

Lower Lee Flood Risk Management Strategy

Strategic Environmental Assessment

Addendum



June 2008



**ENVIRONMENT
AGENCY**

Address: Swift House,
Frimley Business Park
Frimley
Surrey
GU16 7SQ

1. Introduction

The Lower Lee Flood Risk Management Strategy investigates flood risk management options for the Lower Lee catchment through modelling, economic and technical appraisal and Strategic Environmental Assessment. The Strategy is intended to guide those involved in flood risk management and planning. The Strategy makes recommendations for short, medium and long term actions.

A Strategic Environmental Assessment (SEA) was undertaken as an integral part of the Strategy's development during 2006-7. This included consultation with stakeholders and the general public in the region via a workshop (including statutory consultees) and public advertisement of the Strategy proposals between July 2006 and May 2007. Responses received through this consultation were used to refine some details of the Strategy, which was then put forward for funding approval.

The Strategy is now the subject of some additional work to address some detailed requirements of the final funding approval. At the same time, the opportunity is being taken to reflect any changes in the environmental baseline which have occurred since 2006-7.

This SEA document is an Addendum to the full SEA Report *Lower Lee Flood Risk Management Strategy, Strategic Environmental Assessment, Environmental Report for Consultation, August 2006* and should be read in conjunction with it (the addendum can be viewed at www.environment-agency.gov.uk/lowerlee and through this site you can also view our 2006 Environmental Report). It summarises the additional proposals and policies contained in the Strategy, highlights where there are implications for the environment and, where relevant, assesses these implications.

2. Strategy Objectives

The key objectives of the finalised Strategy are:

- To develop a 100 year flood risk management strategy for the Lower Lee catchment, taking account of flood risk and increased risks associated with climate change and development.
- To identify and appraise flood risk management options for implementation in the short, medium and long term, including structural and non-structural measures.
- To scope and investigate foreseeable significant environmental and social impacts of these options and related requirements for mitigation and opportunities for enhancement.

The only change in these objectives is in the life-time of the Strategy, which has now been extended to 100 years. The environmental implications associated with this change are considered in Section 8.

3. The River Lee Catchment

The River Lee rises just north of Luton, and its confluence with the Thames is 2.5 km upstream of the Thames Barrier, at Bow Creek. The Upper Lee is mainly rural but with a number of urban areas. The river character changes downstream of Hertford, where it becomes navigable and increases in size significantly. The Lower Lee flows through an increasingly urbanised environment.

The area covered by this Strategy is shown on Figure 1 and includes the following:

- Lower Lee main channels from Hackney railbridge (just upstream of the Olympics Zone), to the confluence with the River Stort at Fieldes Weir.

- River Lee upstream of Feildes Weir to the confluence with the River Rib downstream of Hertford.
- The Lower Lee tributaries, which include Lynch Brook, Spital Brook, Small River Lee, Nazeing Brook, Cobbins Brook, Turkey Brook, Salmons Brook, Ching Brook, Pymmes Brook and Moselle Brook.

Previously, the Strategy included the River Lee through Hertford, but it was subsequently decided that the complexity of flooding history in Hertford warranted a separate and more detailed study. There are no significant environmental implications associated with this change.

4. Flood Risk

The Lower Lee catchment is heavily urbanised with large parts of the floodplain developed. The combination of man-made surfaces and clayey soils means the local rivers respond rapidly to rainfall and are liable to sudden flooding after storms. Flood risk areas are identified throughout the Lee Valley catchment, although the principal flood risks are associated with the Lower Lee tributaries.

Major flooding in 1947 and before led to the construction of the Lee Flood Relief Channel (FRC), which became fully operational in 1976. Since then there has been no major flooding, although the river system has almost reached full capacity in 1987, 1993 and 2000. In contrast, flooding in the Lower Lee tributaries, such as Salmons Brook, Cobbins Brook and Ching Brook, has been frequent in the last 20 years.

With the lifetime of the Strategy being extended to 100 years, there has been additional consideration of the probable effects of future climate change on rainfall patterns and, thus, on areas most at risk of flooding.

The main flood risk areas are indicated in Figure 1 and include:

- River Lee: Enfield Lock to Sewardstone, Waltham Forest, Lee Valley trading estate, Walthamstow (previously also Hertford, but no longer in the Strategy area)
- Lower Lee tributaries: Waltham Abbey (Cobbins Brook); Grange Park (Salmons Brook); Chingford (Ching Brook); Upper Edmonton (Pymmes Brook); Walthamstow (Dagenham Brook); Turnford (Turnford Brook) and Lower Nazeing (Nazeing Brook).

These were all identified in the previous version of the Strategy. Additional locations at risk in Hoddesdon (Woollens Brook) have been identified in 2008 when considering future long-term climate change scenarios.

5. Existing Flood Defences

The Lower Lee is a complex river system, comprising the Old River Lee, the Lee Navigation and the Flood Relief Channel (FRC). The FRC is a critical flood defence asset. A continuation of current investment to maintain this is a key consideration. Modelling has identified under-capacity as the main weakness of the FRC.

Over 300 properties on the Lower Lee tributaries were affected by flooding in 2000. The Lower Lee Flood Relief Channel (FRC), originally constructed to provide a Standard of Protection against a 1947 scale flood event (estimated to be 1.4% annual probability) operated at almost full capacity in 1987, 1993 and 2000. The current defences are deteriorating and modelling has shown that the level of protection they currently provide has decreased to 2% generally and could be as low as 5% in some areas. With future climate change and no additional flood risk management, the standard of protection is predicted to decline.

6. Environmental Objectives, Constraints and Opportunities

Environmental objectives have been set to provide a basis for environmental appraisal. These are listed in Table 1. These objectives were consulted on and agreed with internal and external consultees prior to the SEA and have remained unchanged throughout the Strategy's development.

Baseline environmental conditions in the Strategy area remain unchanged and are detailed in *Lower Lee Flood Risk Management Strategy, Strategic Environmental Assessment, Environmental Report for Consultation, August 2006*. The main strategic environmental constraints and opportunities are also unchanged and may be summarised as follows:

- The network of water and wetland habitats associated with the floodplains (most significantly the Lee Valley Special Protection Area and Ramsar site) must be protected, and might be added to.
- Relevant spatial plans generally require protection and enhancement of the nature conservation value and landscape value of river corridors and floodplains. This is also emphasised by the developing Water Framework Directive river basin management plan which covers the Lower Lee.
- Options which open up the river corridor, set back flood defences and/or establish new washlands, floodplains and wetlands could contribute to habitat and wildlife value.
- Prominent areas for recreation (notably the Lee Valley Regional Park, Lee Navigation, and National Cycle Network) need to be preserved, and there may be opportunities for improvement. Additional recreational access to the river could be achieved by opening up the river corridor and setting back defences, contributing in particular to London's greenspace initiatives.
- River corridor habitat, landscape and access improvements which could be associated directly with some flood management options would be compatible with relevant spatial planning concepts such as the Blue Ribbon network (enhancing London's waterways), the Green Grid concept (maximising and enhancing greenspace in East London), and local Biodiversity Action Plans..
- Known cultural heritage features in the river corridors and floodplains are generally considered sensitive to flooding and disturbance. The Lee valley in Hertfordshire has no archaeological designations but may offer particular archaeological value. Additional unknown heritage may be sensitive to water levels both above and below ground.
- Spatial plans relevant to the Strategy area recognise a requirement to provide adequate flood protection to support existing economic uses.
- There are a number of significant development areas (throughout the lower catchment in particular) for which flood management has also been identified as critical, but which might also provide opportunities to make additional space for water beyond the needs of the immediate developments themselves. In terms of long-term strategic planning for flood risk management, over a 100 year horizon, the trend of development and ever increasing population (10% in London by 2016) will continue.

Significant environmental constraints and opportunities have been mapped along with the Strategy's proposals in an "indicative landscape plan". This indicative landscape plan also identifies where environmental or social mitigation is planned and where environmental and social improvement opportunities have been identified within the Strategy area. More details on these specific environmental and social considerations are provided in Section 8.

Table 1: Environmental Objectives		
Theme	Purpose (Relevant factor from Annex I of SEA Directive)	Objective
“An enhanced environment for wildlife, a better quality of life”	Protect and enhance biodiversity (Biodiversity, flora and fauna)	<ol style="list-style-type: none"> 1. Avoid damage to designated wildlife sites including those of international, national, regional and local importance and protect or enhance the favourable condition status of habitats or species listed within them. 2. Protect and where possible enhance species and habitats listed in relevant Biodiversity Action Plans (national, local, EA) in line with targets for areas encompassed by the Lower Lee Catchment. 3. Protect and where possible improve the status of fisheries.
“A better quality of life”	Avoid effects on human health and population (Human health, population).	<ol style="list-style-type: none"> 4. Reduce the impacts on humans (the local population) from the effects of flooding related in particular to storm events and channel under capacity. 5. Protect and enhance recreational and amenity facilities.
“Improved and protected inland and coastal waters”	Protect and improve inland waters (Water)	<ol style="list-style-type: none"> 6. Maintain and improve surface water quality where compatible with flood risk management. 7. Ensure that groundwater resources are protected. 8. Reduce the amount of waste and opportunities for waste disposal associated with the river (e.g. fly-tipping). 9. Restore riparian corridors, including floodplain connectivity and natural processes.
“Limiting and adapting to climate change”	Mitigate impacts from climate change (Climatic factors)	<ol style="list-style-type: none"> 10. Reduce vulnerability of the human population & property to changes in flooding patterns/risks resulting from climate change
“A better quality of life”	Protect and enhance features cultural heritage (Cultural heritage).	<ol style="list-style-type: none"> 11. Prevent damage to statutory archaeological / heritage sites (Scheduled Monuments, Registered Historic Parks and Gardens, Listed structures) and non-statutory sites.
“A better quality of life”	Protect and enhance landscape character / visual amenity (Landscape)	<ol style="list-style-type: none"> 12. Protect, enhance and encourage enjoyment of the landscape

7. Links With Other Studies and Schemes

7.1 Thames CFMP

The Environment Agency is producing flood risk management plans to provide an overview for managing the long-term flood risk within river catchments in England and Wales over the next 50 to 100 years. The overview and policies relevant to the River Lee catchment are contained within the Thames Catchment Flood Management Plan (CFMP), in development. The developing Thames CFMP’s main messages for flood risk in the Lower Lee catchment are:

- At present it is still effective to maintain the existing flood defences
- Climate change will mean that these defences will become less effective in the future, therefore it is important that:
 - (a) any re-development reduces the residual flood risk in the areas benefiting from these defences using the measures set out in PP25
 - (b) the natural floodplain retains its potential to accommodate floodwater.

The combination of the preferred flood risk management options identified by the Strategy will manage flood risk to properties in the Lower Lee. The Strategy also identifies flood storage on some tributaries (i.e. Salmons Brook and Cobbins Brook) as a measure for reducing flood risk locally. In addition, a number of non-structural options will be applied alongside the flood storage and local protection schemes. This remains unchanged since 2006-7. (The structural and non-structural options are all summarised in Table 3.)

7.2 On-going Flood Risk Management Actions

The Strategy was developed in parallel with studies to address the severe flooding in 2000 on Cobbins Brook, Salmons Brook and Nazeing Brooks. From these studies, the Cobbins Brook and Salmons Brook flood alleviation schemes are being promoted and are at detailed design stage.

Other relevant schemes which are on-going and have been incorporated into the Strategy are:

- Repair / renovation of FRC Structures (Newmans sluice, Abbey Mill, Fishers Green, Low Hall) (new to the Strategy since the associated feasibility study has been completed).
- Maintenance / repairs to FRC at key locations, plus maintenance / repairs of steel sheet-piled reaches (new to the Strategy since the associated FRC integrity study has been accepted).
- Gauging stations on the Nazeing and Ching Brooks, which will improve flood warning capability (new to the Strategy).
- Repairs to the existing flood storage embankment at Theobalds flood storage area on Turnford Brook (new recommendation arising from review of the Strategy in 2008).
- Modification of a pipe crossing which partially blocks flows on Turkey Brook (new recommendations arising from review of the Strategy in 2008).

These on-going schemes do have some environmental implications, but for the most part these are conceptually the same as considered for similar structural measures in the original SEA.

7.3 The Water Framework Directive

The SEA has made an initial assessment of the likely compatibility of the Strategy with the Water Framework Directive, under which a river basin management plan is being developed for the Thames River Basin.

At present the river basin management plan has not developed proposals for a “programme of measures” to address the pressures that are considered to be putting the River Lee at risk of failing to meet the requirements of the Directive. The most significant pressures are abstraction, invasive species (such as non-native crayfish, Japanese knotweed and floating pennywort) and pollution. The River Lee has also been defined as a Heavily Modified Water Body (HMWB), which means that under the Directive it will be required to achieve good ecological potential, as opposed to good ecological status. Designation of a water body as “heavily modified” means that the water body should still be able to perform the function for which it was modified. In the case of the Lee, this means that the channel must continue to be able to pass a flow volume up to $200 \text{ m}^3\text{s}^{-1}$ at a flow velocity of 4 ms^{-1} . This means that the river basin management plan will almost certainly not include measures to restore natural hydromorphological conditions to the Lee, but it does not preclude river restoration works in particular on the tributaries.

The developing requirements of the WFD specific to the River Lee will be monitored throughout its implementation and future reviews to ensure that the associated flood risk management activities contribute as far as possible to the programme of measures once developed. This might, for example, include specific attention to the distribution of flows along different channel reaches, to contribute to water quality improvements.

7.4 Sustainable Communities

The Environment Agency's *Sustainable Communities Position Statement* (December 2007) identifies priority policies related to improving and protecting the environment when developing new communities, such as those proposed for Opportunity Areas in the Lee valley. Key policies relevant to the Lower Lee flood risk management strategy are to: (1) locate development away from flood risks; (2) reduce the demand for drainage e.g. through implementing SuDS (i.e. sustainable [urban] drainage systems); and (3) ensure greater flood resilience. These policies are reflected in the non-structural measures promoted by the Strategy.

8. Option Selection & Appraisal

8.1 General Approach

An integrated package of non-structural and structural measures is required to manage flood risk in the long term. A long-list of flood risk management options was identified, then a short-list of options selected. This short-list was evaluated to form the preferred strategy.

The approach to options appraisal involved detailed evaluation against economic, technical and environmental criteria necessary to develop, cost and prioritise the options. Specifically the options appraisal included:

- Modelling investigations to identify flood risk and evaluate each option.
- Technical scoping to outline the details of options.
- SEA to establish whether there could be significant environmental benefits or environmental impacts of selected options.

8.2 SEA & Consultation

The environmental appraisal followed the SEA regulations. A broadscale approach was taken whereby features of strategic (regional or greater) interest were identified using mapping software and through consultation, and each option was assessed in terms of the potential contribution to, or impact on, these features and the agreed environmental objectives.

In addition to identifying environmental and social mitigation measures, relevant opportunities for environmental and social enhancement were identified and investigated in the SEA, focussing on improvements to river corridors and floodplains in order to enhance nature conservation and / or recreational access.

An important part of the strategy development process was to consult with key stakeholders, including the local community. The SEA Environmental Report was used to provide information on the types of flood management options being considered and to solicit feedback from external parties and the general public in the Strategy area. The consultation feedback received during 2007 was used to refine the final Strategy as reported here.

Using this approach, all the technically and economically viable Strategy options were appraised. The assessment for the whole revised Strategy area is shown in Table 2. Changes in the Strategy between 2006-7 and 2008 have not resulted in any significant changes in the strategic environmental appraisal (apart from the exclusion of Hertford). Therefore, the more detailed tables provided in the original Environmental Report (2006) for the separate tributaries and sections of the River Lee within the study area still apply.

Table 2: Summary of Predicted Environmental Impacts for the Lower Lee Catchment over the 100-Year Lifetime of the Strategy

Theme	Strategic Environmental Objectives	Indicators	Do-nothing	Do Minimum	Non-Structural	Storage	Hard Defences	Improved Operation of Flood Relief Channel
To protect and, where possible, enhance biodiversity	Avoid damage to designated wildlife sites including those of international, national, regional and local importance and protect or enhance the favourable condition status of habitats or species listed within them.	Extent and type of change in condition of designated site.	Increased floodplain connectivity & total wet habitat area	Unlikely to have significant effect	Increased floodplain connectivity	Increased total wet habitat area	Potentially adverse if adjacent to site	Potential adverse effect on SPA where water levels affected
	Protect and where possible enhance species and habitats listed in relevant Biodiversity Action Plans (national, local, Environment Agency) in line with targets for areas encompassed by the Lower Lee Catchment	Lower Lee assists and supports the achievement of Biodiversity Action Plan objectives and targets	+/- Increased floodplain connectivity but potential to damage existing sites	Unlikely to have significant effect	Unlikely to have significant effect	Increased total wet habitat area (if not located on existing ecological site) Damage to existing river & riparian habitats / ecology	+/- Adverse effects on riparian corridor but opportunity to set existing defences back	Adverse effects on riparian corridor
	Protect and where possible improve the status of fisheries	Status of the fisheries (e.g. diversity and biomass)	+/- Increased floodplain connectivity but potential damage as channel fails	Unlikely to have significant effect	Unlikely to have significant effect	+/- Beneficial or adverse – site specific	+/- Adverse effects on riparian corridor but opportunity to set existing defences back	Adverse effects on riparian corridor
To avoid effects on human health and population	Reduce the impacts on humans (the local population) from the effects of flooding related in particular to storm events and channel under capacity	Number of injuries due to flooding. Number of properties impacted by flooding.	Decreased flood protection	Progressive decrease in flood protection	Increased flood protection	Increased flood protection	Increased flood protection	Increased flood protection
	Protect and enhance recreational and amenity facilities.	Total extent of riparian corridor accessible to the public. Total number/extent (and condition) of riparian recreational assets (cycleways, footpaths, angling sites) and visits (educational, public) to riparian green space.	Loss of safe access	Progressive loss of safe access	More sustainable use of floodplain	Create new resource (unless located on existing resource)	Improved access	Loss of safe & reliable access to facilities
To protect and improve inland waters	Maintain and improve surface water quality (WQ) where feasible	Changes in GQA classifications (chemical and biological) (with dissolved oxygen as a key indicator) or River Ecosystem grade	WQ may be improved if flooded location is greenfield WQ will decline if urban locations flood	WQ may be improved if flooded location is greenfield WQ will decline if urban locations flood	WQ improved through decreased pressure on floodplain	WQ improved through better flood protection	+/- Improved flood protection but decreased connectivity	+/- Beneficial or adverse – site specific
	Ensure that groundwater resources are protected.	Water quality and productivity of the Main Aquifer.	Aquifer may be improved if flooded location is greenfield Aquifer quality will decline if urban locations flood	Aquifer may be improved if flooded location is greenfield Aquifer quality will decline if urban locations flood	Unlikely to have significant effect	Aquifer improved through better flood protection	+/- Improved flood protection but decreased recharge	Unlikely to have significant effect

Table 2: Summary of Predicted Environmental Impacts for the Lower Lee Catchment over the 100-Year Lifetime of the Strategy

	Reduce the amount of waste and opportunities for waste disposal associated with the river (e.g. fly-tipping)	Quantity of waste removed by Operations.	Removal of failed defences	Continuing removal of debris	Greater respect for river corridor	Generates construction waste	Generates construction waste	Unlikely to have significant effect
	Restore riparian corridors, floodplains, including connectivity and natural processes.	Determination of the risk of failing to meet the prescribed morphological quality objectives for the river in accordance with the Water Framework Directive. Area/length recovered or restored through flood management works including river restoration.	Natural processes become dominant	Natural processes largely suppressed	Work with natural processes	+/- Increased total wet habitat area but artificial control of processes	Natural processes suppressed	Natural processes largely suppressed (but system is artificial)
To mitigate impacts from <i>climate change</i>	Reduce vulnerability of the human population & property to changes in flooding patterns/risks resulting from climate change	Level of service offered by flood defences, taking account of future predictions of rainfall event probabilities	Decreased flood protection	Progressive decrease in flood protection	Some increased flood protection	Increased flood protection	Increased flood protection but may not be sustainable	Increased flood protection but may not be sustainable
To protect and enhance features of <i>cultural heritage</i>	Prevent damage to statutory archaeological / heritage sites (Scheduled Monuments, Registered Historic Parks and Gardens, Listed structures) and non-statutory sites	Number and type of sites at risk of flooding or experience flood damage	Increased risk of flood damage	Progressive increased risk of flood damage	Some protection against flooding	+/- Protection against flooding (but risk of construction damage or from flood storage)	+/- Protection against flooding (but risk of construction damage)	Protection against flooding - but few sites along FRC so unlikely to have significant effect
To protect and enhance <i>landscape character/visual amenity</i>	Protect, enhance and encourage enjoyment of the landscape	Changes in Landscape Character (Assessments), changes in character of watercourses / riparian corridors	Flooding could improve greenfield spaces (but derelict defences)	Unlikely to have significant effect	Protects floodplain against development in rural areas	New artificial landscape feature in rural areas	New intrusive structures in rural areas	Likely to lead to decrease in visual amenity
			Flooding adverse in brownfield spaces	Unlikely to have significant effect	Improved floodplains in urban areas	+/- Beneficial or adverse in urban areas – site specific	+/- Opportunity to set back or otherwise improve existing defences, but new intrusive structures if none existing	

Prediction of Impacts

	Negative
	Negligible, or both positive & negative possible (+/-)
	Positive

8.3 Option Selection

The following long-list of options was assessed in the original Strategy and remains unchanged:

- Do Nothing as ‘walk-away’ option under which all operation and maintenance activities would cease, or Do Minimum as a continuation of operation and maintenance activities.
- Non-structural measures include: improved operation and maintenance of existing flood defences; influencing development control to take full account of flooding and making space for water; flood warning and flood forecasting; flood flow monitoring; and land management changes (to reduce storm runoff).
- Structural options - to maintain and enhance the level of service provided by the FRC on the Lower Lee main stem, and to reduce flooding on the Lower Lee tributaries - including:
 - Improving the FRC without major works including alternative control;
 - Upstream storage and flood defence works on the Lower Lee tributaries;
 - Upstream storage in the Upper Lee;
 - Increasing capacity of the FRC to convey high flood flows;
 - Dualling the FRC by constructing a second flood relief channel;
 - Diverting flood flows away from the FRC to the River Lee and Lee Navigation.

Those options which were not viable on technical, economic or environmental grounds were discarded. This led to a short-list of options which included both non-structural and structural options as follows:

- Non-structural
 - Promote partnerships with stakeholders (local authorities and other organisations).
 - Influence land use and development through the planning process.
 - Flood warning improvements that continue and strengthen existing initiatives.
 - Raising awareness of flood risk through public education and communication.
 - Promote land management changes.
- Structural
 - Cease all maintenance (Do-Nothing, Option A)
 - Continue maintenance (Do-Minimum, Option B)
 - Target priority tributaries, i.e. Salmons, Cobbins, Nazeing, Ching and Pymmes Brooks (Option C).
 - Flood storage areas on Upper Lee (Option D).
 - Local flood protection on Lower Lee at Enfield Island, Chingford and Walthamstow (Option E).
 - Local protection in particular to address the increasing flood risk that will result from climate change on a number of tributaries, including Nazeing, Turnford, Woollens, Ching and Pymmes Brooks (new recommendations arising from review of the Strategy in 2008). However, inclusion of these in Strategy implementation is dependent on identifying appropriate compensatory flood storage areas (i.e. undeveloped land that can be allowed to flood) and on positive outcomes from environmental and benefit-cost appraisals of these.

Only the last of these structural options was not included in the original 2006-7 Strategy, i.e. future local protection to address the effects of climate change on tributaries. Each short-listed option was then subject to more detailed appraisal (environmental and economic) to develop the final Strategy Plan, which is summarised in Table 3. The most significant changes from a strategic environmental perspective are as follows (see also the indicative landscape plan):

1. As a result of developing a Strategy for 100 years, the economic and environmental cases related to the repair / renovation of FRC structures (i.e. sluices and gates) have changed somewhat. Thus, the Strategy now includes improvements in linear connectivity along the river channel by replacing a number of existing impounding structures (i.e. gates and sluices) at Abbey Sluice, Chalk Bridge Sluice, David Stoker Gates, Fishers Green Sluice, Hardmead

Gates, Kiora Gates, Meadgate Gates, Richard White Gate and Stansted Gate) with fixed structures (i.e. long-crest weir, labyrinth weir or fixed orifice), incorporating fish passes. As well as benefiting the movement of fish and invertebrates, this will promote improvements in water quality in the FRC. However, replacements are not anticipated until the mid-term implementation (years 11 to 60). This is complementary to the existing Strategy statement that any reaches of the FRC that require remedial works should be the subject of mitigation in the form of river corridor improvements, including setting back defences and naturalisation of the river channel and corridor as far as possible. This relates in particular to steel sheet-piled reaches of the channel, because of their faster rate of decay compared to mass concrete reaches.

2. Analysis of the economic and environmental implications of flood storage areas at various locations in the catchment has resulted in none of these being carried through into the final Strategy.
3. Some additional locations have been identified for new or modified structural flood defences. These are located on Nazeing, Turnford, Woollens, Pymmes and Ching Brooks. Apart from Nazeing Brook, these are new proposals developed during this Strategy review, and have not previously been assessed for their potential environmental impacts and opportunities. Therefore, initial environmental assessment was undertaken as part of this Strategy, and is reported in the appendix to this SEA Addendum. These are all relatively small-scale proposals, and none have strategic environmental implications (i.e. effects on an asset of regional or greater importance).
4. All of those structural options which have been developed in outline (as well as those few schemes which have reached detailed design stage) include appropriate mitigation measures to reduce their adverse environmental effects. Where relevant, environmental and social enhancement measures have also been included. These are identified on the indicative landscape plan.

8.4 Environmental and Social Mitigation Measures

The significant mitigation measures included in the Strategy as component parts of flood risk management improvements are summarised below, with their locations and further details provided in the indicative landscape plan.

Confirmed environmental and social mitigation:

- FRC river corridor improvements: Mitigation of structural works in the FRC channel by replacement of piles with bioengineering. Possible setting back of bank. Locations of replacement reaches not known.
- FRC fish passage improvements: Improve fish passage - coarse fish passage initially, but should not rule out future salmonid fishery.
- Cobbins Brook wetland creation: New wetland complex in intermittent flood storage area.
- Salmons Brook river corridor improvement – Montagu Road: Enhanced river corridor habitat, improved access & landscaping.
- Salmons Brook river corridor improvement – Eley's Estate: Replacement of engineered river bank with naturalised slope, to widen river channel / corridor.

8.5 Environmental and Social Enhancement Opportunities

In addition to developing mitigation measures for specific flood risk management options, the Strategy has identified a number of enhancement measures to improve river corridors and floodplains in accordance with *Making Space for Water*, the *London River Restoration Strategy* and local authority proposals for improving open spaces. Enhancements which involve the creation of valuable wildlife habitats will also contribute to the UK Biodiversity Action Plan. These environmental and social enhancements – which draw together existing project proposals within the catchment plus some opportunities identified specifically during Strategy development

- are all compatible with the proposed flood risk management activities included within the final Strategy Plan. They are summarised below, with their locations and further details provided in the indicative landscape plan.

Confirmed environmental and social enhancement projects:

- Tottenham Marshes – wetland creation: Series of pools; reedbed, tiered pool system, water off take and input system with river (standalone scheme).
- Turkey Brook river corridor improvement – Albany Park: River channel / bank enhancements (standalone scheme).
- Rammey Marsh river corridor improvements: Restore historic ditch line, in-channel habitats & sinuous flow (standalone scheme).

Speculative environmental and social enhancement projects:

- Glen Faba lake enlargement: Extend open water & wetland (reedbed preferred) southwards (although still an active extraction site)
- Extension of Lee Valley Canoe Circuit: Extend canoe circuit from Kings Weir up to Feildes Weir
- Creation of 2-day canoe route: Canoe Access facilities & H&S improvements
- Hackney Marsh river and floodplain improvement: Channel restoration in River Lee plus floodplain improvement
- River Stort river / floodplain restoration: Reconnection of river and floodplain; habitat; improved recreational access enhancements;
- Patty Pool Mead – wetland creation: Creation of new wetland habitat (suitable for breeding waders)
- Walthamstow Marshes floodplain improvement: Floodplain improvements to area south (and east) of the SSSI
- Dagenham Brook river corridor improvement - Leyton Marshes: Reduce culverting & canalisation of Dagenham Brook
- Enfield Living Rivers Project – Salmons Brook: River channel / bank enhancements
- Lower Nazeing floodplain restoration: Creation (re-creation) of grassland & wetland in the Lee Valley towards and beyond Lower Nazeing
- Nazeing Mead floodplain restoration: Establishment of wetland & wet grassland suitable for waders and over-wintering birds
- Great Amwell – wetland improvement: Enhancement of wetland
- Improvement of Lea Valley Walk at King George’s Reservoir: Improved pedestrian & cycle access along FRC as part of National Cycle Network route
- Cycle path east of William Girling Reservoir: Improved cycle access along FRC
- Blackhorse Lane Waterfront Park: (a) Waterfront park with set back east bank of FRC, (b) Pedestrian access along FRC plus footbridge over FRC; (c) Re-engineer concrete FRC banks to improve landscaping; (d) De-culverting Dagenham Brook
- Old Moselle Brook river corridor improvement – Markfield Park: Clear silt from brook; vegetation clearance to open views to brook
- Moselle Brook river corridor improvement – Lordship Recreation Ground: Opening up river; landscaping & improved facilities
- Oak Hill Park river corridor improvements – re-naturalisation of c.600 of Pymmes Brook, including removal / lowering of weir and deculverting of c.50m of tributary stream
- Whitewater canoeing at Dobbs Weir: H&S improvements to allow reinstatement of whitewater canoeing below sluice

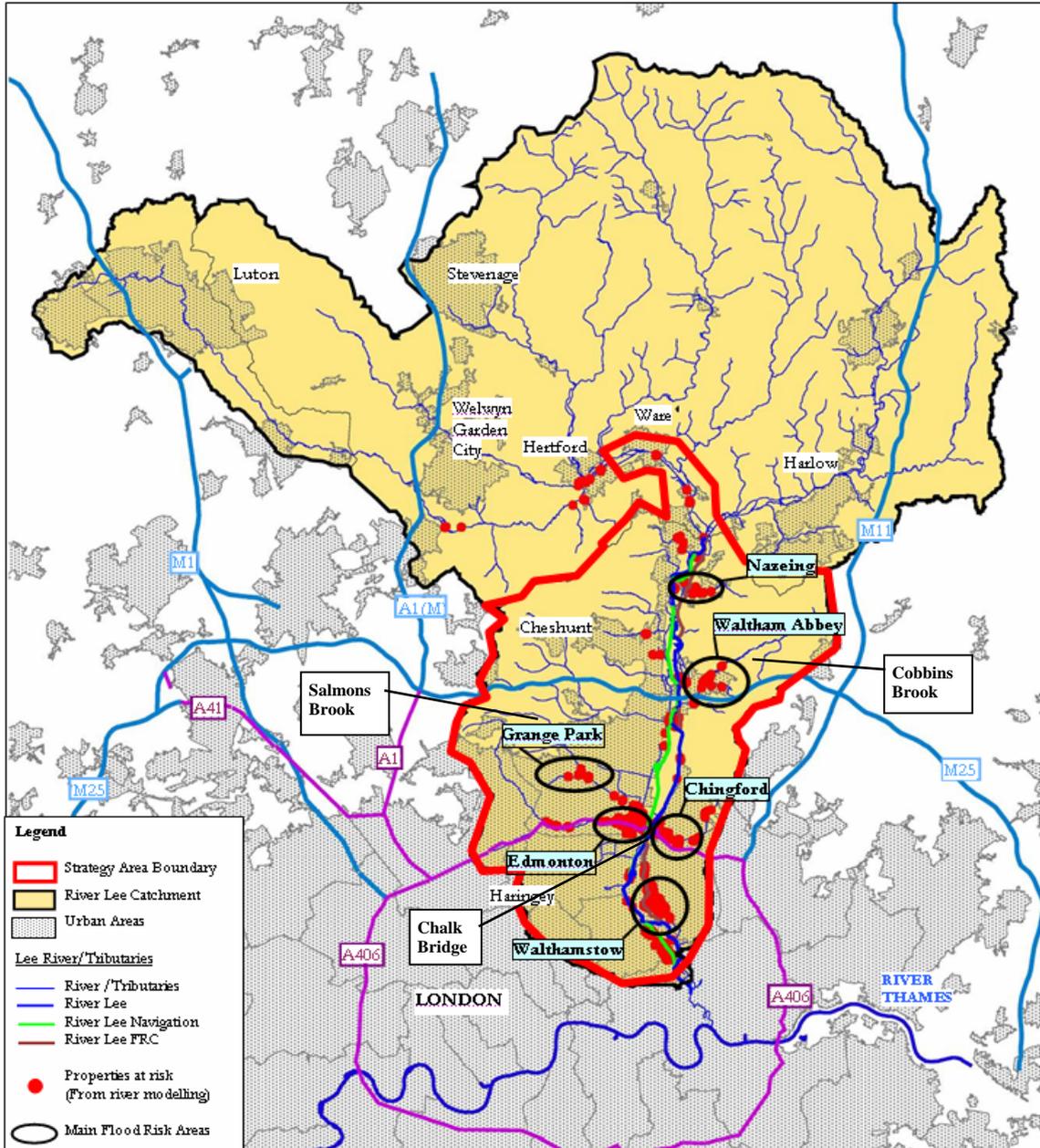
Table 3: The Strategy Plan

Short Term Measures (0-10 years)		
Measure	Location	Details
No maintenance (Do Nothing)	Upper rural reaches of: <ul style="list-style-type: none"> • Cuffley Brook • Cobbins Brook • Turnford Brook • Other tributaries 	Consequence of failure rating classified as low risk
Maintain Standard of Protection (Do Minimum)	All except above	Continue current level of maintenance and vegetation clearance on the FRC, River Lee and tributaries
Maintain SoP (Do Maintain, Refurbish & Replace)	FRC	Maintain Abbey Mills and Fishers Green; Railway Bridge repairs; FRC repairs, Tottenham; Low Hall Sluices; Cattlegate Road Access Bridge
	Turnford Brook	Access Improvements; Theobalds FSA repairs; Cheshunt North Flood Storage Reservoir repairs
	Nazeing Brook	Gauging Station
	Ching Brook	Gauging Station
	Pymmes Brook	Pymmes remedials; Wilmer Way Footbridge
	Turkey Brook	Turkey Brook Pipe Crossing
Flood protection measures (raise SoP)	FRC	Flood defences at Low Hall Lane upstream of Ching; raised banks (FRC) adjacent to industrial estate near Ching confluence; Dagenham Brook FAS
	Pymmes Brook	Culvert entrance improvements; Pymmes Brook FAS (dependent on identifying appropriate compensatory flood storage area and on a positive outcome from environmental and benefit-cost appraisals of this)
Third party flood defence assets	FRC	Strategy recommends that Thames Water operate, on the Agency's request, Lower Hall sluices near Flanders gate and Keids Sluices to reduce flood impacts Continue operation and maintenance of flood defence structures*, incl. Newmans, Dobbs and Keids weirs, Lea Bridge Roundhouse, Low Hall and Abbey sluices, Flanders radial gates
	Lower Lee Salmons Brook Ching Brook Pymmes Brook Moselle Brook	Continue operation and maintenance of third party culverts, to be enforced by the Agency where necessary (risk based approach)
Planned and approved works supported by strategy	Upper Lee	Hardmead & Stanstead Sluices H&S in 2008-09
	FRC	Newmans Sluices refurbish in 2008-11 Dagenham Brook channel works in 2008-09
	Salmons Brook	Salmons Brook FAS in 2009-12
	Cobbins Brook	Cobbins Brook FAS in 2008-11
	Moselle Brook	Wedges Yard Trash Screen in 2008-09
Non Structural measures		
<p>Strategy supports the Agency's ongoing flood risk management related initiatives:</p> <ul style="list-style-type: none"> • Use of PPS25 and planning liaison to strengthen influence over Local Authority and Regional Spatial Planning early in the process to prevent inappropriate development. • Continued promotion of SUDS through PPS25. • Introduction of Performance based Asset Management Systems (PAMS) • Continued improvement of its flood warning network and flood forecasting capabilities • Extend flood warning to include gauging on Ching Brook and Nazeing Brook • Enforce third parties to maintain flood defence assets where necessary (risk based approach) 		
CFMP Strategic Action Plan (to 2060)		
<ul style="list-style-type: none"> • Continue to maintain the integrity of the FRC • Where possible reduce the operation and maintenance cost of structures and channel lining by replacing moveable structures with fixed structures and naturalising some of the embankments • Achieve a net reduction in flood risk from development, with key components identified as layout (e.g. set back) and design (e.g. flood resistant buildings) • Reduce the consequences of flooding through continued action to raise public awareness • As a long term objective, make a growing proportion of the housing stock resistant to all forms of flooding. 		

Medium to Long Term Measures (11-60 years)		
Measure	Location	Details
No maintenance (Do Nothing)	As for short term	Consequence of failure rating classified as low risk
Maintain SoP (Do Minimum)	All, except Do Nothing	Continue current level of maintenance and vegetation clearance
Maintain SoP (Do MR&R)	All	Major repair works along natural channels, 2020-60
	FRC	<ul style="list-style-type: none"> Replacement of sheet piling on the flood relief channel FRC structures mid-life upgrade (radial gates and sluices replaced by fixed structures) at 9 locations, 2030-60. FRC structures refurbishment at 17 locations, 2035-60
	<ul style="list-style-type: none"> Pymmes Brook Salmons Brook Ching Brook 	Major repair works of engineered channels, 2035-60 (includes sheet piling replacement where necessary)
Flood protection measures (raise SoP)	<ul style="list-style-type: none"> Pymmes Brook Ching Brook Turnford Brook Woollens Brook 	<ul style="list-style-type: none"> Pymmes Brook FAS to raise SoP above 2% Local improvements to raise SoP above 2%, with compensatory flood storage to mitigate 'lost' floodplain
	Nazeing Brook	Flood alleviation scheme
Flood protection measures (raise SoP)	Cobbins Brook Salmons Brook	Options to raise SoP above that provided by on-going flood alleviation schemes
Third party flood defence assets	FRC	Continue operation and maintenance (as above), to be enforced by the Agency where necessary (risk based approach)
	<ul style="list-style-type: none"> Lower Lee Salmons Brook Ching Brook Pymmes Brook Moselle Brook 	Major repair works on third party culverts, 2035-60
Non Structural measures		
<ul style="list-style-type: none"> Monitor output on rural land-use management research to identify effect on reducing flood risk Promote Environmental Stewardship schemes which have potential to decrease flood risk by changing land use to reduce the volume of soil and water entering rivers from surrounding rural land Continuation of short term non structural measures 		

Long Term Measures (61-100 years)		
Measure	Location	Details
No maintenance (Do Nothing)	As for short term	Consequence of failure rating classified as low risk
Maintain SoP (Do Minimum)	All except Do Nothing	Continue current level of maintenance and vegetation clearance
Maintain SoP (Do MR&R)	All	Major repair works along natural channels, 2070-2110
	FRC	<ul style="list-style-type: none"> FRC structures end of life replacement at 17 locations, 2060-80. FRC structures refurbishment at 17 locations, 2080-2110
	FRC Pymmes Brook Salmons Brook Ching Brook	Refurbishment works of engineered channels, 2085-2110 (includes sheet piling replacement where necessary)
Third party flood defence assets	FRC	Continue operation and maintenance (as above), to be enforced by the Agency where necessary (risk based approach)
	Lower Lee Salmons Brook Ching Brook Pymmes Brook Moselle Brook	Major repair works on third party culverts (to be enforced by the Agency where necessary (risk based approach), 2085-2110

Figure 1: Strategy Area Boundary and Main Flood Risk Areas



River Lee & Flood Relief Channel

The construction of the FRC increased the conveyance capacity of the Lower Lee catchment. This reduced the area of land at risk of flooding

Between the historic flood extent and the current modelled 1% flood envelope are approximately 13,000 properties that would be at risk without the construction of the FRC.

The operation of the existing FRC defences protects 3,312 properties in a 1% flood event, however there are still 4,124 at risk in this scale of flood event.

