projected values so that the results are not biased towards where there is a greater MDSF coverage. The highest damages (over £200 million) are in the south London policy units, the Crane, Colne, Lower Lee, Lower Thames and Reading. This also reflects where the greatest concentrations of people, properties and infrastructure are at risk (see Table 3.14).

Table 3.14 summarises the level of social, economic and environmental assets at risk for the 1% AEP flood event (based on MDSF data).

The policy unit with the greatest area of SSSIs within the 1% AEP floodplain is the Upper Thames followed by the Ingrebourne and the Lower Thames. The majority of the sites in the Upper Thames are neutral hay meadows where it is important to maintain the surface drainage. There are also a number of sites where winter flooding is an important factor in the management of the floodplain fen habitats, for example Tuckmill Meadows and Whelford Meadow. The Upper Thames also has the greatest area of SACs in the 1% AEP floodplain (Oxford Meadows and North Meadow and Clattinger Farm). Both of these sites have areas that would benefit from an increase in winter flooding. The Lower Thames (SW London Waterbodies) and Lower Lee (Lower Lee Valley) policy units have the greatest area of SPAs in the 1% AEP floodplain. The current hydrological regime of these sites is generally favourable so they may be impacted by an increase or decrease in water levels.

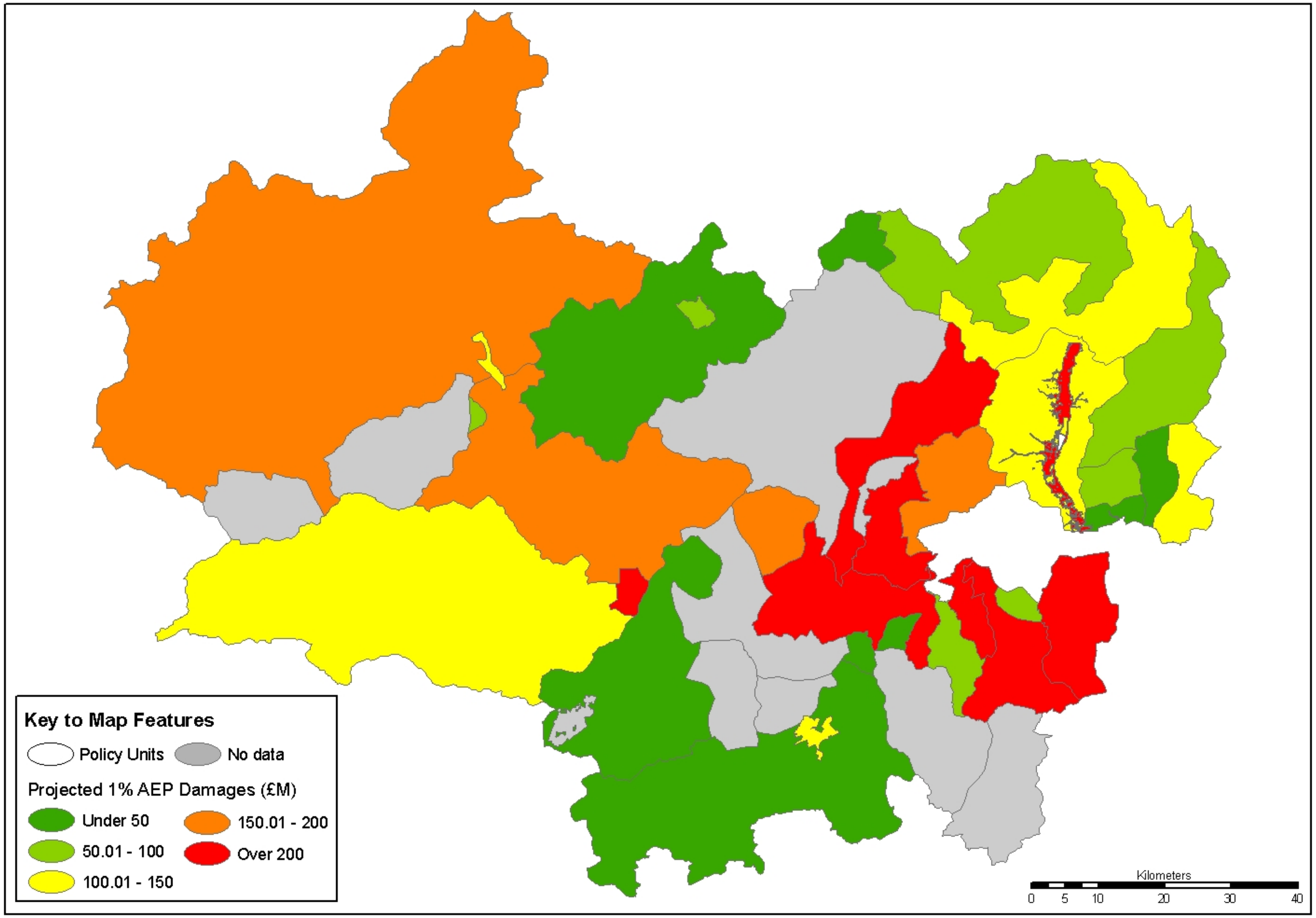


Figure 3.19 Projected 1% AEP damages per policy unit

Policy Unit	Social		Economic				Environment		
	No. of People	% with SFVI of 4 or 5	No. of Properties	Damages (£M)	Vulnerable Infrastructure		Area of Designated Sites (km2)		
					High	Lower	SSSI	SAC	SPA
Abingdon	4100	58.1%	1822	65.55	7	0	0	0	0
Addlestone Bourne, Emm Brook, The Cut									
Aylesbury	4543	52.3%	2019	52.76	3	2	0	0	0
Basingstoke									
Beam	947	29.0%	421	6.80	1	0	0	0	0
Beverley Brook	13066	7.4%	5087	185.22	27	1	0.37	0	0
Brent	6003	38.6%	2668	96.76	8	0	0.022	0	0
Byfleet and Weybridge	1895	12.9%	842	35.29	3	0	0	0	0
Colne	15505	23.3%	6891	415.50	21	0	2.213	0	0.014
Colne tribs & Wye									
Crane	17231	16.5%	7658	205.63	10	1	0	0	0
Graveney	8773	30.7%	3899	84.11	5	0	0	0	0
Guildford	1859	33.9%	826	107.23	2	0	0.019	0	0
Hoe Stream									
Hogsmill	2560	16.4%	1138	29.73	2	0	0	0	0
Ingrebourne	2464	54.8%	1095	108.23	5	2	2.766	0	0
Kennet	5884	31.7%	2615	102.80	10	4	0.886	0.298	0
Loddon	1010	14.7%	449	14.32	3	4	0.005	0	0
Lower Lee	48353	58.7%	21490	841.58	56	6	2.211	0	1.336
Lower Lee tribs	12224	52.3%	5433	122.17	16	0	0.017	0.012	0.002
Lower Mole	1051	0.0%	467	11.09	2	1	0	0	0
Lower Roding	835	29.6%	371	18.47	4	1	0	0	0
Lower Thames	60453	14.4%	26868	1049.75	69	7	2.662	0	1.598
Luton	1710	73.0%	760	1.51	0	0	0	0	0
Middle Lee & Stort	4979	14.1%	2213	91.59	3	4	1.019	0	0.491
Middle Mole									
Middle Roding	5441	84.3%	2418	61.87	12	0	0	0	0
Ock									
Oxford	12224	68.9%	5433	124.80	10	0	1.065	0.609	0
Pinn									
Ravensbourne	14794	33.4%	6575	194.14	21	3	0	0	0
Reading	11012	19.1%	4894	235.96	3	0	0	0	0
Rural Wey	1343	9.4%	597	27.41	3	4	1.166	0.001	0.001

Sandford to Cookham	11606	32.5%	5158	174.05	9	8	0.299	0.060	0
Swindon									
Thame	245	45.9%	109	3.95	0	1	0	0	0
Upper & Middle Blackwater									
Upper Lee	1136	34.7%	505	34.39	2	1	0.030	0	0.030
Upper Mole									
Upper Roding	3665	34.3%	1629	48.45	1	2	0.174	0	0
Upper Thames	8404	34.7%	3735	137.30	9	5	3.104	1.866	0
Wandle	13984	29.3%	6215	423.74	17	1	0	0	0
Windsor & Maidenhead	18023	15.9%	8010	122.63	12	2	0.102	0	0
TOTAL	317318	32.6%	140310	5234.78	356	60	18.13	2.846	3.472

Table 3.14 Summary of flood risk for the 1% AEP event (using MDSF data)

3.5 Existing flood risk management

3.5.1 Introduction

The Land Drainage Act of 1930 marked a major milestone in the management of the Thames and Lee catchments. This Act made the Thames Conservancy and the Lee Conservancy responsible for managing land drainage and watercourses.

Through the 1930s and in the decades following the Second World War, the focus was on improving land drainage to improve agricultural production. In the Wey catchment, for example, a land improvement scheme was introduced in the 1930s. This involved creating flood channels, control structures and straightening and widening the river channel to reduce winter flooding to agricultural land and generally improve drainage. This type of management was typical across the rural parts of the Thames and Lee catchments throughout this period.

The 1947 floods were the catalyst for major work on the Thames and Lee Rivers. The Lee Flood Relief Scheme was constructed to protect against a repeat of the 1947 flood. Widening of the river and construction of a relief channel was completed in 1960, with further expansion of the scheme taking place in the 1970s to cater for development in the Lower Lee catchment. On the River Thames, strategic dredging was started in 1948 to lower the bed of the river between Reading and Teddington by 300mm and modifications were made to the weirs to increase their capacity. These improvements on the Thames do not provide protection against a repeat of the 1947 flood, but they do reduce the impact of small-scale floods. Unlike in other parts of England and Wales, there are very few embankments that provide protection against fluvial flooding. Widening and deepening to increase the capacity of the river channels has been the favoured approach. The drift geology of the Thames, characterised in many areas by gravel, makes the construction of embankments impractical.

Attention gradually shifted to managing flooding in urban areas. Throughout the 1950s, 60s and 70s the emphasis was on providing flood protection in urban areas by straightening and canalising urban watercourses to improve the conveyance of water.

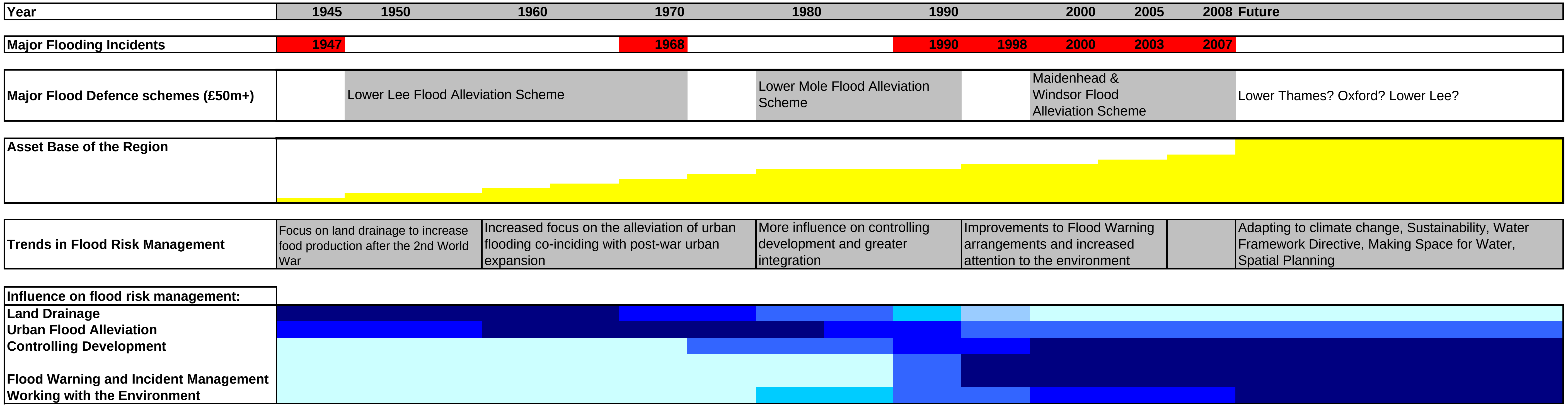
In 1974 the Thames Conservancy, Lee Conservancy and part of the Essex River Authority became the Thames Water Authority, which, in 1986, also took on responsibility for land drainage and flood defence from the Greater London Council. This marked the end of the Local Flood Defence committees and a move to a single Thames Flood Defence Committee. This has continued, as responsibilities passed to the National Rivers Authority in 1989, and then to the Environment Agency in 1996. Bringing the management of flood defence under one organisation and committee has gradually led to a more joined up approach and a wider range of activities, such as a greater emphasis on development control and flood warning.

A chronology of flood risk management in Thames region is provided in Figure 3.20. It shows when major flood defence schemes were implemented in relation to large flood events, how the asset base of the region has grown over time and what the influences on flood risk management have been since 1945.

Examples of major flood defence schemes that have been completed in Thames region include the River Mole scheme in Surrey that was constructed following the major floods in 1968; the Lower Colne Scheme to the West of London and the Maidenhead, Windsor and Eton Flood Alleviation Scheme (MWEFAS) on the River Thames.

Recently there has been a strong move towards managing flood risk in ways that are sensitive to the environment. Through all of our flood risk management work, we aim to protect and enhance the environment by complying with European legislation, habitats directives and by applying environmental impact assessment where appropriate.

Figure 3.20 Chronology of flood risk management in Thames Region



The diagram shows the chronology of the major features of flood risk management in Thames Region since the Second World War. In setting policy for future flood risk management we can draw the following lessons;

Flooding occurs regularly, very major flooding occurs on average once a decade.

Very major flood alleviation schemes have, in part, been progressed following major flood events.

The wider trends that have driven our approach to flood risk management change quite rapidly.

The scope of the business has broadened.

The flood defence asset base within the region has expanded.

Looking to the future, the lessons include;

The frequency and severity of flooding is likely to increase.

We are developing plans, which may lead to three or four very major fluvial flood defence schemes being progressed (over £100m of investment each). We have never carried out this scale of work simultaneously. It may take several decades to complete this work if the plans prove to be viable.

In the future, the business of flood risk management is likely to become more complex.

We are creating far more assets than we are decommissioning and our maintenance requirement is therefore increasing.

Degree of influence on flood risk management

- Very strong influence
- Strong influence
- Moderate influence
- Small influence
- Little or no influence

3.5.2 Flood Mapping and Data Management

As well as capital and operational work, activities that aim to prevent inappropriate development in the floodplain and the provision of flood warnings, we also work with our professional partners and the public to support all of these activities. This includes mapping the floodplain, monitoring the hydrology of the catchment, direct consenting of works on main rivers, enforcement, survey and increasingly taking a strategic view on how we manage flood risk in the future through Catchment Flood Management Plans.

Environment Agency staff manage work to update and improve the available flood maps and outlines such as the flood zones, which are used by many stakeholders and other interested parties for a variety of purposes. Our main flood mapping output is the Flood Map of England and Wales, which replaces the Indicative Flood Plain Map (IFM). It shows the extent of flooding resulting from a 1% fluvial and 0.5% tidal event (Flood Zone 3). The extreme flood outline is also published for a 0.1% fluvial and tidal event (Flood Zone 2). The Flood Map displays flood defences and the areas that benefit from them. Detailed flood mapping is undertaken under Section 105 of the Water Resources Act, for areas known to be prone to flooding.

We maintain and continually update our National Flood and Coastal Defence Database (NFCDD). This database is a single and easily accessible source of all data relating to flood and coastal defences. We have used the existing NFCDD database, previous reports and local knowledge to extract information on existing flood defence assets in the Thames CFMP area and the standard of protection they provide.

3.5.3 Development Control

Since the 1980s, preventing further inappropriate development in the floodplain has been a central part of managing flood risk. The Town and Country Planning Act of 1990 meant specific policies relating to flood defence could be included in county structure plans and district wide, local plans. We now seek to influence development at a strategic level through regional assemblies and regional Government, and, at a local level, through local planning authorities. Since October 2006 we have been a statutory consultee on matters relating to most development in Flood Zones 2 and 3; major development in Flood Zone 1; development within 20 metres of main rivers and all proposals involving culverting or controlling the flow of any river or stream

Planning Policy Statement 25: Development and Flood Risk (PPS25) was published in December 2006 and puts a greater emphasis on reducing flood risk by considering consequences, flood resilience and resistance and closer liaison with flood risk management planning and emergency planning. PPS25 is based on avoiding flood risk by using plans to locate development in lower risk locations first, and the new Flood Direction also allows Government to call-in major applications where local planning authorities were minded to over-rule Environment Agency advice.

It is essential that the policies developed through the CFMP feed into and support the development of the Regional Spatial Strategy and Local Development Frameworks to make sure that decisions in these plans are sustainable in terms of flood risk and other environmental criteria.

3.5.4 Flood Defence Asset Management

Today, we invest approximately £75 million every year in managing flood risk in Thames region. £30 million is invested in capital work; this includes creating new flood defence schemes, replacing and maintaining existing defences and meeting health and safety obligations at our sites.

Most of the operational work we do in the region involves routine (e.g. bank clearance, in-channel work to remove weed growth and silt) and non-routine (e.g. removal of blockages) maintenance of watercourses, along with inspection and routine maintenance of defences and structures. Some of the work on the River Thames overlaps with our navigation responsibilities, to maintain levels on the Thames by operating and maintaining locks and weirs on the river. Table 3.15 details the type and purpose of the maintenance work that is carried out in each policy unit and what standard of protection this work provides.

Policy Unit	Approximate Total Expenditure (£k)	Purpose of Maintenance	Approximate Standards of Protection (SoP) that apply
Abingdon	45	£45k on maintenance to reduce the probability of flooding from flow order flood events (up to a 10% to 5% AEP flood). Flooding in Abingdon on the minor tributaries (River Stert and Radley Park Ditch) can occur from point sources (for example blockages at pinch points). On the Ock the maintenance is aimed at maintaining the capacity of the natural channel in the absence of any major flood defences in Abingdon	5% to 2% AEP on the River Ock Approximately 3% to 1% AEP on the River Stert and Larkhill Stream
Addlestone Bourne, Emm Brook, The Cut	252	Removal of blockages and obstructions (e.g. from trash screens) and the maintenance of channel conveyance.	In Wokingham, approximately 2% AEP, elsewhere 5% to 3% AEP.
Aylesbury	236	To maintain the Aylesbury FSA and the conveyance of the channels through the town	1% AEP
Basingstoke	11	Maintaining channel conveyance through Basingstoke through the removal of debris at pinch points.	4% to 2% AEP
Beam	200	To maintain channel conveyance and to maintain numerous structures in the policy unit. Removal of blockages that can cause flooding.	Typically 2% AEP.
Beverley Brook	193	Maintaining conveyance through the dense urban areas.	Typically 5% to 2% AEP
Brent	683	To maintain channel conveyance and to maintain numerous structures in the policy unit. Removal of blockages that can cause flooding.	There is a wide range of standards of protection in the Brent catchment. For most areas it is in the range 5% to 2% AEP, but locally it is 1% AEP.
Byfleet and Weybridge	18	Maintain the capacity of the River Wey channel.	Approximately 10% AEP.
Colne	1099	Maintenance of the Lower Colne defences and maintenance of channel conveyance elsewhere in the policy unit.	Parts of the Lower Colne are protected to a 1% AEP standard. Elsewhere, the standard of protection is in the range 10% to 2% AEP.
Colne tributaries and Wye	615	Maintaining channel conveyance	10% to 2% AEP is typical through the urban areas.
Crane	320	Maintaining existing defences; for example Hayes FSA. Maintenance of channel conveyance.	2% to 1% AEP.
Graveney	75	Maintaining conveyance, including the removal of obstructions and blockages.	Typically 2% AEP
Guildford	47	Maintain the capacity of the channel and maintenance	Approximately 10% to 5% AEP.

		to existing river control structures.	
Hoe Stream	47	Maintenance of channel conveyance.	10% AEP.
Hogsmill	114	Maintenance of channel conveyance.	5% to 2% AEP
Ingrebourne	580	Maintenance of existing defences and maintaining conveyance in urban locations	Typically 5% to 2% AEP
Kennet	311	Maintain conveyance in urban areas and the control of water levels, particularly at designated sites.	10% AEP is typical. Slightly higher standard (5% AEP) in the larger urban areas such as Newbury.
Loddon	299	Maintain the capacity of the river channel in urban areas.	50% AEP for much of the natural floodplain, 10% to 4% AEP in urban locations.
Lower Lee	952	Maintenance of the Lower Lee defences	2% AEP. In some areas 4-3% AEP.
Lower Lee tributaries	361	To maintain channel conveyance.	Highly variable. Typically in the range 5% to 2% AEP based on previous channel improvements.
Lower Mole	254	Maintenance of the Lower Mole defences.	0.5% AEP
Lower and Middle Roding	537	Maintenance of existing defences in the Lower Roding. It is estimated that the existing defences have a residual life of about 20 years.	3% to 2% AEP. Locally 1% AEP.
Lower Thames	406	Maintenance of the locks and weirs.	10% to 5% AEP
Luton	176	To maintain conveyance through Luton. This includes the removal of blockages and obstructions.	Typically, 2% AEP through the centre of Luton. Locally, 10% to 2% AEP in residential areas affected by both fluvial and surface water flooding.
Middle Lee and Stort	663	Maintenance of the capacity of the channel and assets in the lower reaches of the policy unit.	Quite a wide range in existing standards of protection. On the natural floodplain, flooding occurs regularly (50% AEP is typical). In urban areas, previous channel improvements result in a 10% AEP to 2% AEP being typical.
Middle Mole	162	To maintain the capacity of the channel to convey water through the towns and villages.	Typically 5% to 2% AEP in urban locations and 10% AEP in areas of natural floodplain.
Ock	41	Maintaining channel capacity in Wantage, Grove and Steventon.	Within the villages the standard of protection is typically 10% to 5% AEP. Locally this is less, particularly where there are restrictions to flow associated with mills and other structures.
Oxford	300	Maintain the current levels of conveyance through the city, particularly on the smaller watercourses (for example, the Seacourt Stream, Castle Mill Stream and Wolvercote Stream).	Approximately 300 properties are vulnerable to low order fluvial flooding (20% AEP) which has occurred three times since 2000.
Pinn	233	Maintenance of existing defences and maintaining conveyance in urban areas.	2% AEP.

Ravensbourne	607	To maintain channel conveyance and to maintain numerous structures in the policy unit. Removal of blockages that can cause flooding.	Typically 5% AEP, locally up to 1% AEP.
Reading	110	To maintain conveyance, particularly on the Kennet and Foudry Brook through Reading.	Typically 20% to 5% AEP on both the Thames and Kennet. Low lying properties, particularly in Caversham are vulnerable to frequent flooding. Along the Kennet through Reading redevelopment has improved the standard of protection to 1% AEP.
Rural Wey	749	Maintaining channel conveyance	20% AEP for most natural floodplain. 10% AEP to 2% AEP in urban locations.
Sandford to Cookham	1160	The vast majority of maintenance expenditure in this policy unit (approximately £930k per annum) is spent on maintaining the Thames locks and weirs.	Typically, 50% to 20% AEP on the natural floodplain and 10% to 2% AEP in urban locations.
Swindon	310	Removal of blockages and obstructions (e.g. from trash screens) and the maintenance of channel conveyance.	Typically 5% to 3% AEP
Thame	100	To maintain conveyance through small towns and villages: Chalgrove, Aston Turville and Wendover	The Thame is a relatively flat, clay catchment. The River Thame spills out of banks frequently in the winter after heavy rainfall. Through the towns and small villages maintenance and previous channel improvements result in a 10% to 4% AEP being typical.
Upper and Middle Blackwater	243	Maintenance of channel conveyance.	Generally a 5% AEP standard. In some localities there is a higher standard; for example in the Cove Brook.
Upper Lee	317	Maintain conveyance in urban areas.	Typically 20% to 4% AEP.
Upper Mole	246	Maintenance of conveyance in urban areas and the removal of blockages and obstructions to flow.	Highly variable. Typically 5% to 3% AEP.
Upper Roding	426	To maintain existing flood storage areas and maintain conveyance in urban areas.	Quite a wide range in existing standards of protection. On the natural floodplain, flooding occurs regularly (50% AEP is typical). In urban areas, previous channel improvements result in a 10% AEP to 2% AEP being typical.
Upper Thames	1100	There are very few major defences in the Upper Thames and maintenance is aimed at maintaining the capacity of the natural channel to convey flow to reduce the risk of low order flooding (up to 5 to 10%	Natural floodplain: 100% to 20% AEP Market towns and villages such as Witney and Standlake: 10% to 2% AEP Kidlington: 1% AEP

		AEP). Maintenance expenditure per length of watercourse is low in the Upper Thames, whilst expenditure per property at risk is above average for the region. This can be expected in the Upper Thames where there are relatively few flood defences and a greater dependence upon watercourse maintenance to manage the probability of flooding. A typical system in the Upper Thames is the Radcot Cut system, classified as medium risk and covering the villages of Clanfield, Brize Norton and Bampton. Here the maintenance regime comprises an annual clearance in the Autumn (weed cutting, bank clearance and the removal of woody obstructions) through the villages. Occasionally localised de-silting takes place. In general the capacity of the watercourses through these villages is limited by the capacity of structures (mainly bridges) to convey flow so increasing channel capacity beyond the capacity of the structures would have no impact. No maintenance is carried out outside of the villages. On the whole, the distribution of maintenance is proportional to risk within the Upper Thames policy unit. The 35km of agricultural defences in the Upper Thames will not be maintained by the Environment Agency (reflecting current practice).	
Wandle	239	Maintain conveyance in urban areas.	Typically 5% to 2% AEP
Windsor & Maidenhead	525	Maintenance of the Jubilee River and the associated structures.	5% to 2% AEP.

Table 3.15 Details of the maintenance work carried out in each policy unit in Thames region

The annual maintenance expenditure per length of main river in each policy unit is shown in Figure 3.21. The average annual maintenance expenditure per property in each policy unit is shown in Figure 3.22. No tidal properties were included in this analysis and as a result, the level of expenditure per property in the tributaries that discharge into the Thames Estuary (e.g. Lower Roding, Beam and Ingrebourne) are higher than might be expected.

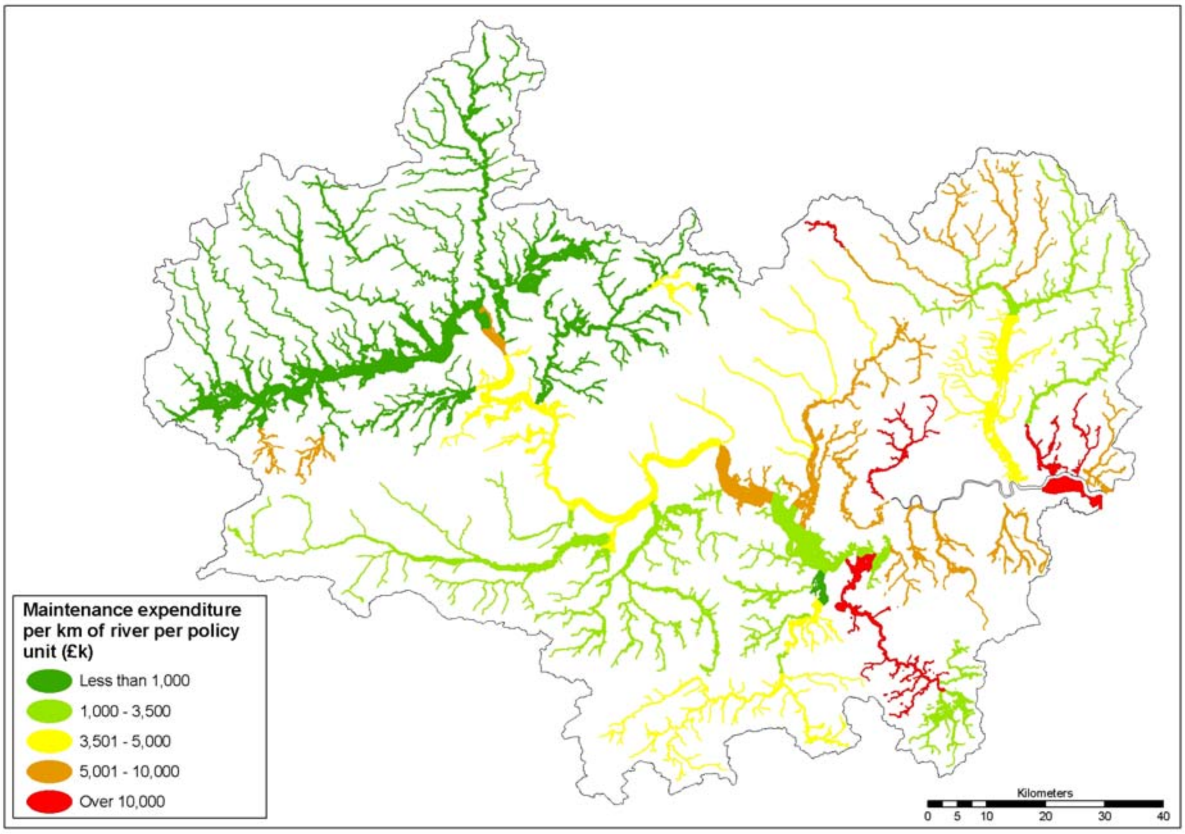


Figure 3.21 Annual maintenance expenditure per length of main river in each policy unit

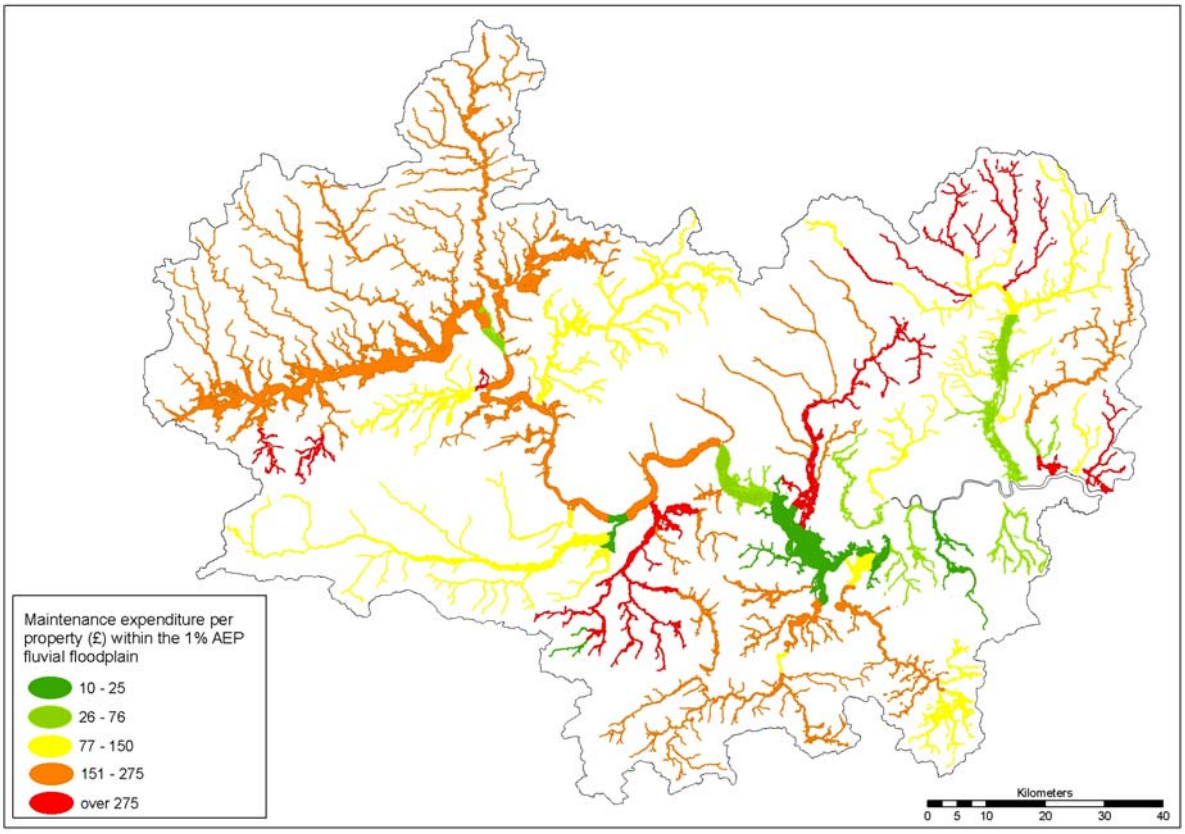


Figure 3.22 Annual average maintenance costs per property at risk in each policy unit

Over the last twenty years, the priority for maintenance has shifted from land drainage to reducing the risk in mainly urban areas. At the current time we do not have the data to be able to quantify the impact of this maintenance work in terms of the number of properties protected. However, maintenance is prioritised according to the level of flood risk and how effective the maintenance is judged to be at reducing that risk.

The location of flood defence assets in Thames region is shown in figures 3.23 to 3.26. The maps were produced using data extracted from NFCDD. The length and type of defences varies between policy units. The totals are shown in shown in Table 3.16.

The policy units with the longest lengths of culverts are all within London. The only exception is the Upper Mole. The high total is due to the presence of a large urban area (Crawley) and a long length of culvert that carries the River Mole underneath a runway at Gatwick Airport. The Lower Lee, Windsor and Maidenhead and Aylesbury all have long lengths of man-made raised defences associated with major flood alleviation schemes.

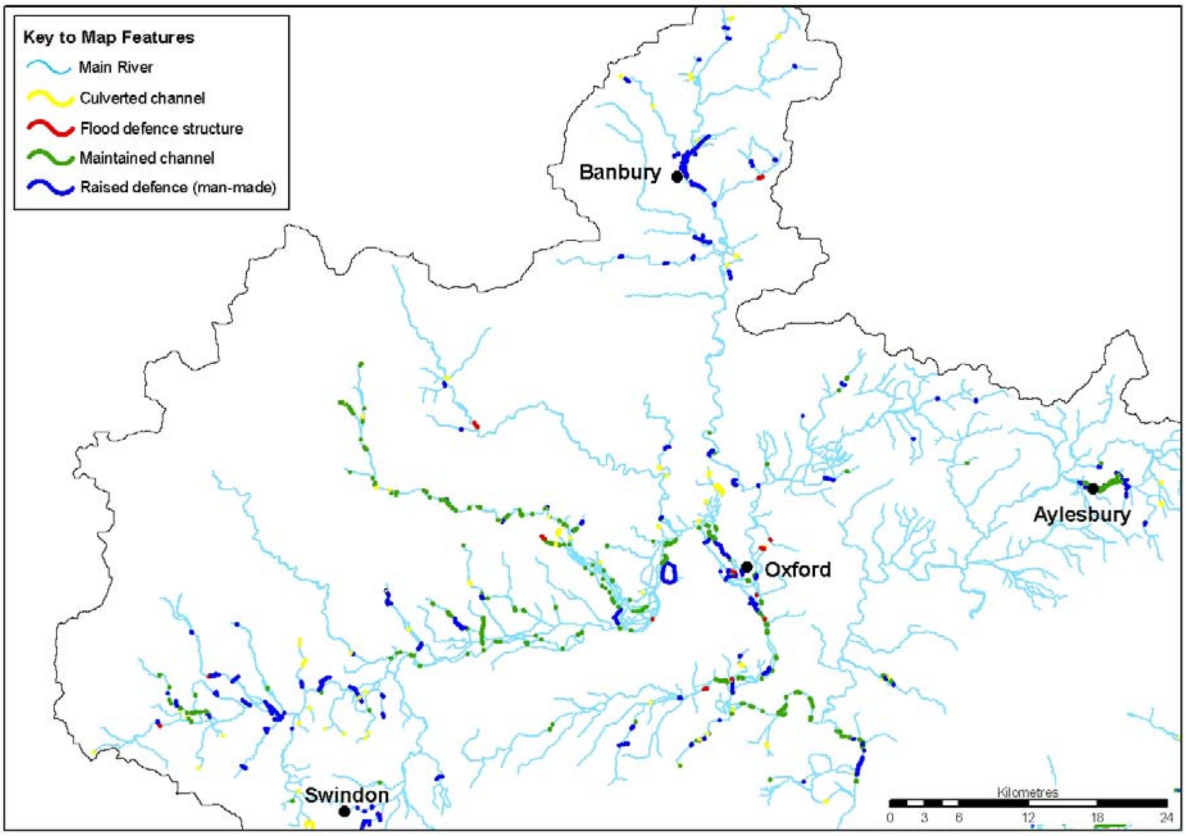


Figure 3.23 Location of flood defence assets in the upper Thames including the Ock and Thame

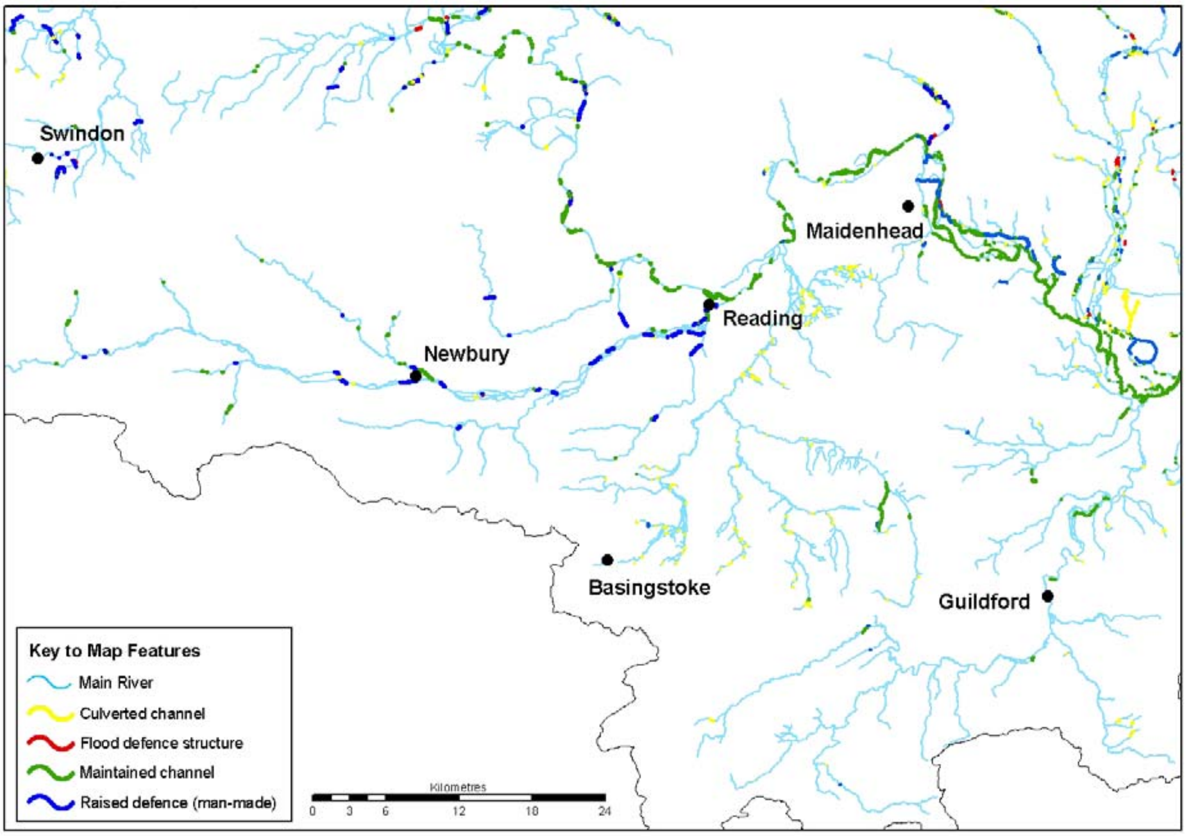


Figure 3.24 Location of flood defence assets in the middle Thames, Kennet, Loddon, Wey and Colne

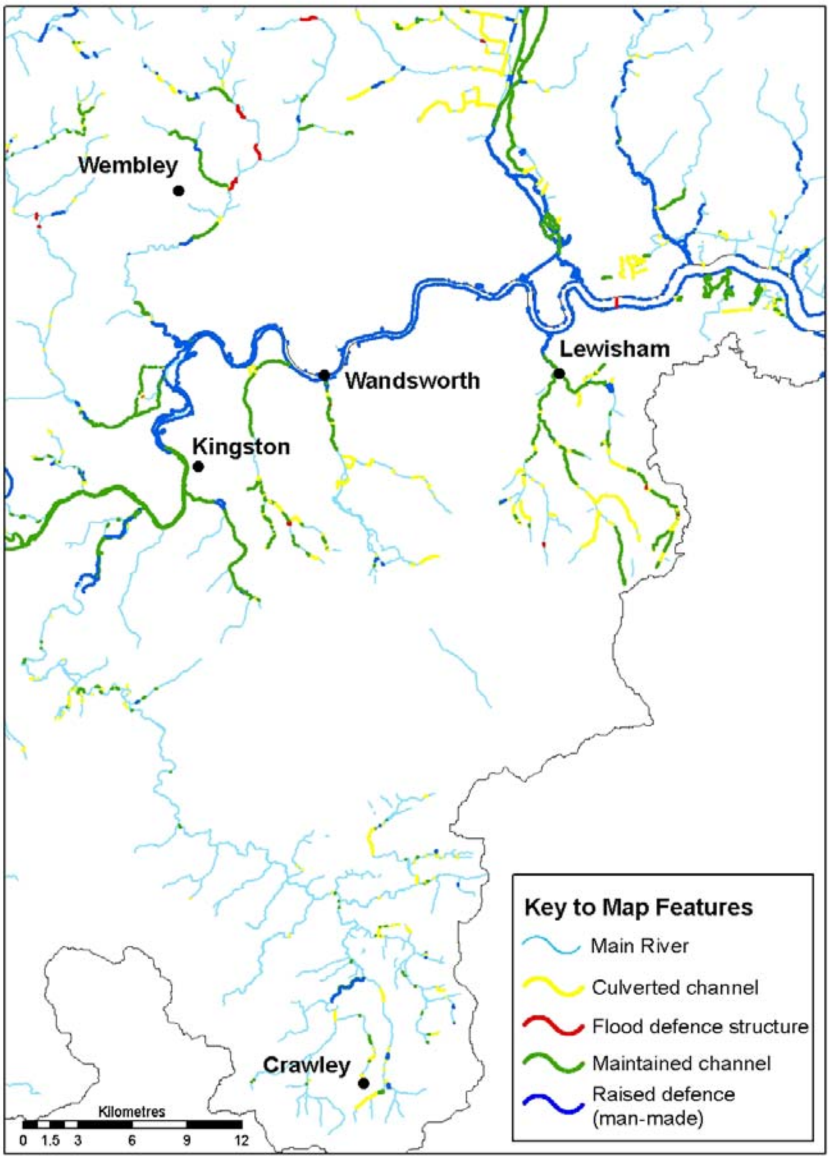


Figure 3.25 Location of flood defence assets on the Mole and the London rivers

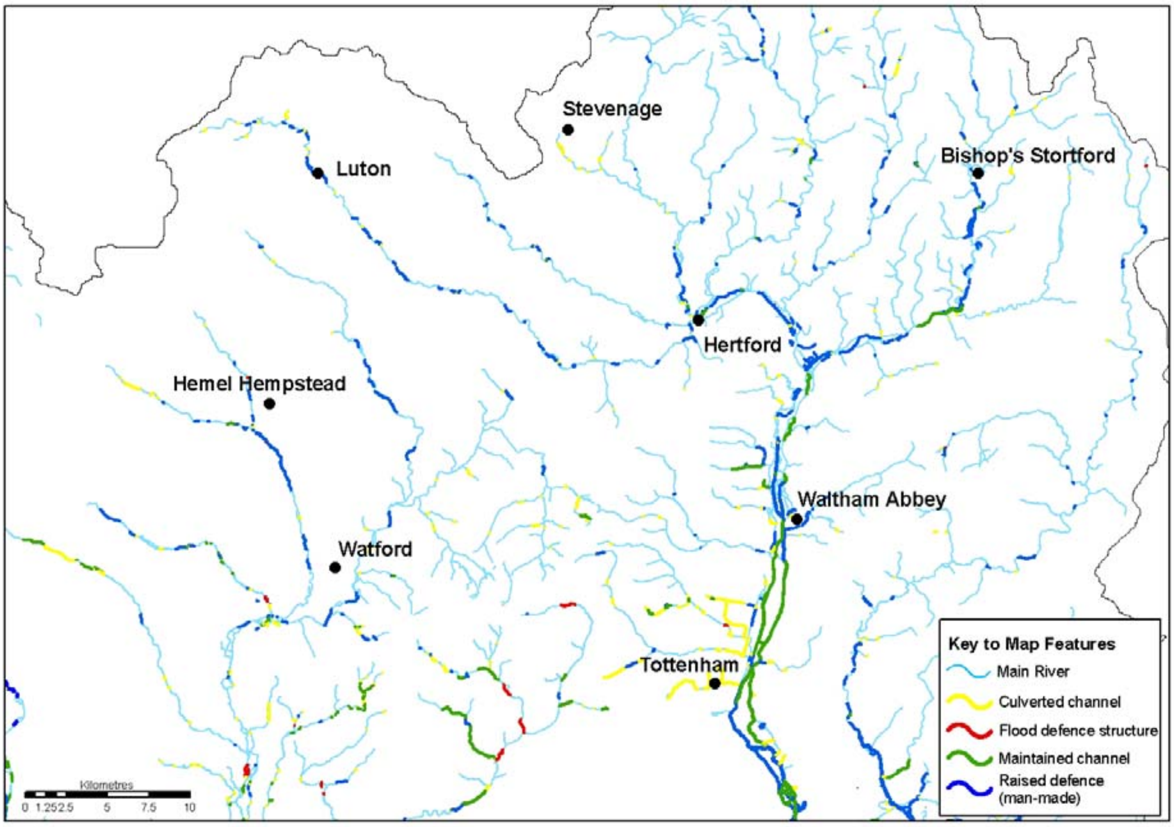


Figure 3.26 Location of flood defence assets in the Lee catchment including the upper Colne and Roding

Policy Unit	Length of Defence – Left and Right Bank Total (Km)						
	Culverted Channel	Flood Defence Structure	Flood Storage Area	Maintained Channel	Raised Defence (man-made)	Raised Defence (natural)	Total
Abingdon		0.33		0.49	0.07		0.89
Addlestone Bourne, Emm Brook, The Cut	0.16			0.83	0.77	0.07	1.84
Aylesbury	0.26			11.16	2.78		14.20
Basingstoke	0.22				0.19		0.40
Beam	0.09		1.55		3.72		5.36
Beverley Brook	3.45	0.55		19.73			23.73
Brent	1.66	4.46		21.14	5.22		32.48
Colne	2.91	1.36		3.87	8.80	0.41	17.35
Colne tribs and Wye	5.26	0.80		4.07	20.92	0.66	31.72
Crane	0.30	0.32		12.97	3.29		16.89
Graveney	1.50						1.50
Guildford	0.05			0.88			0.92
Hoe Stream				0.05			0.05
Hogsmill				15.01	1.01		16.43
Ingrebourne	0.33		0.74	0.11	1.55		2.73
Kennet	0.17	0.00	0.17	3.05	11.81	0.23	15.44
Loddon	4.77			0.72			5.50
Lower Lee	15.31	0.16	0.08	87.04	56.07	0.79	159.46
Lower Lee tribs	1.49			0.31	1.73	0.18	3.71
Lower Mole	0.07			11.37	8.33		19.77
Lower Roding	0.49		0.19	0.24	4.73	1.22	6.88
Lower Thames	1.77	0.13		92.18	7.20		101.28
Luton	1.39				5.78		7.17
Marsh Dykes	4.54			16.46	1.28		22.28
Middle and Upper Blackwater	0.02			9.89	0.33		10.23
Middle Lee and Stort	1.49	0.02		9.55	43.09	0.68	54.82
Middle Mole	0.65			2.28	0.10	0.10	3.12
Middle Roding	0.08			3.21	10.12		13.41
Ock				0.04	0.40		0.44
Oxford		0.38		0.94	2.99		4.31
Pinn	1.03	0.02	0.17	3.10	0.18		4.50

Ravensbourne	14.75	0.66		42.61	2.47	0.61	61.17
Reading	0.62			7.06	4.09		11.78
Rural Wey	0.62			7.49	0.25		8.35
Sandford to Cookham	1.14	0.01		40.43	7.02		48.60
Swindon	0.39	0.07		0.16	2.19		2.81
Thame	0.11			0.90	0.38		1.39
Upper Lee	2.83			0.75	17.31		20.89
Upper Mole	5.41			3.99	3.60		12.99
Upper Roding	0.45	0.09			7.31		7.85
Upper Thames	1.93	0.57		11.54	35.70	2.67	52.41
Wandle	1.73	0.40		6.07	0.37		8.56
Weybridge and Byfleet	0.10			2.85			2.95
Windsor and Maidenhead	0.58	0.18		61.08	14.06		75.89
Total	**80.13**	**10.50**	**2.90**	**515.63**	**297.19**	**7.62**	**914.45**

Table 3.16 Length and type of defence assets per policy unit (data taken from NFCDD)

Not all of these defences are maintained by the Environment Agency and a large proportion of the raised defences shown on the maps do not actually function as a flood defence. A large percentage are also maintained by private landowners and Local Authorities. The number of third party assets in each policy unit and their replacement cost is shown in Table 3.17 (this information has been collated using NFCDD).

Policy Unit	Number of Third Party Assets	Estimated Total Replacement Cost (£)
Abingdon	8	3,810,000
Addlestone Bourne, Emm Brook	106	8,536,000
Aylesbury	6	1,570,000
Basingstoke	21	4,725,000
Beam	75	9,268,500
Beverley Brook	23	11,963,200
Brent	162	17,288,000
Byfleet & Weybridge	20	2,695,000
Colne	412	53,687,000
Colne tribs & Wye	297	23,122,820
Crane	84	18,157,100
Graveney	11	4,450,400
Guildford	9	1,545,000
Hoe Stream	11	1,095,000
Hogsmill	18	3,125,800
Ingrebourne	70	9,533,000
Kennet	291	17,928,300
Loddon	413	27,477,700
Lower Lee	228	46,820,000
Lower Lee tribs	165	18,658,000
Lower Mole	17	555,000
Lower Roding	36	3,140,000
Lower Thames	208	28,438,500
Luton	74	7,471,000
Middle Lee & Stort	507	45,316,750
Middle Mole	39	8,394,200
Middle Roding	56	9,075,000
Ock	22	1,280,900
Oxford	18	9,981,500
Pinn	38	5,014,000
Ravensbourne	104	72,378,200
Reading	31	2,675,000
Rural Wey	212	17,311,000
Sandford to Cookham	103	9,094,000
Swindon	48	6,115,000
Thame	82	5,706,800
Upper & Middle Blackwater	159	19,690,075

Upper Lee	411	22,109,025
Upper Mole	97	32,720,700
Upper Roding	127	9,532,500
Upper Thames	419	40,130,270
Wandle	38	24,381,600
Windsor & Maidenhead	64	16,390,000
Total	**5629**	**721,872,685**

Figure 3.17 Number of third party assets per policy unit and approximate replacement costs

3.5.5 Flood Incident Management

Following the floods of 1998 in the Cherwell catchment within Thames region, and more generally across central England and Wales, flood warning arrangements have been improved. We aim to provide at least two hours notice of flooding occurring and the flood warning service covers all main river in Thames region. This presents particular challenges on fast responding watercourses, such as those in urban areas and London in particular.

People living within the floodplain can now receive direct flood warnings via Floodline Warnings Direct (FWD), which came on line in 2006. This is a multi-media warning dissemination system that sends warning messages via telephone, fax, e-mail or SMS text message to Local Authorities, emergency services, utility companies, the media and members of the public who have registered with the service.

The number of properties that are registered for the FWD service varies across the region and even between Flood Warning Areas (FWAs) in a single policy unit (see Table 3.18). For example in London, the percentage of properties in the floodplain that are registered to FWD in the Ravensbourne catchment is only 3% whereas in the Crane catchment the figure is 39%. In a number of catchments, the take-up is much lower on the smaller tributaries. For example, the number registered in the Lower Colne is 46% but on it’s tributaries, this figure falls to 24% on the River Misbourne and less than five properties are registered on the River Gade, Ver and Chess out of a total of 1,550. The area with the highest percentage registered on FWD is the Upper Lee, with approximately 60% of properties signed up to the service.

We also provide a dial-in phone service called Floodline. The public can listen to a recorded message giving details of flood warnings for their local river. There is the option to speak to an operator, to report flooding, request information booklets or inquire about the flood status of local rivers.

We hold flood awareness campaigns every year, which focus on encouraging people to take measures to reduce the impacts that flooding can have on them. The campaign uses a combination of national media and local events. The largest part of the campaign is targeted mail to those identified in the ‘at-risk’ database. We also target businesses and ‘hard to reach’ groups such as the elderly.

Details of flood warning, awareness and forecasting activities that are currently planned for 2008-09 in each policy unit are detailed in Table 3.18. These plans are subject to change.

There is an ongoing programme of improvements to the quality of the flood warnings that we provide through our telemetry infrastructure and forecasting models. The improvement works that are currently planned are shown in the final column of Table 3.18. The programme of works is being informed though an ongoing review of all Flood Warning Areas in Thames Region. The review is improving the Flood Warning Service through establishing more community targeted flood warning areas. It will also clearly identify which properties within the Extreme Flood Outline cannot currently be offered a full service. This review is due to be completed in 2010.

Policy Unit	% of properties at risk registered to FWD	Detection (telemetry) improvements	FWD recruitment activities	Flood awareness events	Forecasting improvements
Abingdon	25%	Site planned on River Stert	Yes		
Addlestone Bourne, Emm Brook and The Cut	9%	Site planned near Maidenhead	Addlestone Bourne - done in March 2008 Emm Brook - Yes		Rainfall runoff models to be delivered
Aylesbury	<1%		Yes		
Basingstoke	4%		Yes		
Beam	40%		Yes	Flood Awareness stand at local event (May 08)	
Beverley Brook	23%		Yes		
Brent	32%	Site planned at Brentford	Yes		
Byfleet and Weybridge	40%		Done in March 2008		
Colne	35%	Site planned at Borehamwood	Yes	Flood Awareness stand at local event (May 08)	Routing models to be delivered Rainfall runoff models to be delivered
Colne tributaries and Wye	10%		Colne tributaries - Yes Wye - No (will take place in 09-10)		Routing models to be delivered
Crane	39%		Yes		Routing models to be delivered Rainfall runoff models to be delivered
Graveney	3%		Yes		
Guildford	24%		Done in March 2008	Flood Awareness stand at local event (May 08)	
Hoe Stream	19%	Raingauge planned at Pirbright	Done in March 2008		
Hogsmill	4%		Yes		Rainfall runoff models to be delivered
Ingrebourne	23%		Yes		

Kennet	15%		No (will take place in 09-10)		Hydrodynamic model to be delivered Routing models to be delivered
Loddon	22%		Yes	Flood information days (Mar 09)	
Lower Lee	9%		Yes		
Lower Lee tributaries	18%	Site planned at Chingford	Yes	Flood Awareness evening (Aug 08)	
Lower Mole	9%		Yes	Flood information days (Mar 09)	
Lower Roding	22%		Yes	Flood Awareness stand at local event (Jul 08)	
Lower Thames	18%		Yes	Flood Awareness stand at local event (May 08) Flood Awareness stand at local event (Jul 08) Flood information day (Mar 09)	Refinements to existing hydrodynamic model
Luton	10%		Yes		
Middle Lee and Stort	38%		Yes		
Middle Mole	20%	Site planned at Brockham	Yes	Flood Awareness stand at local event (Jun 08) Flood information days (Mar 09)	Routing models to be delivered
Middle Roding	22%		Yes		
Ock	25%		Yes		
Oxford	40%		Yes	Flood Protection Products Fair (Jul 08)	
Pinn	40%	Site planned at Ruislip	Yes		
Ravensbourne	3%		Yes		Hydrodynamic model to be delivered
Reading	30%		Yes		

Rural Wey	15%		Done in March 2008		Routing models to be delivered Rainfall runoff models to be delivered
Sandford to Cookham	15%		Yes	Planning for museum exhibition in 09-10 (Henley)	
Swindon	1%		Yes	Flood Protection Products Fair (Jun 08)	Routing models to be delivered
Thame	7%		Yes		
Upper and Middle Blackwater	<1%	Site planned at Cove	Yes		
Upper Lee	60%		Yes		Rainfall Runoff models to be delivered
Upper Mole	2%	Site planned at Crawley	Yes	Flood information days (Mar 09)	Rainfall runoff models to be delivered
Upper Roding	30%	Site planned at Abridge	Yes		
Upper Thames	20%	Site planned at Bampton Site planned at Moreton in Marsh Site planned at Wantage Site planned at Witney	Thames River - Yes Cotswolds, Cherwell, etc - No (09-10)	Cotswolds - Flood Protection Products Fair (May 08)	Refinements to existing hydrodynamic model Routing models to be delivered Rainfall runoff models to be delivered
Wandle	13%		Yes	Flood week (Mar 09)	Rainfall Runoff models to be delivered
Windsor and Maidenhead	2%		Yes		

Table 3.18 Flood warning, awareness and forecasting activities planned for 2008-09