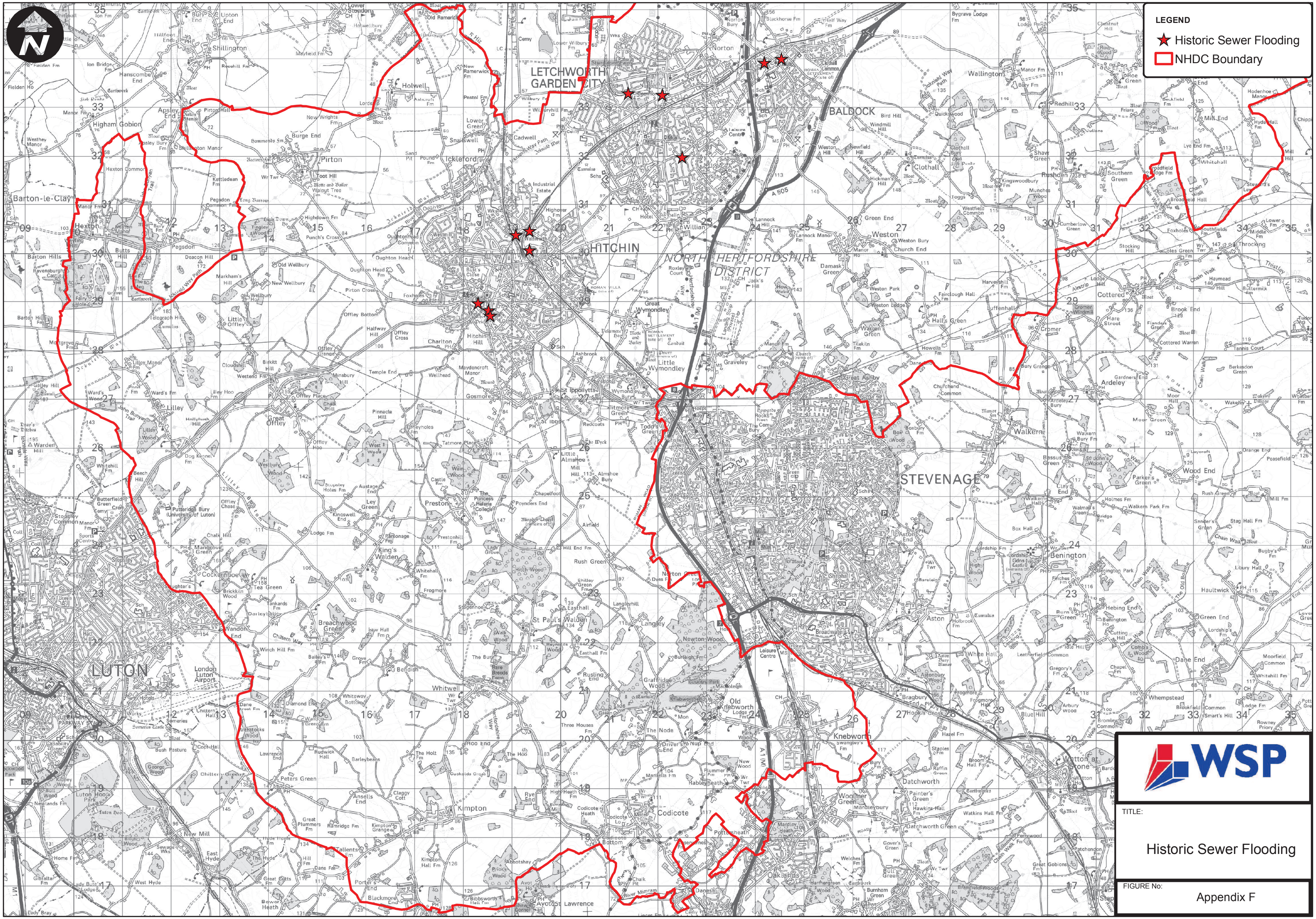
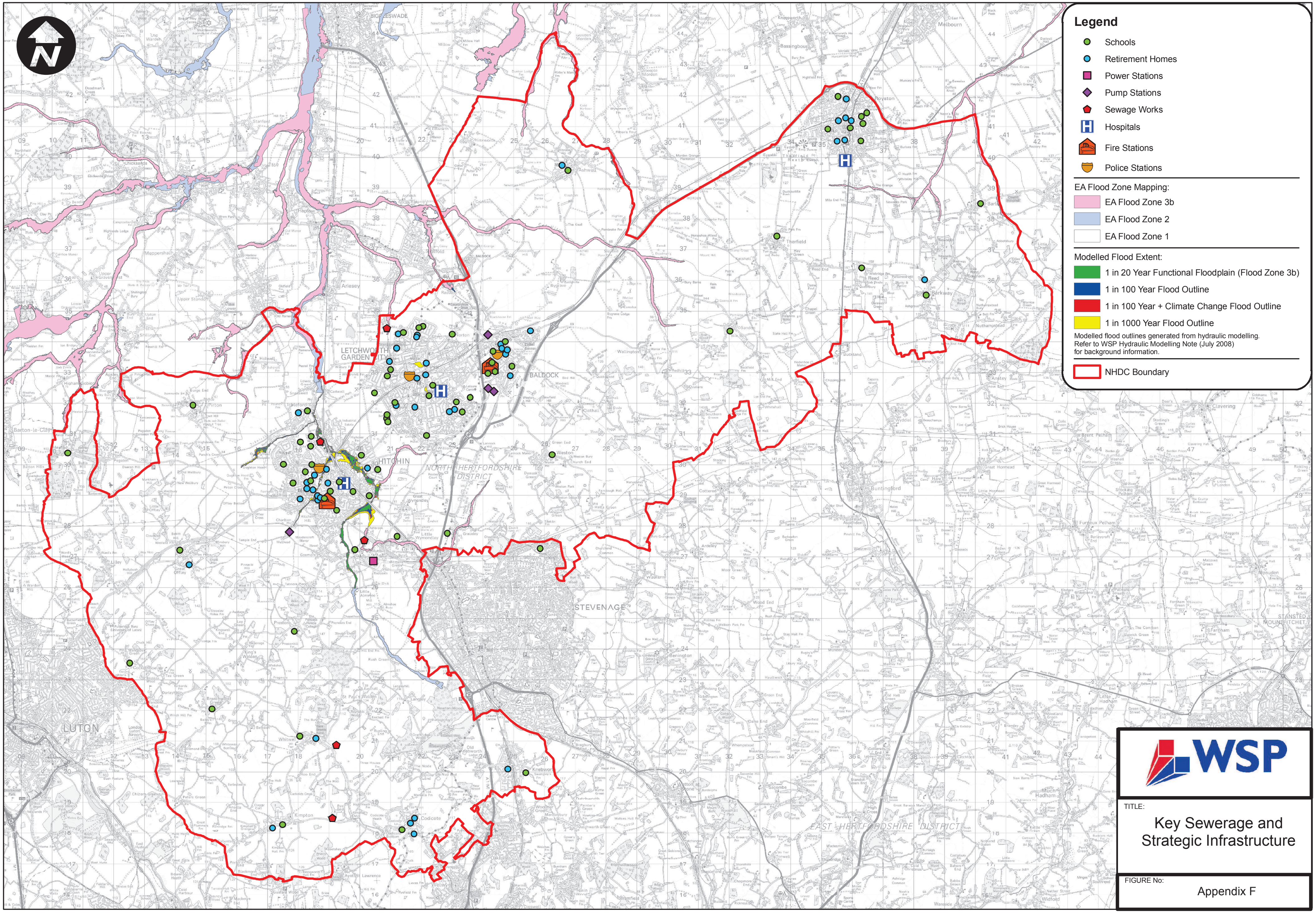


0 0.5 1 Kilometers

NTS

Produced by WSP Group ©
Last Updated: August 5, 2007



WSP

TITLE:

Key Sewerage and Strategic Infrastructure

FIGURE No:

Appendix F

0 0.5 1 Kilometers

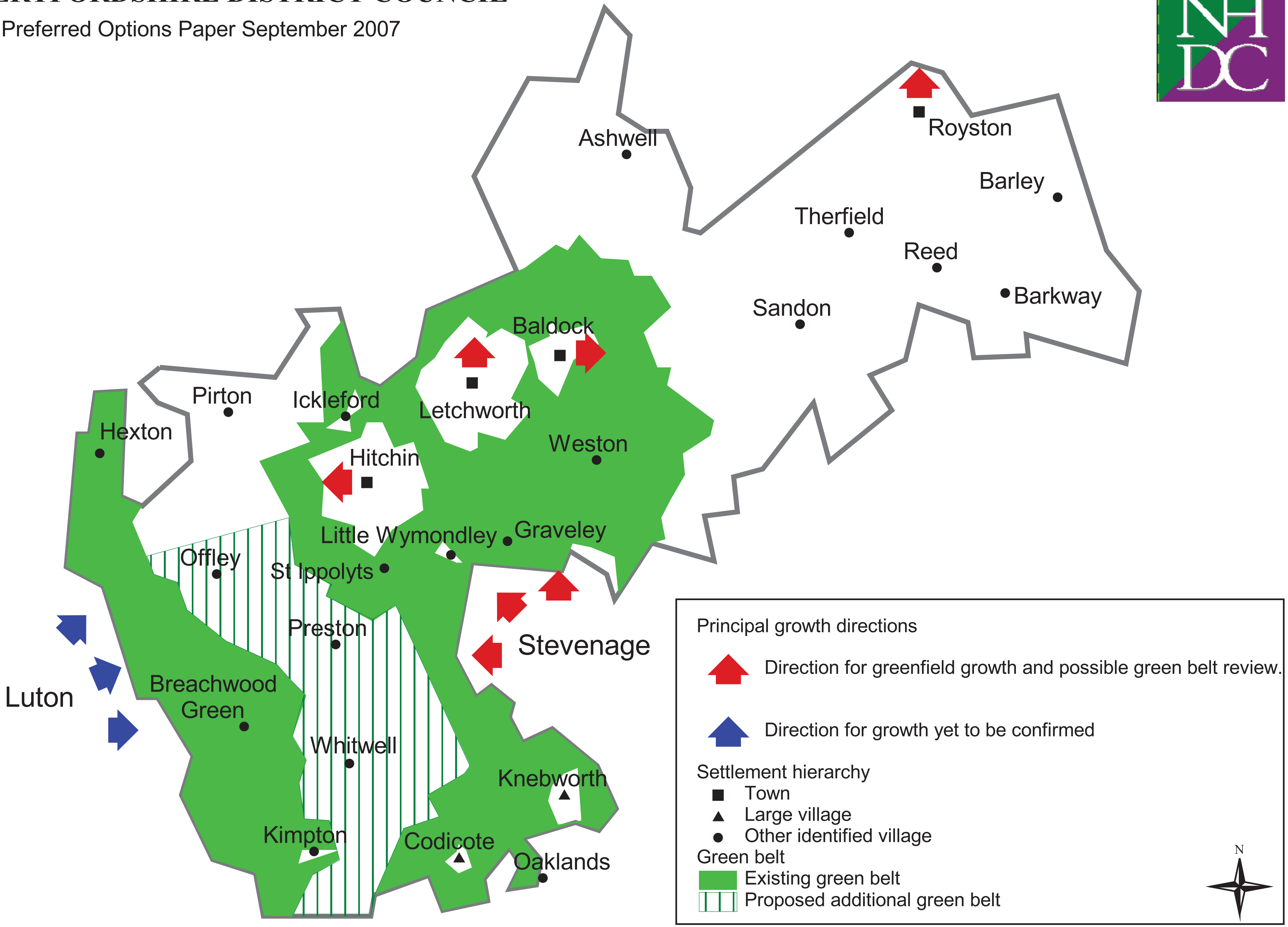
NTS

Produced by WSP Group ©
Last Updated: July 2, 2008

NORTH HERTFORDSHIRE DISTRICT COUNCIL

Core Strategy Preferred Options Paper September 2007

Key Diagram

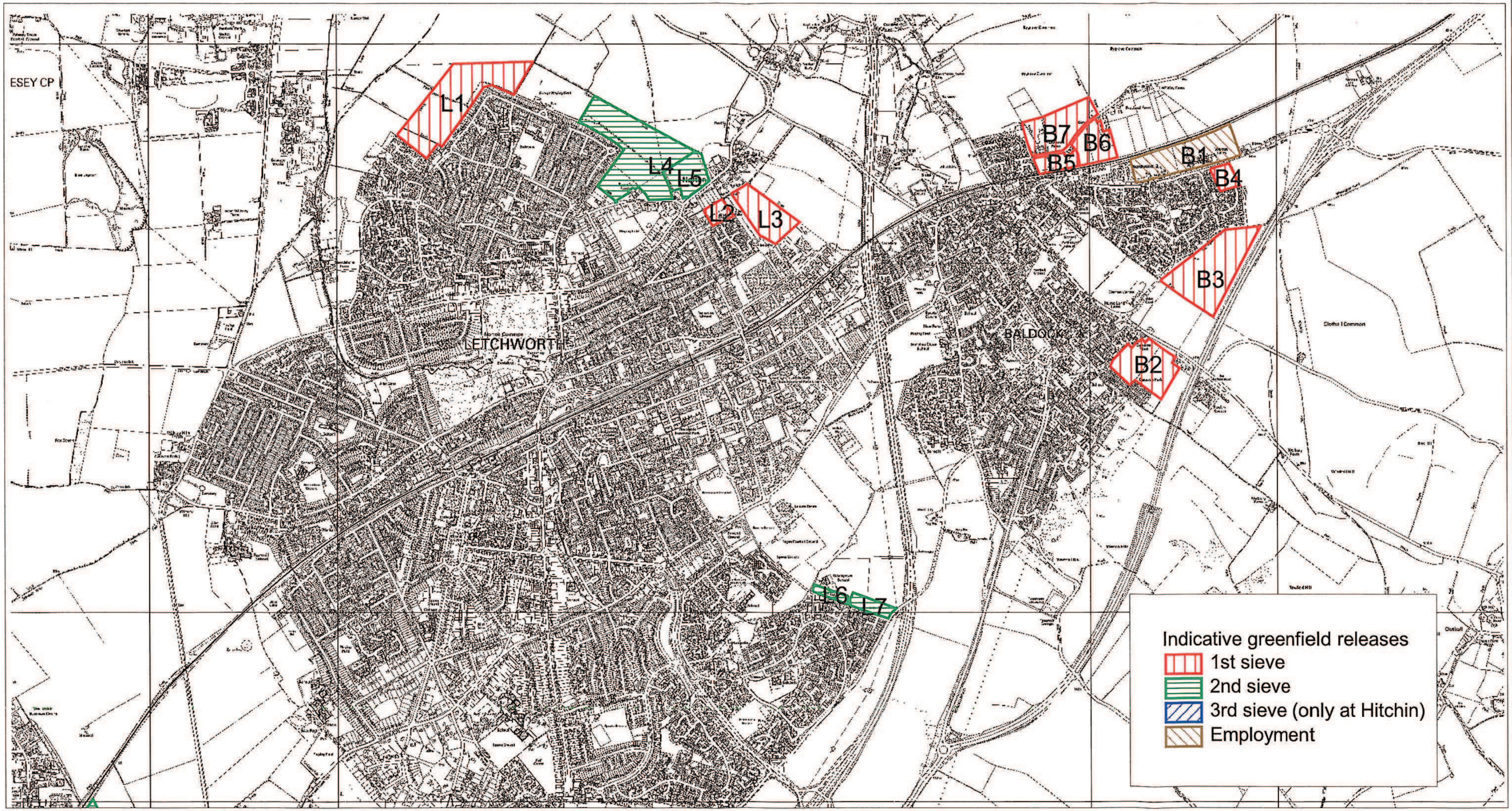


This map was produced by Planning Policy & Projects, North Hertfordshire District Council

Scale 1 : 150,000 at A4

NORTH HERTFORDSHIRE DISTRICT COUNCIL

Possible development zones around Baldock and Letchworth Garden City
To identify transport and utilities constraints

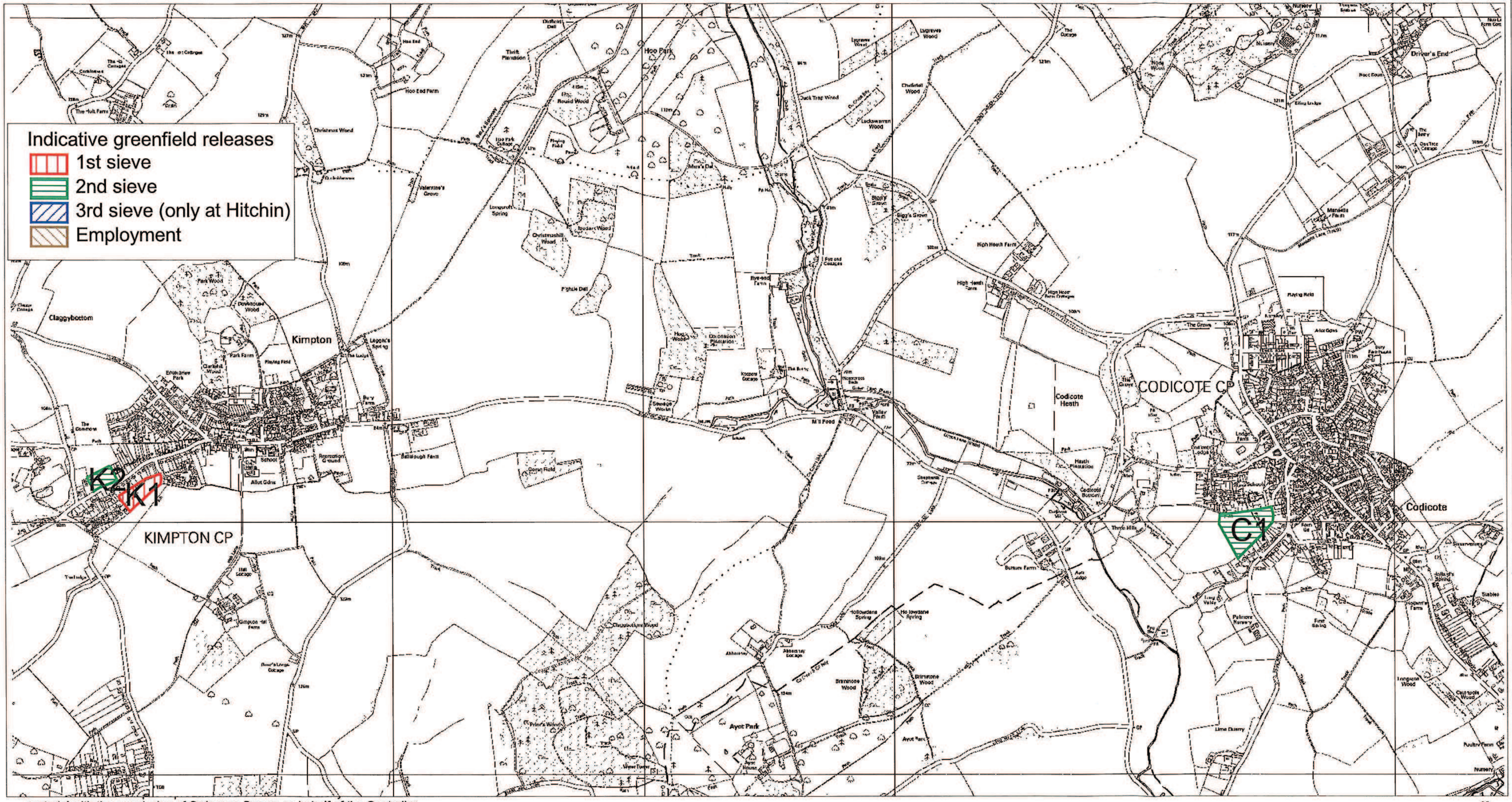


Scale 1 : 20,000 at A3

This map was produced by North Hertfordshire District Council

NORTH HERTFORDSHIRE DISTRICT COUNCIL

Possible development zones around Codicote and Kimpton
To identify transport and utilities constraints



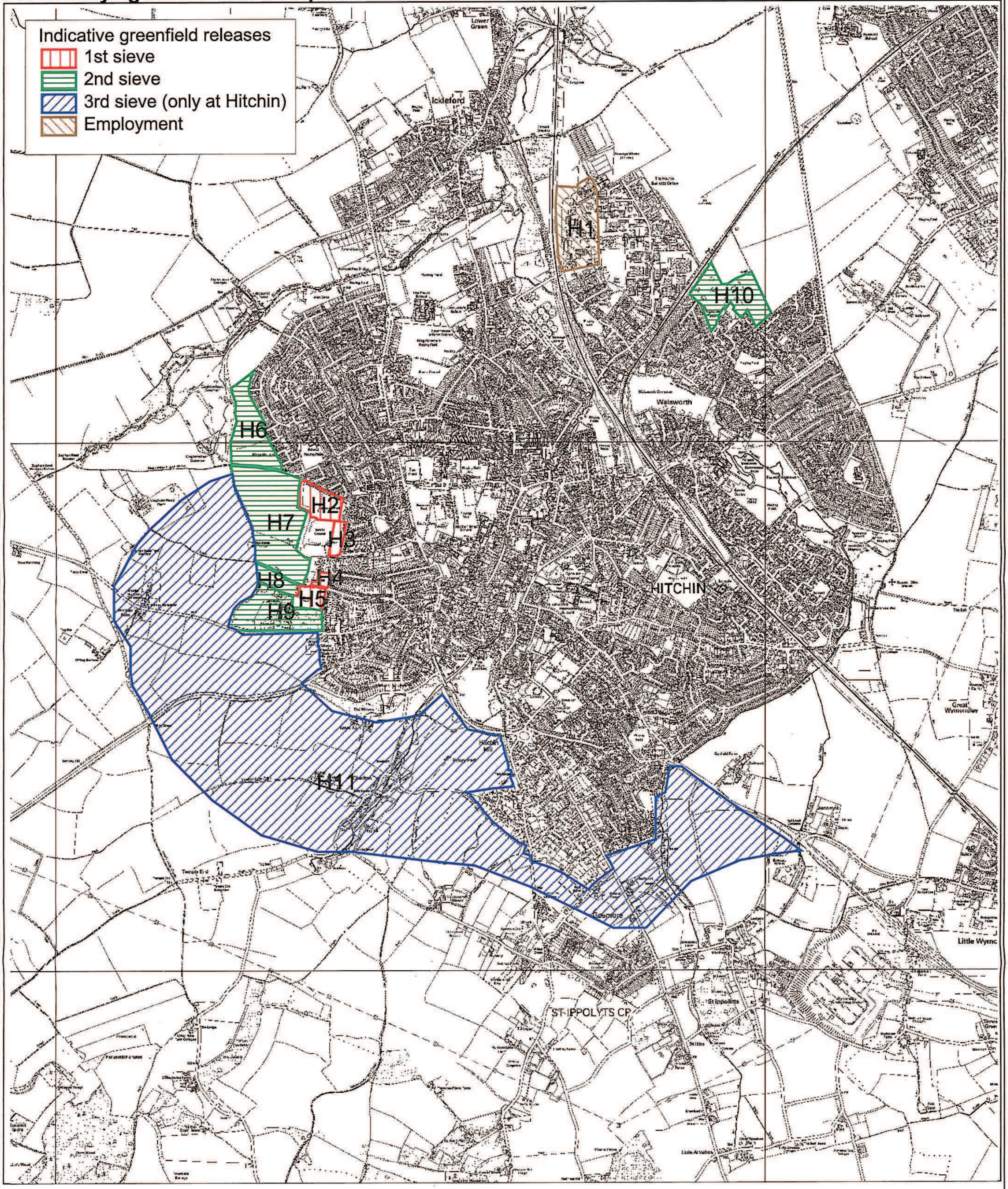
Scale 1 : 15,000 at A3

This map was produced by North Hertfordshire District Council

NORTH HERTFORDSHIRE DISTRICT COUNCIL

Possible development zones around Hitchin

For identifying utilities and transport constraints



This map was produced by North Hertfordshire District Council

Scale 1 : 20,000 at A3

N

SUDS INFORMATION

1 ALTERNATIVE SUDS TECHNIQUES

Background

1.1 Traditionally, built developments have used piped drainage systems to manage storm water and convey surface water run-off away from developed areas as quickly as possible. Typically these systems connect to the public sewer system for treatment and/or disposal to local watercourses. Whilst this approach rapidly transfers storm water from developed areas, the alteration of natural drainage processes can potentially impact on downstream areas by increasing flood risk and reducing water quality.

1.2 Due to the difficulties associated with updating sewer systems it is uncommon for sewer and drainage systems to keep pace with the rate of development / re-development and the increasingly stringent controls placed on discharges to watercourses. As development progresses these systems become inadequate for the volumes and rates of storm water they receive, resulting in increased flood risk and / or pollution of watercourses. In the future this problem is likely to be exacerbated as the impact of climate change is predicted to lead to higher rainfall intensity storms.

1.3 In addition, as flood risk has increased in importance within planning policy, a disparity has emerged between the design standard of conventional sewer systems (1 in 30 year) and the typical design event (1 in 100 year) for assessing flood risk. This often results in developments with inadequate drainage for the required flood return period. This often leads to potential flood risk from surface water sewers and combined sewer systems.

1.4 A sustainable solution to these issues is to reduce the volume and / or rate of water entering the sewer system and watercourses

SUDS Techniques

1.5 SUDS techniques can be used to reduce the rate and volume of surface water discharges from sites to the receiving environment (i.e. natural watercourse or public sewer etc), as well as improve the water quality. Various SUDS techniques are available, however the techniques operate on two main principles:

- Infiltration
- Attenuation

All systems generally fall into one of two categories, or a combination of the two.

1.6 The design of SUDS measures should be undertaken as part of the drainage strategy and design for a development site. A ground investigation will be required to access the suitability of using infiltration measures, with this information being used to assess the required volume on on-site storage. Hydrological analysis should be undertaken using industry approved procedures such as the Flood Estimation Handbook to ensure a robust design.

1.7 The viability of alternative SUDS techniques would need to be robustly assessed as part of any site specific FRA, and must take full account of a number of criteria, including:

- Underlying Geology and results of on-site Geo-Environmental Investigations;
- Proximity of Groundwater Table;
- Long term maintenance and management of the SUDS asset;
- Sewerage Undertaker's criteria relating to any public sewer systems that would rely upon the function of the SUDS asset; Environment Agency criteria relating to protection of underlying groundwater and water resources; Contaminated Land issues (refer to NHDC Contaminated Land Officer).

1.8 During the design process, liaison should take place with the Local Planning Authority, the EA, Thames Water / Anglian Water in order to establish that the design methodology is satisfactory and to also agree on a permitted rate of discharge from the site.

1.9 Building Regulations advise that a SUDS hierarchy be followed in order to select the appropriate solution for a development site, with preference given to infiltration techniques over attenuation systems, provided that underlying conditions allow.

Infiltration SUDS

1.10 This type of SUDS relies on discharges to ground, where suitable ground conditions allow. Therefore, infiltration SUDS are reliant on the local ground conditions (i.e. permeability of soils and geology, the groundwater table depth and the importance of underlying aquifers as water resources etc) for their successful operation.

1.11 Various infiltration techniques are available for directing the surface water run-off to ground. However, development pressures and a desire to maximise development potential often results in typically small land areas available for infiltration systems. This small area, allied to the rapid rates of runoff generation often require some form of supplementary attenuation as part of the infiltration system. The storage may be provided in the sub-base of a permeable surface, within the chamber of a soakaway, as a pond / water feature, or within underground storage pipes / tanks.

1.12 Infiltration measures include the use of permeable surfaces and other systems that are generally located below ground.

Permeable Surfaces

1.13 Permeable surfaces are designed to allow water to drain through to a sub-base at a rate greater than the rain that falls onto the surface. Permeable surfaces act by directly intercepting the rain where it falls and are therefore true source controls. In theory this system would prevent any surface water running off the site, however in reality it is impractical to design permeable surfaces to directly infiltrate intense rainfall events. The permeable sub-base can be used to temporarily store infiltrated run-off underground allowing it to percolate into the ground below. Alternatively, stored water within the sub-base can be discharged from the site.

1.14 Maintenance programmes will need to ensure that the surface is kept clear of silt and voids are clear. The use of grit and salt during the winter months will adversely affect the drainage potential of paved surfaces, however this should not be required often as ice is less likely to form on these types of surfaces.

1.15 Types of permeable surfaces include:

- **Grass / Landscaped Areas:** Grassed or landscaped areas provide a permeable surface that allows for the infiltration of rain falling onto these areas, and potentially also run-off from adjacent impermeable areas. Grassed or landscaped areas are a relatively inexpensive SUDS measure, however they are likely to be restricted to areas where vehicles are not present.
- **Reinforced Grass:** Techniques are available that allow grass to be incorporated into a pavement type surface. These provide varying ratios of hard-pavement to grass dependant on the site requirements. These range from concrete block arrangements to plastic meshes and can be used in those areas where the hard permanence of a typical pavement might be undesirable, such as in conservation areas, roadside verges, emergency services access, canal towpaths, farm tracks, rural settings etc. In the past these systems have been typically adopted for situations where a load bearing surface is required to fit into the surrounding environment, however these systems are often now installed for surface water management purposes. The grass: hard pavement ratio will be one of the dominant factors that determine the rate of infiltration through to the sub surface.
- **Gravel:** A bed of gravel with a high void space on a permeable sub-base offers a cost effective solution for trafficked areas. Rain falling directly onto the area is able to infiltrate through to the sub-base.
- **Solid Paving with Void Spaces:** Solid paving can be installed in such a way that voids are present that can be in-filled with a permeable material such as grass or gravel etc. If this is to be used as a SuDS measure, a permeable sub-base is required to allow infiltration into the underlying ground and/or temporary storage to attenuate discharges.
- **Permeable Pavements:** Permeable pavements allow the rain falling directly onto the area to infiltrate through into a sub-base and where suitable, through into the underlying strata. Permeable pavements are constructed using porous concrete blocks allowing the infiltration of rainwater. Small projects of less than 100m^2 (depending on sub-grade permeability) can often be managed using 100% infiltration, whereas larger schemes will often require a combined system, with some form of attenuation provided as back-up for periods of exceptional flows. The use of geo-membranes can trap pollutants and prevent them being carried into the receiving environment. The use of an impermeable membrane beneath the sub-base will work to contain any pollutants within the sub-base. One major advantage of tanked permeable paving systems is that any significant contamination, for example, a diesel spillage, will be restricted to the immediate area and not transported into local sewers or watercourses. The performance of permeable pavements will dramatically decrease over a period of time with the clogging of voids and this should be taken into consideration during the design process and maintenance.

Sub Surface Infiltration

1.16 Where permeable surfaces are not a practical option more defined infiltration systems are available. In order to infiltrate the generated run-off to ground, a storage system is provided that allows the infiltration of the stored water into the surrounding ground through both the sides and bottom of the storage. These systems are constructed below ground and therefore may be advantageous with regards to the developable area of the site. However consideration needs to be given to construction methods and maintenance access to any development that takes place over an underground infiltration system. Consideration is also needed of the depth to the groundwater table. The provision of large volumes of infiltration / storage underground has potential cost implications and infiltration devices should not generally be built within 5m of a building, under a road or on soil that may dissolve or be washed away, in line with Building Regulations advice.

1.17 Various methods for providing sub-surface infiltration include:

- **Geocellular Systems:** Modular block systems can be used to provide an underground infiltration facility. The modular structures are usually made of plastic and can be staked side by side or on top of each other to construct an infiltration/storage unit of the required size. The modular blocks are usually sited upon a highly permeable sub-base through which the surface water run-off is discharged (usually through the perforated pipes). The outlet from the pipes are restricted, which causes the run-off to rise up through the sub-base into the geocellular storage system. The storage systems are usually tanked with a geomembrane. These types of systems are quick and easy to install, flexible in their configuration, and have minimal maintenance requirements (providing the inflow of silt is limited). While many manufacturers claim that their products are suitable for installation beneath roadways or car parks, their use in these areas should be considered with caution. Geocellular systems can also be used for providing storage without infiltration in order to attenuate discharge rates. In these situations the system is tanked with a geomembrane or similar.
- **Filter Drain:** A filter drain is a trench that contains a perforated or porous pipe that runs along its bottom. The trench is filled with a suitable filter material, granular material or lightweight aggregate fill, all with a high void space. The fill may be exposed at the ground surface or capped with turf, topsoil etc that allow the trench to flood (i.e. not an impermeable surface that could pressurise the trench). Surface water run-off generated by the site is directed through the perforated pipe which then flows into the trench and infiltrates into the surrounding ground. Filter drains have been used extensively for highways and car parking areas, where they have generally been constructed in the verge and median strip.
- **Soakaway (Chamber):** Surface water run-off is directed to a chamber set in the ground with holes in the sides and base. This allows the stored water to soak into the ground. The storage capacity of soakaway chambers are limited and therefore they are more suited to serve dwellings rather than large developed areas. The chambers are prone to silting up over time and, therefore, need regular maintenance.
- **Soakaway (Trench):** Where the linear space is available, soakaways that use a trench rather than a chamber may be used to manage the runoff from larger areas.

- **Soakaway (Granular Soakaway):** similar to a filter drain, a soakaway (either chamber or trench) filled with a high percentage void, granular material can be used to store surface water runoff as it is infiltrated into the surrounding ground. The granular fill will offer structural strength to the soakaway although the storage volume will be substantially reduced.

Attenuation SUDS

1.18 Where site ground conditions are deemed unsuitable for the widespread implementation of infiltration techniques, surface water runoff will need to be attenuated using on-site attenuation storage. While this is a SUDS technique that will reduce the rate of discharge from the site, the overall volume will not be minimised using on-site storage alone. An important factor that needs to be taken into consideration when assessing the suitability of on-site storage is the volume required, and the impacts the storage will have on development proposals and risks to neighbouring properties.

1.19 Should the use of infiltration not be feasible, on-site storage will be required in order to attenuate the discharge from the site. An allowable rate of discharge from the site will need to be agreed with the Environment Agency, Thames Water / Anglian Water, and the LPA. This can have significant implications to the proposed development with regards to the large volume of storage that may be required. On-site storage can be constructed above ground or below ground; the above ground systems usually being the cheaper option on a cost per m^3 of storage basis. It should be noted, however, that the below ground systems may pose less constraints on the developable area of the site.

1.20 On-site 'above ground' storage measures include basins and ponds, with 'below ground' facilities generally following the more engineered forms of underground storage.

Basins and Ponds

1.21 Basins are areas that have been re-profiled (or alternatively embanked) to allow for the temporary storage of runoff from a developed site. Basins are drained in such a way that ensures that they are free from water in dry weather. Therefore between periods of rainfall they can be used for other purposes such as open public space, recreation etc. Basins treat run-off in a variety of ways i.e. settlement of solids in still water, absorption by aquatic vegetation or biological activity etc. The construction of basins uses relatively simple techniques. Local varieties of vegetation should be used wherever possible and should be fully established before the basins are used. Access to the basin should be provided such that a maintenance programme can be implemented. This would include inspections, regular cutting of grass, annual clearance of aquatic vegetation and silt removal as required.

1.22 Various types of basins are available to use as SUDS measures. These include:

- **Detention Basins:** A detention basin is designed and constructed to store surface water run-off temporarily in order to attenuate flows over a minimal period of time. Detention basins provide better flow attenuation than floodplains as they store water until the flood has passed. The stored water is then released at a controlled rate after the storm, to avoid flooding downstream. If the runoff is held back for long enough, solids start to settle out of the water, which improves water quality.

- **Extended Detention Basins:** If the period of detention increases to approximately 24 hours, the basin is referred to as an extended detention basin. This results in the surface water runoff being stored beyond the time normally required for attenuation, which provides extra time for natural processes to remove some of the pollutants in the water.

Ponds

1.23 Ponds are similar to basins except that the outflow is configured such that a volume of water is contained during dry weather, usually for amenity, recreational, or agricultural purposes. Ponds are designed to hold the additional surface water runoff generated by the site during rainfall events. Like basins, ponds are designed to control discharge rates by storing the collected runoff and releasing it slowly once the risk of flooding has passed. Ponds can provide wildlife habitats, water features to enhance the urban landscape and, where water quality and flooding risks are acceptable, they can be used for recreation. It may be possible to integrate ponds and wetlands into public areas to create new community ponds. Ponds and wetlands trap silt which may need to be removed periodically. Ideally, the contaminants should be removed at source to prevent silt from reaching the pond or wetland in the first place. In situations where this is not possible, consideration should be given to a small detention basin placed at the inlet to the pond in order to trap and subsequently remove the silt. Depending on the setting of a pond, health and safety issues are an important consideration. The design of the pond can help to minimise any health and safety issues (i.e. shallower margins to the pond to reduce the danger of falling in). A fence may also be required for keeping children and wildlife out.

1.24 Various types of ponds are available to use as SUDS measures. These include:

- **Balancing / Attenuating Ponds:** A balancing or attenuation pond is designed only to store surface water run-off and attenuate discharge until the flood / storm peak has passed. Therefore, storage periods may not be long enough to significantly improve water quality capacity compared with ponds with longer retention times. They contain some water at all times with the water level fluctuating as the runoff passes through the device.
- **Flood Storage Reservoirs:** Flood storage reservoirs are very similar to balancing / attenuation ponds except that they are usually much larger. They are generally used to attenuate fluvial flood flows rather than surface water runoff from developed area and are therefore likely to be used as a SUDS measure. Should an existing flood storage reservoir in the vicinity of the proposed development be identified to offer spare capacity, then depending on ownership and agreement, it may be possible to use the spare capacity for storm water management of development areas.
- **Lagoons:** Should the surface water run-off have a high suspended solids content, a lagoon could be a suitable method for attenuating its discharge to the receiving environment. Lagoons are similar to balancing / attenuation ponds except that they are also designed for the settlement of suspended soils. Usually they are long and narrow in shape to ensure the longest retention time and therefore an efficient removal of suspended solids. However lagoons are usually free of vegetation and therefore do not provide any biological treatment.

- **Retention Ponds:** Retention ponds are designed to detain the surface water run-off for periods between several days and two weeks. This allows for a higher level of settlement, biological treatment and limited attenuation of flows. Retention ponds provide a greater degree of treatment than extended detention basins.
- **Wetlands:** A wetland is similar to a pond except that it has a high proportion of emergent vegetation in relation to open water. Wetlands use plants to make the treatment of surface water run-off more efficient and can allow the detention times required to fully treat the run-off to be reduced to a couple of weeks. Constructed wetlands are ponds with irregular perimeters and undulating bottom contours into which wetland vegetation is purposely placed to enhance pollutant removal from surface water runoff. Surface water runoff enters a constructed wetland through a forebay where the larger solids and course organic material settle out. The runoff discharged from the forebay passes through emergent vegetation which acts to filter organic materials and soluble nutrients. The use of constructed wetlands can be looked at from two perspectives. The first is that the wetland is used primarily to maximise pollutant removal from storm water runoff and also help to attenuate storm water flows. Alternatively, it may be used primarily to control storm water flows, with increased pollutant removal capabilities.

Alternative Forms of Attenuation

1.25 In many situations the development of a site may involve proposals that would inhibit the use of basins or ponds as a means of managing the surface water runoff. This may be due to land take, economic feasibility, or other issues such as health and safety etc. In these situations it may be appropriate to use a storage option that is viewed as being more 'engineered' than an open basin or pond. Most of these methods involve the provision of storage beneath the ground, which may be advantageous with regards to the developable area of the site. However, consideration needs to be given to construction methods, maintenance access, and to any development that takes place over an underground storage facility. The provision of large volumes of storage underground also has potential cost implications.

1.26 Methods for providing alternative attenuation include:

- **Deep Shafts**: Deep shafts can be utilised in areas with low groundwater tables, though they should only be used under exceptional circumstances.
- **Geocellular Systems:** See previous discussion.

Oversized pipes: Oversizing the pipes that make up the on-site drainage network is a cost effective method that is often used for providing attenuation storage within the network. The main draw back is that it can be very difficult to obtain the required level of storage as the pipe diameters are often restricted by the depth of cover (vertical distance between top of pipework and ground surface) available and the need to gravity drain into an existing network. A solution to this is to lay multiple pipes side by side. However this increases the excavation areas and may also place restrictions on the development footprint. The use of oversized pipes is not an effective method of providing on-site storage if the network is at a relatively steep gradient. This is because the storage at the upstream end of the pipe is unlikely to be used.

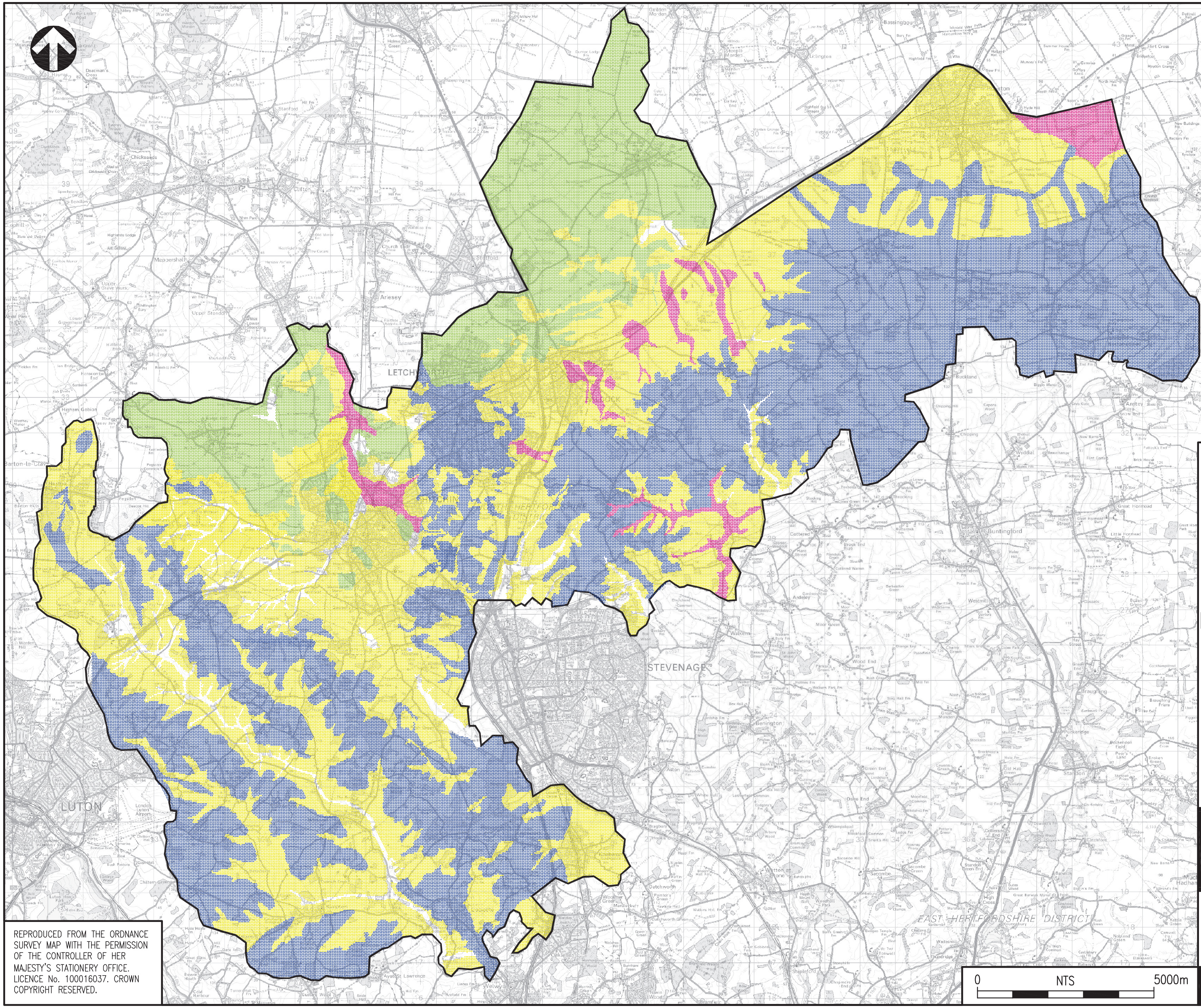
- **Rainwater Harvesting:** Rainwater harvesting is the process of collecting rain that falls directly onto roofs (and in some cases hardstanding areas) such that it can be re-used for non-potable uses around the home or business (typically flushing toilets, car washing and irrigation etc). The simplest form of rainwater harvesting involves the collection of runoff from a roof via a water butt situated at the bottom of a down pipe. This water can then be used for irrigation. For systems where the collected runoff is to be used for toilet flushing, washing machines etc, it is likely that the water would be pumped from a storage tank installed on the grounds of the property. Packaged systems are available although the costs (including ongoing maintenance) may outweigh the payback in terms of reduced water supply charges. The use of rainwater harvesting fits well with the overall water cycle, as it may assist with a minor reduction in volumes of off-site runoff 'post development' together with reducing overall demand for potable water. Rainwater harvesting will not be considered in terms of reducing the volume of storage required on site due to the possibility of bypassing or overflowing in wetter months.

- **Tanks:** There are a number of tanks available for the provision of storage to attenuate surface water runoff. While most storage tanks are installed beneath the ground, above ground storage tanks may be feasible for industrial or commercial developments, where amenity issues or space are not significant restrictions. Tanks are likely to be prefabricated, but could also be constructed in-situ for below ground concrete tanks. Plastic and Glass Reinforced Plastic (GRP) tanks are also often used, with sizes of up to $25m^3$ being available off the shelf (although larger tanks used above ground may have additional reinforcing requirements). Consideration must be given to below ground tanks with regards to cover depths, load bearings, and also invert depths should the tank be drained by gravity. The storage requirements need to be based on a sound hydrological assessment, as undersizing the tank would be costly to remediate.
- **Green Roofs:** A roof area that is used for growing appropriate types of vegetation, which provides a degree of retention and attenuation. In addition, vegetation and substrate can absorb a range of pollutants. Green roofs are more suitable for public and institutional buildings that have good maintenance programmes and support. Green roofs are available in both prefabricated and in-situ construction however they are heavy systems and can have major structural implications for buildings and are usually impractical to retro-fit.

Combined Infiltration / Attenuation Systems

1.27 In most situations, SUDS systems include both infiltration and storage. Most of the techniques identified above can be used in combination, however dedicated infiltration and attenuation systems include swales and filter strips.

- **Swales:** A swale is a grass-lined channel designed to control both the flow rate and quality of surface water run-off that is generated by the adjacent site. Not only does the water run down the sides of the swale at a reduced speed, but it can also be slowed further as it flows along the channel before being discharged from the site. This detention of the runoff also increases the infiltration from the swale.
- **Filter Strips:** A filter strip runs along the edge of a permeable area and is sloped to allow the sheet flow across the vegetated strip. Unlike a swale however, no storage is offered other than what is held back by the vegetation. The overland flow across the filter strip is likely to run into a water course at some point rather than being formally collected and discharged at a controlled rate from the site.



KEY: SUDS VIABILITY

- UNSUITABLE DRIFT/SUITABLE SOLID
- UNCERTAIN
- YES
- NO
- NHDC BOUNDARY

NOTES:

1. THIS PLAN HAS BEEN PRODUCED USING INFORMATION TRANSCRIBED FROM BRITISH GEOLOGICAL SURVEY MAPPING, SHEETS 204, 205, 220, 221, 22 AND 239.

2. THE PLAN SHOULD BE READ IN CONJUNCTION WITH SECTION 5.13 OF THE NHDC SFRA

0 NTS 5000m

WSP

TITLE:

SUDS VIABILITY PLAN

FIGURE No:

APPENDIX H

Site Specific FRA 'Toolkit'

A.1 OVERVIEW OF FLOOD RISK

A.1.1 Mapping within Appendix E of the North Hertfordshire District SFRA provides a pictorial representation of the variation in flood risk across the district.

A.1.2 NHDC should review the risk of flooding posed to a particular site by reference to the attached maps. Clear planning and development control recommendations have been provided in Section A.6, to be applied only once the Sequential Test has been applied in accordance with PPS25 (refer to Sections 1.5 and 6.2 of the SFRA).

A.1.3 It is highlighted that, in addition to a risk of flooding from rivers, there is also a potential risk of flooding from localised sources, including sewers, blocked gullies and culverts, and surface water runoff. This is more difficult to predict, and within more intensely urbanised areas within the district, may occur at any location and / or point in time. It is essential that all future development is designed to minimise the potential impacts of localised flooding (e.g. through the provision of SUDS, overland flood flow routing, and careful location of on-site flood detention areas).

A.1.4 Within Sections A.3 and A.4, a 'toolkit' has been provided to inform NHDC and prospective developers of the likely flood risk issues to be addressed on a site-specific basis.

A.2 SCOPE OF THE DETAILED FLOOD RISK ASSESSMENT

A.2.1 The SFRA is a strategic document that provides an overview of flood risk throughout the area. It is imperative that a site based Flood Risk Assessment (FRA) is carried out by the developer for all proposed 'major' developments, and this should be submitted as an integral part of the planning application.

A.2.2 The site specific FRA toolkit has been based upon planning policies and information available at the time of report issue (July 2008). Flood risk classifications may be subject to change in line with future planning policy. It should also be noted that flood zoning may be subject to change following consideration of detailed topographical information, and following investigation of site specific flood risk issues in further detail as part of the site specific FRA required to be undertaken by developers to accompany any future planning applications for 'major' development, and for any proposed development in a medium or high probability flood risk area.

A.2.3 Flood risk will need to be considered by developers as part of any specific development proposals in the future. Developers must:

- carry out site specific FRA's;
- engage the EA from the outset; and
- seek guidance from the EA on requirements for a FRA.

A.2.4 The FRA should be commensurate with the risk of flooding to the proposed development. For example, where the risk of flooding to the site is negligible (e.g. 'low probability' Flood Zone 1), there is little benefit to be gained in assessing the potential risk to life and / or property as a result of fluvial (river) flooding. Rather, emphasis should be placed on ensuring that runoff from the site does not exacerbate flooding lower than in the catchment. The particular requirements for FRAs, for specific development uses, and within each delineated flood zone are outlined within Sections A.3 and A.4.

A.2.5 In all areas, a localised risk of flooding may also occur, typically associated with local catchment runoff following intense rainfall passing directly over the local catchment area. This localised risk of flooding must also be considered as an integral part of a detailed FRA.

A.3 FRA TOOLKIT: BY PROPOSED DEVELOPMENT USE

A.3.1 Set out below is an initial guide to the key issues identified as part of this SFRA, but this is not an exhaustive list. The exact scope and requirements of any site specific FRA will be set by the Environment Agency and North Hertfordshire District Council. It is recommended that early consultations take place with the EA in order to ensure a satisfactory FRA is prepared and submitted with any future planning application for new development. Reliable site level information, preferably in the form of a topographical survey, verified to Global Positioning System (GPS) datum, will be required in the first instance to determine the actual flood zone for the site.

Essential Infrastructure

A.3.2 The FRA will need to address the safe access and egress to any bridge structures or other essential infrastructure to be sited in flood risk areas. The design of any bridge deck arrangements will need to allow sufficient clearance (to be advised by the EA) above the 1 in 100 year flood level (incorporating an allowance for climate change) and ensure that no afflux is generated by the proposed deck and parapet arrangements.

A.3.3 The FRA will need to ensure that the infrastructure is designed and constructed to:

- Remain operational in times of flood
- Compensate the nett loss of floodplain storage
- Not impede water flows
- Not increase flood risk elsewhere

Other Proposed Development

A.3.4 The FRA should consider the appropriateness of proposed development uses in flood risk areas in line with Table D.3 of PPS25.

A.3.5 Further investigation of any recently modelled flood levels and topography will give a better understanding of the flooding mechanism of the site.

A.3.6 Sustainable drainage techniques to be implemented where appropriate as part of the development proposals.

A.3.7 Surface water runoff should look to be controlled as close to the source as possible with run-off rates set to mitigate any impact to the receiving environment and to seek to provide a tangible reduction in flood risk to adjacent and downstream areas prone to historic flooding.

A.3.8 The developer should **seek to reduce runoff rates <u>and</u> volumes to the receiving surface water drainage system** and watercourse ‘post development’ in order to reduce the flood risk to downstream areas prone to historic flooding. For areas served by separate sewer systems, a 20% reduction in surface water flows should be sought ‘post development’ for the lifetime of the development. Nil detriment should be viewed as the absolute minimum requirement. Discharge rates from the proposed development into the receiving watercourse should be agreed by the EA or IDB.

A.3.9 The impact of foul and surface water flows resulting from proposed development upon the receiving combined public sewer should be assessed, following liaison with Thames Water / Anglian Water and the EA. For areas served by combined sewer systems, a 20% reduction in net foul and surface water flows should be sought 'post development' for the lifetime of the development. Nil detriment should be viewed as the absolute minimum requirement.

A.3.10 The FRA should take into account the requirements for safe access (dry access where possible), and compensatory flood storage to mitigate any loss of potential flood storage volumes as a result of development proposals.

A.3.11 Where volumes of flood storage are displaced by the development proposals, compensatory flood storage must be provided within the site (or upstream) on a 'level for level', 'volume for volume' basis up to and including the 1 in 100 year flood level incorporating climate change. This compensation must be achieved on land that does not currently flood and is attached to the existing floodplain.

A.3.12 Climate change impacts should also be considered for all types of flooding (including sewer flooding) and minimum finished floor levels for the development should be set above the 1 in 100 year flood level (incorporating climate change), with an allowance for freeboard.

A.3.13 Appropriate to the scale and nature of the development, the FRA should take into account residual risks due to extreme events and potential culvert blockages.

A.3.14 A risk-based Sequential Test should be applied at all stages of the planning process on a case by case basis. In areas at risk from fluvial or sea flooding, preference should be given to locating new development in Flood Zone 1. If there is no reasonably available site in Flood Zone 1, the flood vulnerability of the proposed development can be taken into account in locating development in Flood Zone 2 and then Flood Zone 3. If, following the application of the Sequential test it is not possible or consistent with wider sustainability objectives, for the development to be located in zones of lower probability of flooding, the Exception Test can be applied.

A.3.15 PPS25 describes the Exception Test as providing a 'method of managing flood risk while still allowing necessary development to occur'. For the Exception Test to be passed it must be demonstrated that;

a) the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment where one has been prepared;

b) the development should be on developable previously developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable previously developed land; and

c) a FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible will reduce flood risk overall.

A.4 FRA TOOLKIT : BY FLOOD ZONE

Proposed Development within Zone 3a 'High Probability' and Zone 3b 'Functional Floodplain' (Developed Areas)

A.4.1 All FRAs supporting proposed development within both Zone 3b 'Functional Floodplain' (existing developed areas only) and Zone 3a 'High Probability' should include an assessment of the following :

- The vulnerability of the development to flooding from other sources (e.g. surface water drainage, groundwater) as well as from river flooding. This will involve discussion with the Environment Agency, Thames Water / Anglian Water, District Council and County Council to confirm whether a localised risk of flooding exists at the proposed site.
- The vulnerability of the development to flooding over the lifetime of the development (including the potential impacts of climate change), i.e. maximum water levels, flow paths and flood extents within the property and surrounding area. The Environment Agency may have carried out detailed flood risk mapping within localised areas that could be used to underpin this assessment. Where available, this will be provided at a cost to the developer. Where detailed modelling is not available, hydraulic modelling by suitably qualified engineers will be required to determine the risk of flooding to the site.
- The effect of the new development upon depth and velocity of floodwater. This will require a detailed assessment, to be carried out by a suitably qualified engineer.
- Volumes of flood storage displaced as a result of the development proposals. Compensation should be provided on a level for level, volume for volume basis up to and including the 1 in 100 year event including climate change; compensation should be provided on land that does not currently flood and is attached to the existing floodplain.
- The potential for the development to increase flood risk elsewhere through the addition of hard surfaces, and the effect of the new development on surface water runoff. Details of proposed mitigation measures and SUDS must be provided, with accompanying hydraulic calculations to demonstrate the robustness of the approach taken. A tangible reduction in surface water flows should be sought 'post development' for the lifetime of the development.
- For areas deemed to be protected by flood defences or alleviation schemes, the risk of breach (failure) of defences or exceedance of their design criteria. This will require a detailed assessment, to be carried out by a suitably qualified engineer.
- A demonstration that residual risks of flooding (after existing and proposed flood management and mitigation measures are taken into account) are acceptable. Measures may include flood defences, flood resistant and resilient design, escape / evacuation, effective flood warning and emergency planning.
- Details of existing site levels, proposed site levels and proposed ground floor levels. All levels should be stated relevant to Ordnance Datum (confirmed by Global Positioning System Datum).

Proposed Development within Zone 2 'Medium Probability' (Incorporating Areas Affected by the 1 in 100 Year Flood Including Climate Change)

A.4.2 For all sites within Zone 2 'Medium Probability' a high level FRA should be prepared based upon readily available existing flooding information, sourced from the EA, and should include an assessment of the following :

- The vulnerability of the development to flooding from other sources (e.g. drainage, groundwater) as well as from river flooding. This will involve discussion with the Environment Agency, Thames Water / Anglian Water, District Council and County Council to confirm whether a localised risk of flooding exists at the proposed site.
- The vulnerability of the development to flooding over the lifetime of the development (including the potential impacts of climate change).
- Volumes of flood storage displaced as a result of the development proposals. Compensation should be provided on a level for level, volume for volume basis up to and including the 1 in 100 year event including climate change; compensation should be provided on land that does not currently flood and is attached to the existing floodplain.
- A demonstration that residual risks of flooding are effectively managed through, for example, the provision of raised floor levels, and the provision of a planned evacuation route and / or safe refuge.
- The potential for the development to increase flood risk elsewhere through the addition of hard surfaces, and the effect of the new development on surface water runoff. Details of proposed mitigation measures and SUDS must be provided, with accompanying hydraulic calculations to demonstrate the robustness of the approach taken. A tangible reduction in surface water flows should be sought 'post development' for the lifetime of the development.
- Details of existing site levels, proposed site levels and proposed ground floor levels. All levels should be stated relevant to Ordnance Datum (confirmed by Global Positioning System Datum).

Proposed Development within Zone 1 'Low Probability'

A.4.3 For all sites within Zone 1 'Low Probability' a basic FRA should be prepared, and should include an assessment of the following:

- Alternative sources of flooding (e.g. urban drainage and / or groundwater).
- The potential for the development to increase flood risk elsewhere through the addition of hard surfaces, and the effect of the new development on surface water runoff. Details of proposed mitigation measures and SUDS must be provided, with accompanying hydraulic calculations to demonstrate the robustness of the approach taken. A tangible reduction in surface water flows should be sought 'post development' for the lifetime of the development.

A.4.4 From perusal of flood zone mapping it can be readily established that despite a history of flooding, the Kimpton area lies within Flood Zone 1. Any proposed development within the Kimpton area must pay due regard to the historical flood routes, and not exacerbate existing levels of risk within the Kimpton area, and downstream.

A.4.5 From perusal of flood zone mapping it can be readily established that land West of Stevenage lies predominantly within Flood Zone 1. Any proposed development within this area must pay due regard to the subterranean drainage inter-connectivity of this area to the River Hiz and its tributaries, and not exacerbate existing levels of risk within the downstream catchment areas.

POTENTIAL FLOOD MITIGATION MEASURES

A.4.6 The SFRA provides specific recommendations with respect to the provision of sustainable flood risk mitigation opportunities that will address both the risk to life and the residual risk of flooding to development within particular 'zones' of the area. These recommendations should form the basis for the site-based FRA, and have been briefly set out below.

Raised Floor Levels and Basement Thresholds (Freeboard)

A.4.7 The raising of finished floor levels above the 1 in 100 year fluvial flood level will ensure that the damage to property is minimised.

A.4.8 Wherever possible, finished floor levels should be situated a minimum of 300mm above the 1 in 100 year plus climate change flood level, determined as an outcome of the site based FRA. A minimum of 600mm above the 1 in 100 year flood level should be adopted if no specific climate change data is available. The height that the floor level is raised above flood level is referred to as the 'freeboard'.

A.4.9 The use of basements within flood affected areas should be discouraged. Where basement uses are permitted however, it is necessary to ensure that the basement access points are situated 300mm above the 1 in 100 year flood level plus climate change. The basement must be of a waterproof construction to avoid seepage during flooding conditions. Habitable uses of basements within flood affected areas should not be permitted.

Sustainable Drainage Systems (SUDS)

A.4.10 SUDS is a term used to describe the various approaches that can be used to manage surface water drainage in a way that mimics the natural environment. The management of rainfall (surface water) is considered an essential element of reducing future flood risk to both the site and its surroundings.

A.4.11 SuDS may improve the sustainable management of water for a site by:

- Reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream;
- Reducing volumes and the frequency of water flowing directly to watercourses or sewers from developed sites;
- Improving water quality over conventional surface water sewers by removing pollutants from diffuse pollutant sources;
- Reducing potable water demand through rainwater harvesting;
- Improving amenity through the provision of public open space and wildlife habitat;
- Replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

A.4.12 In catchment terms, any reduction in the amount of water that originates from any given site is likely to be small. But if applied across the catchment in a consistent way, the cumulative affect of a number of sites could be significant.

A.4.13 There are numerous different ways that SUDS can be incorporated into a development and the most commonly found components of a SUDS system are described in the Section 5.13 of the SFRA. The appropriate application of a SUDS scheme to a specific development is heavily dependent upon the topography and geology of the site (and its surrounds). Careful consideration of the site characteristics must be assured to ensure the future sustainability of the adopted drainage system.

A.4.14 For more guidance on SUDS, the following documents and websites are recommended as a starting point:

- CIRIA C697 – The SUDS Manual, 2007
- CIRIA C698 – Site Handbook for the Construction of SUDS, 2007
- National SUDS Working Group- Interim Code of Practice for Sustainable Drainage Systems, 2004

www.ciria.org.uk/SUDS/

A.4.15 Furthermore, the Environment Agency (Thames Region) has issued best practice guidance for Sustainable Drainage Systems (October 2006), available from the Environment Agency development control teams. This provides clear hierarchy for SUDS, reflecting the degree of sustainability offered by the SUDS application as captured in Table I.1 below:

Most Sustainable

SUDS Technique	Flood Reduction	Water Quality Improvement	Landscape & Wildlife Benefit
Living Roofs	✓	✓	✓
Basins and ponds - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✓	✓	✓
Filter strips and swales	✓	✓	✓
Infiltration devices - Soakaways - Infiltration trenches and basins	✓	✓	✓
Permeable surfaces and filter drains - gravelled areas - Solid paving blocks - Porous paving	✓	✓	
Tanked systems - Over-sized pipes/tanks - Storms cells	✓		

Least Sustainable

Table I.1

A.5 LOCAL COMMUNITY ACTIONS TO REDUCE FLOOD DAMAGE

A.5.1 Where properties are deemed to be at 'significant' risk of flooding (i.e. situated in Flood Zone 3) it is essential to provide the community with the knowledge (and tools) that will enable them to help themselves should a flood event occur.

A.5.2 Details of flood warning and flood resilience have been set out within the following 'community based measures' that local communities may introduce to minimise the damage sustained to their own homes in the event of flooding.

Flood Warning

A.5.3 Where available, communities in flood risk areas should be registered upon the EA's Floodline facility. While this may not always cover the specific local watercourses that pose the greatest risk to the locale, advance warning of the onset of extreme weather conditions may be gathered and actions taken by residents at a local level.

Flood Resilience/Resistance

A.5.4 Flood resistance involves constructing a building in such a way so as to prevent floodwater entering the structure and damaging it's fabric. Flood resilience involves constructing a building so as to permit floodwater to enter the structure but to reduce the impact of any damaged caused (i.e. no permanent damage is caused, structural integrity is maintained and drying and cleaning are facilitated). Details of flood resilient construction can be found within the Department for Communities and Local Government publication; 'Improving the Flood Performance of New Buildings published in May 2007. Examples of flood resilient and resistant measures that can be adopted are listed below;

Raising of floor levels (Resistance)

The raising of floor levels above the anticipated maximum flood level ensures that the interior of the property is not directly affected by flooding, avoiding damage to furnishings, wiring and interior walls. It is highlighted that plumbing may still be impacted as a result of mains sewer failure.

Raising of electrical wiring (Resilience)

The raising of electrical wiring and sockets within flood affected buildings reduces the risks to health and safety, and reduces the time required after a flood to rectify the damages sustained.

Use of sacrificial construction materials (Resilience)

These are materials used in housing fittings that are likely to be damaged in case of flooding but can also be repaired i.e. gypsum plaster board. This would be used for a 'water entry' strategy where the emphasis is placed on allowing water into the building, facilitating draining and consequent drying.

Flood boards / gates (Resistance)

The placement of a temporary watertight seal across doors, windows and air bricks to avoid inundation of the building interior. This may be suitable for relatively short periods of flooding, however, the porosity of brickwork may result in damage being sustained should water levels remain elevated for an extended period of time.

Boundary walls and fencing (Resistance)

Boundary walls and fencing can be designed with high water resistance materials and/or effective seals to minimise water penetration for low depth, short duration floods (but not for groundwater flooding).

A.6 DEVELOPMENT CONTROL RECOMMENDATIONS

Future Developments within Zone 3b 'Functional Floodplain' (developed areas)

A.6.1 Table D.3 of Planning Policy Statement 25: Development and Flood Risk (PPS25) advises that only essential infrastructure and water compatible development uses are appropriate in Flood Zone 3b.

A.6.2 Any proposed future development within Zone 3b 'Functional Floodplain' will require a detailed Flood Risk Assessment (FRA).

A.6.3 SUDS should be implemented to ensure that runoff from the site is not increased and where possible reduced; any SUDS design must take due account of groundwater and geological conditions.

A.6.4 As previously mentioned in section A.3.10, dry access is to be provided wherever possible (above the 1 in 100 year flood level) to enable the safe evacuation of residents and / or employees in the event of flooding. In exceptional circumstances where this is not achievable, safe access must be provided at all locations, defined in accordance with DEFRA research as outlined in "Flood Risks to People" (FD2320). It is essential to ensure that the nominated evacuation route does not divert evacuees into a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event.

A.6.5 Proposed development shall not result in an increase in maximum flood levels within adjoining properties. This may be achieved by ensuring (for example) that the existing building footprint is not increased and / or flood plain compensation should be provided on a level for level, volume for volume basis up to the 1 in 100 year event including climate change.

A.6.6 A suitable buffer zone (advice must be sought from the EA) must be provided to 'top of bank' within sites immediately adjoining the river corridor. The Environment Agency (EA) has established a policy directive that encourages the retention of an open river corridor for environmental and recreational purposes. Future development should give due consideration to these directives, ensuring a setback from the riverfront is provided where practicable.

Future Development within Zone 3a 'High Probability'

A.6.7 All proposed future development within Zone 3a 'High Probability' will require a detailed Flood Risk Assessment (FRA), in compliance with PPS25, current guidance and policy. All potential sources of flood risk are to be considered.

A.6.8 Minimum finished floor levels must be situated above the 1 in 100 year predicted maximum flood level plus climate change, incorporating a 300mm allowance for freeboard.

A.6.9 Where possible, dry access is to be provided (above the 1 in 100 year flood level) to enable the safe evacuation of residents and / or employees in the event of flooding. Where this is not achievable, safe access must be provided at all locations.

A.6.10 Basements are not to be utilised for habitable purposes. All basements must provide a safe evacuation route in times of flood, providing an access point that is situated above the 1 in 100 year plus climate change flood level.

A.6.11 The SUDS principles relevant to Flood Zone 3b should be applied to Flood Zone 3a.

A.6.12 Proposed development shall not result in an increase in maximum flood levels within adjoining properties. This may be achieved by ensuring (for example) that the existing building footprint is not increased; compensation should be provided on a level for level, volume for volume basis up to the 1 in 100 year event including climate change.

A.6.13 As with Flood Zone 3b, a suitable buffer zone (advice must be sought from the EA) must be provided to 'top of bank' within sites immediately adjoining the river corridor.

Future Development within Zone 2 'Medium Probability'

A.6.14 All proposed future development within Zone 2 'Medium Probability' will require a Flood Risk Assessment (FRA) in compliance with PPS25, current guidance and policy, that is commensurate with the risk posed to the proposed development. All potential sources of flood risk are to be considered.

A.6.15 Minimum finished floor levels must be situated above the 1 in 100 year predicted maximum flood level plus freeboard, incorporating a 300mm allowance for climate change.

A.6.16 Where possible, dry access is to be provided (above the 1 in 100 year flood level). In exceptional circumstances where this is not achievable, safe access must be provided at all locations, defined in accordance with the emerging DEFRA research as outlined in "Flood Risks to People" (FD2320).

A.6.17 SUDS should be implemented to ensure that runoff from the site (post redevelopment) is not increased.

Future Development within Zone 1 'Low Probability'

A.6.18 All proposed 'major' future development within Flood Zone 1 'low probability' will require a basic Flood Risk Assessment (FRA), in compliance with PPS25, current guidance and policy. Major development is typically defined as that exceeding 9 residential units, or any development site exceeding 0.5 hectare. The FRA will need to focus primarily upon drainage impact assessment, implementation of appropriate forms of SUDS, and control of surface water runoff. It is important, however, that all potential sources of flood risk are considered.

A.6.19 Control of surface water runoff will involve the introduction of SUDS techniques.

WSP