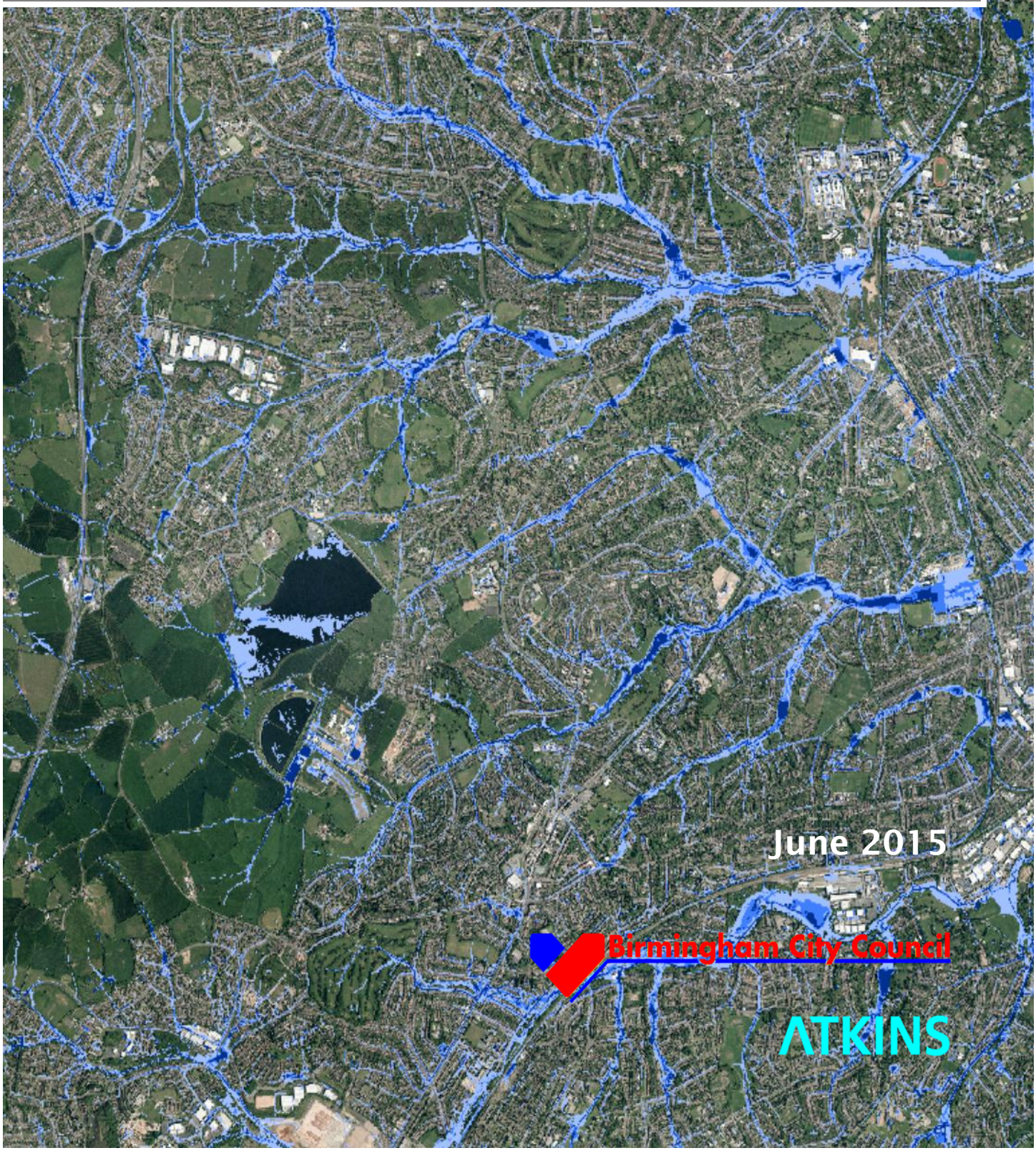
Surface Water Management Plan for Birmingham

Final Report



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Birmingham City Council

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1. Introduction

1.1. Background

On 18th August 2009 DEFRA on behalf of the Government announced that Birmingham City Council (BCC) would be allocated £300,000 to produce a Surface Water Management Plan (SWMP) (DEFRA1, 2010). The grant allocation was based on an assessment of the estimated number of properties susceptible to surface water flooding resulting from severe rainfall, with Birmingham having an estimated 22,900 properties and therefore being the highest ranked settlement outside of London.

The SWMP process is a framework through which key local partners with responsibility for surface water and drainage in their area work together to understand the causes and effects of surface water flooding and agree the most cost effective way of managing surface water flood risk for the long term. The process of working together as a partnership is designed to encourage the development of innovative solutions and practices. The purpose is to make sustainable urban surface water management decisions that are evidence based, risk based, future proofed and inclusive of stakeholder views and preferences.

The SWMP is the culmination of this collaborative process; a description of the level of risk posed and an agreement about who will do what to better manage these risks. A SWMP should establish a long-term action plan to manage surface water in an area and should influence future capital investment, drainage maintenance, public engagement and understanding, land-use planning, emergency planning and future developments.

In this context, surface water flooding describes flooding from sewers, drains, small watercourses and ditches that occurs during heavy rainfall in urban areas. It includes:

- Pluvial flooding – flooding as a result of high intensity rainfall when water is ponding or flowing over the ground surface (surface runoff) before it enters the underground drainage network or watercourse, or cannot enter it because the network is full to capacity.
- Sewer flooding[1] – flooding which occurs when the capacity of underground systems is exceeded, resulting in flooding inside and outside of buildings. Normal discharge of sewers and drains through outfalls may be impeded by high water levels in receiving waters.
- Flooding from small open-channel and culverted urban watercourses[2] which receive most of their flow from inside the urban area.
- Overland flows from the urban/rural fringe entering the built-up area, including overland flows from groundwater springs.

The framework for undertaking a SWMP study is illustrated through a wheel diagram (Figure 1-1), identifying the four principal phases: Preparation, Risk Assessment, Options, and Implementation and Review. The first three phases involve undertaking the SWMP study, whilst the fourth phase involves producing and implementing the action plan, based on the evidence gained from the SWMP study. It is based on a widely adopted generic approach to evidence and risk based decision making.

[1] *Consideration of sewer flooding in "dry weather" resulting from blockage, collapse, or pumping station mechanical failure is excluded from SWMPs as this is for the sole concern of the sewerage undertaker*
[2] *Interactions with larger rivers and tidal waters can be important mechanisms controlling surface water flooding*

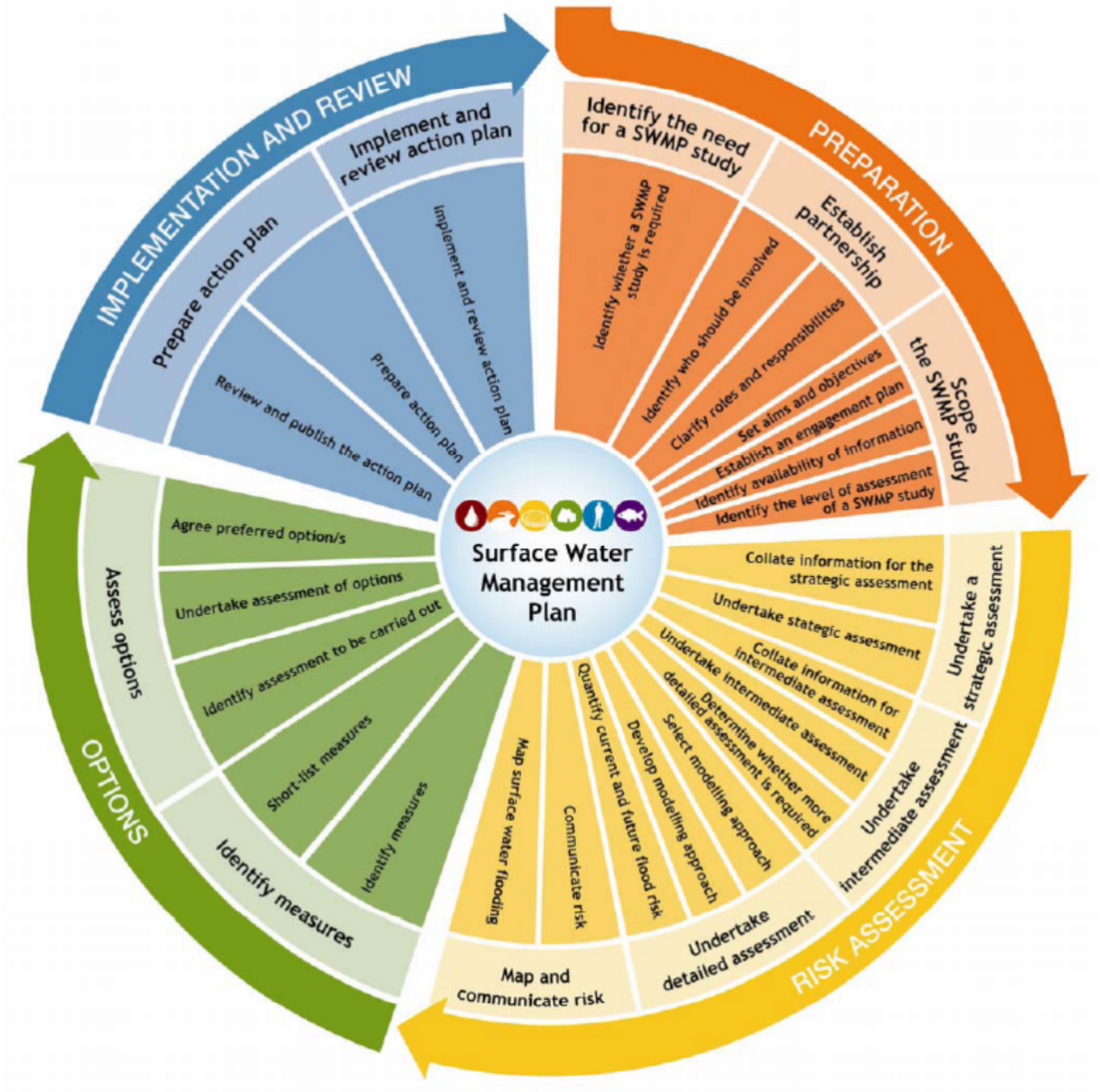


Figure 1-1 – Surface Water Management Plan Wheel

1.2. This Report

This report describes the work that has been undertaken to complete the SWMP for Birmingham and covers the four phases identified by the SWMP Guidance (DEFRA2, 2010) (hereafter referred to as "*the guidance*"): preparation, risk assessment, options and implementation and review, however the review element will continue for a number of years following the development and implementation of the action plan.

Following the completion of each stage this report will be updated to summarise the work undertaken and provide the results/findings of that stage. The purpose of this approach is to ensure that the findings from all phases are reported in a single document; this report is therefore a 'live' document until the final stage of work has been completed.

2. Preparation Phase

2.1. Introduction

This phase of the SWMP focused on preparing and scoping the requirements of the study and is split into three main parts:

- Identifying the need for a SWMP study (which was already identified by DEFRA)
- Establishing a Partnership, and
- Scoping the SWMP study.

2.2. Establishing a Partnership

The guidance identifies that a partnership approach is the most efficient way to co-ordinate flood risk management activities given the complex nature of surface water flooding. A partner is defined as someone (person or organisation) with responsibility for the decision or actions that need to be taken. They will share responsibilities for the decisions and actions and are therefore critical at the outset.

Partner group membership was discussed at the first meeting where Birmingham City Council (BCC), the Environment Agency (EA) and Severn Trent Water (STW) were identified as key partners. The following departments from each of the partner organisations were identified to form part of the partnership:

Birmingham City Council

- Drainage
- Resilience Team
- Climate Change and Adaptation
- Planning Strategy
- Park and Nature Conservation
- Highways (delivered through and Amey Private Finance Initiative (PFI) Contract)

Environment Agency

- Development and Flood Risk
- Flood Risk Mapping and Data Management
- Partnerships and Strategic Overview (latter part of review)

Severn Trent Water

- Flooding
- Asset Management

2.3. SWMP Scope

The aims and objectives for the SWMP which were agreed by the project partners are outlined below.

2.4. Aims

- increased understanding of the causes, probability and consequences of surface water flooding
- increased understanding of where surface water flooding will occur, which can be used to set out priorities for action, maintenance needs, and links into local development frameworks and emergency plans
- increased awareness of the duties and responsibilities for managing flood risk of different partners and stakeholders
- improved public engagement and understanding of surface water flooding
- to establish a long-term action plan to manage surface water in an area
- to identify opportunities where Sustainable Drainage Systems (SuDS) can play a more significant role in managing surface water flood risk and may also contribute to fulfilling the requirements of the Water Framework Directive
- to provide an evidence base to meet the requirements of the Flood Risk Regulations (2009) Preliminary Flood Risk Assessment (PRFA)
- to inform the development of a local flood risk management strategy as required by the Floods and Water Management Act 2010
- to identify opportunities for water quality improvements to inform the Water Cycle Study and assist in meeting the requirements of the Water Framework Directive (WFD)
- to inform the green infrastructure strategy for the City, to include the development of a woodland plan, and
- to enhance the existing evidence base contained in the Strategic Flood Risk Assessment (SFRA).

2.5. Objectives

- to map current and potential surface water flood risk areas, irrespective of source
- to quantify the risk and determine the consequences of surface water flooding, now and in the future
- to establish priorities and understand and compare the merits of different mitigation strategies
- to identify effective, affordable, achievable and, cost-beneficial measures to mitigate surface water flood risk which achieve multiple benefits where possible
- to develop a strategy to inform the strategic planning of drainage provision in large new developments
- to develop an implementation plan showing how partners and stakeholders will work together to finance and implement the preferred strategy
- to engage the community and all stakeholders to share this knowledge, and
- to periodically review the plan and monitor the effectiveness of chosen solutions.

2.6. Engagement Plan

The guidance identifies that during the course of the SWMP study there should be ongoing communication and engagement between partners who should also consider how to engage more widely with stakeholders. The main advantages to stakeholder engagement are identified as:

- Building trust
- Gaining access to additional local knowledge, and
- Increasing chances of stakeholder acceptance.

In order to ensure that this process is effective and the benefits are realised by partners it was agreed that an engagement plan would be drawn up to outline the following:

- Clarify what is to be achieved through stakeholder engagement
- Identify the stakeholders to be reached and why they may need to be engaged
- Identify the levels of engagement the partnership wants from different stakeholders, and
- At what stage of the process engagement with different stakeholders will take place.

At the preparation stage, however, it was agreed by project partners that stakeholders would be initially engaged to provide information on known flooding problems/locations so as to assist with future prioritisation of activities. The partners agreed that greater engagement would occur when the group had a better understanding of surface water flood risk as shown in Table 2-1.

	Partners	Stakeholders	Wider Community
Preparation	✓	x	x
Risk Assessment	✓	x	x
Options	✓	✓	x
Implementation	✓	✓	✓

Table 2-1 – Engagement throughout study

2.6.1. Availability of Information

The guidance states that in the early stages of a SWMP study it is important to understand the availability and quality of data and information to support the SWMP study. It also notes that much data and information will already be held by partners and stakeholders and maximum use should be made of existing sources of evidence, as this will avoid duplication of effort.

In completing the Birmingham Level 1 SFRA (Birmingham City Council & Atkins, 2010) numerous digital data sets were collated which were identified as providing a valuable starting point to understand the availability of information. The data sets that were available from the SFRA are outlined below:

- Locations of strategic development sites
- Locations of existing water features: main river, ordinary watercourses, canals and reservoirs
- Historic flooding locations (for watercourses, surface water, groundwater, sewers, canal breaches and incidents whose cause is unknown)
- Main river flood zones

- Areas Susceptible to Surface Water Flooding Mapping
- Mapping for groundwater flooding susceptibility
- Modelled watercourses
- Drainage Area Plan (DAP) boundaries
- LiDAR coverage
- Rain and flow gauge locations
- Mapped extents for main river fluvial functional floodplain and climate change fluvial model outlines
- Flood Warning Areas, and
- Geological and superficial deposits mapping.

In order to progress the SWMP assessment, the data that could be made available for the study was identified by the project partners. A project data register was established and is provided in Appendix A1 which details the type of data, source, availability, format and quality of the data. It is important to understand the quality of the data so that any uncertainty or perceived weakness is understood and available for consideration during the risk assessment and option appraisal stages. The data register also provides a valuable tool for identifying gaps in data.

Partners also agreed that in considering flood risk we should include data only from 10 years prior to the start of the study (1999 onwards), as many of the flooding issues prior to this are likely to have been alleviated or redevelopment may have taken place which has alleviated the previously reported issues.

2.6.2. Level of Assessment for SWMP Study

A SWMP study can work at several different geographical scales. The guidance considers three 'levels of assessment' (strategic, intermediate and detailed), each operating at a different geographical scale and level of detail. All three levels of assessment may be considered, or alternatively, depending on the geographical scale partners may decide to only undertake one or two levels. Due to the geographical scale of Birmingham it was agreed that all three levels of assessment would be undertaken, as detailed in Table 2.2 below.

Level of Assessment	Scale	Outputs	Why approach is to be used
Strategic Assessment	Birmingham	Broad understanding of locations which are more vulnerable to surface water flooding Prioritised list for further assessment Identify strategic actions which can be introduced for less vulnerable catchments Inform spatial planning	To better understand areas vulnerable to surface water flooding To develop a prioritised list of locations for further assessment Inform SWMP Birmingham Action Plan

Level of Assessment	Scale	Outputs	Why approach is to be used
Intermediate Assessment	Sub-Catchments	Identify local flood risk areas which might require further analysis Identify immediate mitigation measures which can be implemented Inform spatial planning Identify locations where mitigation is unviable and take appropriate action in terms of warning, resilience and resistance and informing emergency planning	To identify a prioritised list of local flood risk areas to consider for detailed assessment To develop a suite of actions to be applied at sub-catchment level as part of the SWMP Action Plan
Detailed Assessment	Local Flood Risk Areas	Detailed assessment of the causes and consequences of flooding, which can be used to understand the flooding, and to test mitigation measures Inform spatial planning Inform Emergency Planning	To develop a suite of actions to be applied at local level as part of the SWMP Action Plan

Table 2-2 – Levels of Assessment

3. Strategic Assessment – Objectives & Methodology

3.1. Introduction

This Section of the report outlines the objectives and methodology used to undertake the strategic phase of the SWMP.

3.2. Strategic Assessment Objectives

Incorporating the SWMP aims and objectives with the guidance, it was agreed that the objectives of the strategic SWMP assessment would be to:

- Identify areas more vulnerable to surface water flooding
- Produce a prioritised list of areas for further assessment, and
- Identify and outline the objectives and associated scopes of work for the subsequent phase of the assessment, the Intermediate phase.

3.3. Approach

To identify and prioritise the areas of Birmingham at risk of surface water flooding, the BCC administrative boundary was disaggregated into catchment areas using the Digital Terrain Model (DTM) contained within the Flood Estimation Handbook (FEH) CD-ROM so as to have regard for catchment wide flooding issues. It was agreed that this would be undertaken to generate a manageable number of relatively large areas, as neither defining every watercourse catchment boundary nor using the large scale catchments of Birmingham (Rivers Tame, Rea and Cole) would provide an appropriate scale to prioritise from. This has meant that the small areas of catchments that drain away from the administrative boundary have been amalgamated with their nearest neighbours, and the large scale catchments being broken down at particular locations. The subcatchments defined and used in the assessment are provided in Appendix B1.

Once the catchment areas had been defined, a scoring method that accounted for the frequency of flooding, the impact of flooding, density of the urban fabric, as well as the confidence and reliability of the data was developed in conjunction with the respective project partners. To have a transparent prioritisation process it was agreed through discussion at stakeholder meetings that for each of the catchments a score would be generated for the following categories:

- the predicted risks of surface water flooding
- the recorded incidents of surface water flooding, and
- the potential for flood alleviation through the re-development process, as the project partners recognised that this is where the greatest gains in regards to flood alleviation may arise, due to the financial constraints of the economic climate at the time of undertaking the assessment.

The three different scores for each of the catchments were then compared and prioritised, giving reasons as to why certain catchments were given priority over others. Appreciating that this scoring method would not account for factors such as scheme implementation, where necessary, or appropriate, the priority of the respective catchments was raised or lowered to account for this, with reason being provided.

3.4. Data and Scoring Methods

As detailed in Section 2.6.1, the Level 1 SFRA (Birmingham City Council & Atkins, 2010) collated and produced a number of flood risk data sets. Whilst the specific objectives of this study do

differ, the data has been re-used, updated, and supplemented where appropriate, or necessary. A summary of the respective data sets and how they have been used in the scoring methods for the strategic SWMP assessment is provided below.

3.4.1. The Predicted Risks of Surface Water Flooding – Data and Scoring Method

3.4.1.1. Susceptibility

To assess how susceptible each of the catchments are to surface water flooding, the EA's Flood Map for Surface Water (FMfSW, updated version used in later stages of the study), has been made use of. Two rainfall events, one with a 1 in 30 (referred to as T30) and the other with a 1 in 200 (referred to as T200) chance of occurring in any year are modelled and mapped. For each rainfall probability, the FMfSW provide two layers indicating the depth of flooding, either greater than 0.1m deep or greater than 0.3m deep.

These maps are a development of the EA's Areas Susceptible to Surface Water Flooding (AStSWF), as they consider:

1. More storm events
2. The influence of buildings, and
3. The influence of the sewer system.

However, whilst these maps are an improvement over the AStSWF maps, they are not without their differences and limitations, and their accompanying guidance notes (EA1, 2010) should be read for a full understanding. One of the issues that are particularly relevant for Birmingham is the fact that they will be less representative over large flat landscapes where there will be locations at risk outside of the areas predicted, as highlighted in the guidance notes where it uses the West Midlands as an example (example 3). Although this does inevitably mean that these maps would need to be improved to make robust flood risk management decisions at a local level, it was agreed that they would be suitable for the objectives of this strategic assessment, since

- Their use would limit any additional modelling that may be just as coarse, or strategic, as the readily available data, and
- Through cross examination it was felt that the mapping did largely represent the incidents of flooding or indicators of flooding. An example is provided in Figure 3.1 (note: the sets of data the FMfSW maps are compared to are described thereafter).

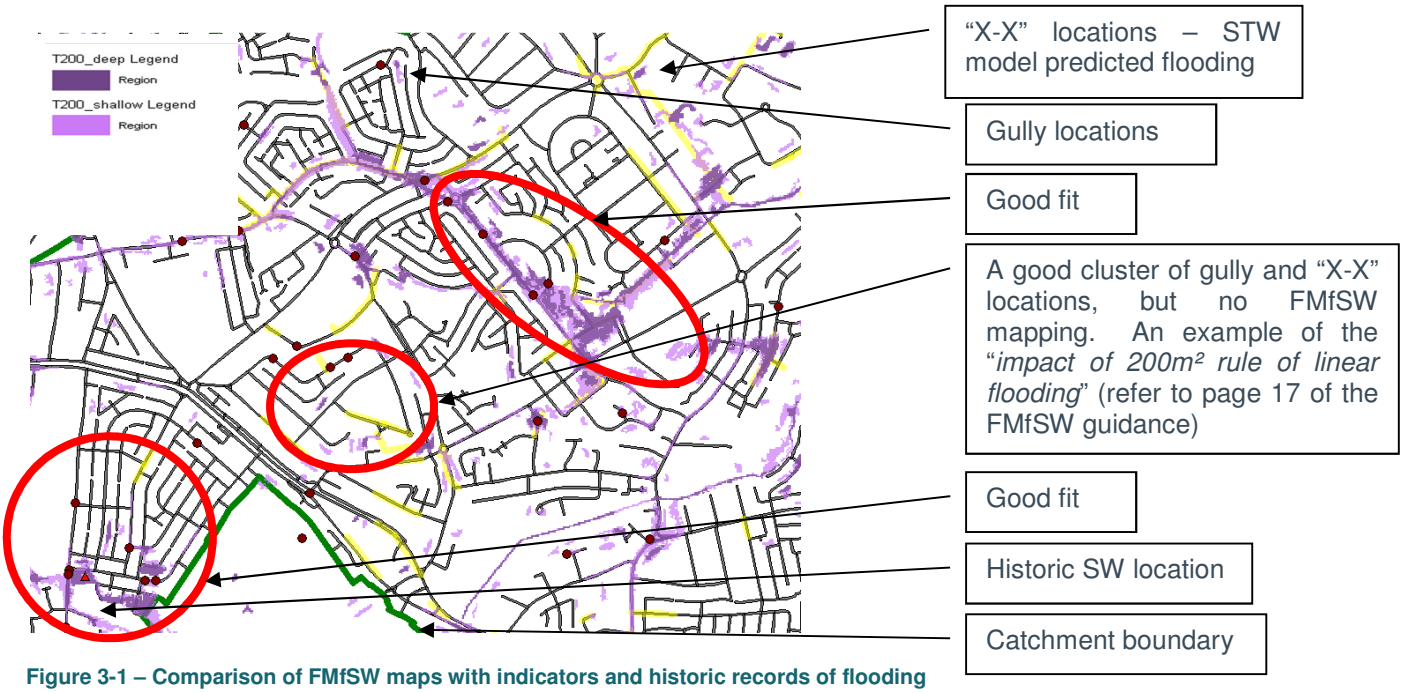


Figure 3-1 – Comparison of FMfSW maps with indicators and historic records of flooding

3.4.1.2. Vulnerability

To determine how vulnerable the respective catchments are to surface water flooding, the FMfSW maps have been overlaid with a buildings and transport layer which have been generated for the purposes of this study. These layers are explained and discussed below.

3.4.1.3. "*The Buildings Layer*"

The buildings layer has been generated by associating each of the Ordnance Survey MasterMap buildings with a National Receptors Database (NRD) property point and removing all of the points not within a building polygon, and not considered to be "properties", e.g. ponds and outbuildings. Where duplicate points could be associated with a particular building polygon, for example a block of flats or a shop front with flats above, the details of the ground floor point have been adopted to represent the building, or what the receptor is. This approach was decided upon, since the methodology (EA2, 2010) used for developing the numbers of properties at risk for the national assessment (the FMfSW data – spatially joining the "topotoid" values in the NRD property points with those contained within the OS MasterMap) was essentially removing 2,400 property points which in instances should have been retained. This is highlighted in Appendix B2 which shows a number of buildings that should quite clearly be retained. This, however, is not to suggest that the methodology used for the national mapping is not appropriate, but rather that the approach used for this study is a refinement of it. Sensitivity testing of this approach is, however, provided in Section 6.

Once the buildings layer had been generated, it was overlaid with the FMfSW maps to determine the buildings at risk of surface water flooding. Using the OS classes provided in Appendix A2, those at risk have then been categorised as follows:

- Residential
- Commercial
- Sensitive properties (e.g. police stations, hospitals)
- Utilities and major transport routes (e.g. a train station), and
- Governmental properties.

The respective categories have then been totalled and divided by the density of the urban fabric (since this is where the greatest risk will lie – determined by dividing the catchment area by the total number of MasterMap buildings) to generate a final score for each of the categories.

3.4.1.4. "The Transport Layer"

The transport layer has been generated for the purposes of this study through the production of a road and railway (including the Metro line) layer. They have both then be used to provide the number of areas that are intersected by the FMfSW maps. This is then divided by the density of the urban fabric to generate a final score, in the same way the buildings layer has been. The method used to generate the respective transport layers is outlined below.

The roads layer has been generated by selecting the reaches of the NRD roads layer that are deemed traffic sensitive by BCC, as these are the roads that would be considered most vulnerable during times of flood, and buffering it by 3.5m either side to generate a "typical" road width. The following categories have been considered traffic sensitive and used to generate the roads layer (note: the "Christmas embargo route" has not been considered due to only operating during the festive season):

- Winter Gritting Route 07:00-19:00, 7 days a week
- Winter Gritting and Christmas Embargo Route 24 Hours a day 7 days, and
- Tourist Route 24 Hours a Day, 7 days a week.

The railways layer (including the Metro line) has been generated by isolating the OS MasterMap railway polygon features, as it was deemed that all the lines of the railway would be just as vulnerable as one another.

3.4.2. The Incidence of Surface Water Flooding – Data and Scoring Method

To assess how prone the respective catchments have been to surface water flooding in the past, the scoring method has made use of the historic records of flooding and data that has been deemed to be an indicator of surface water flooding. Both sets of data have been summed per catchment and then divided by the density of the urban fabric of the catchment to generate a score. The respective data sets used for this scoring method are discussed below.

3.4.2.1. Historic Records

Although strictly speaking the definition of "*surface water flooding*" is defined as any floodwaters on the lands surface, explained further in Section 1.1, only the following historic internal flooding records have been taken forward for the purposes of the strategic assessment:

- Watercourse/fluvial flooding (produced as part of the level 1 SFRA (Birmingham City Council & Atkins, 2010)
- Surface water flooding (produced as part of the level 1 SFRA (Birmingham City Council & Atkins, 2010), and
- Sewer flooding (STW's DG5 "At Risk Flooding Register" for surface water sewers only).

The groundwater and other flooding records that were produced as part of the level 1 SFRA (Birmingham City Council & Atkins, 2010) have not been included in the scoring method, as the records have been deemed to not be that accurate (e.g. historic groundwater flooding locations are not closely aligned with readily available data) or reflective of the risks of surface water flooding (e.g. canal breaches date as far back as 1799).

3.4.2.2. Indicators of Surface Water Flooding

Appreciating that the predicted risks of flooding will inevitably outweigh the actual locations where surface water flooding has occurred, it was decided that the following sets of data would be used to supplement "the incidents of flooding" scoring approach:

- BCC's New gully locations – All the locations where new gullies have been installed between 1999-2010, as a means of highlighting where surface water flooding is/has been problematic

- BCC's gully cleansing locations – All the locations where gullies have been cleaned within two working days of a daily gauged rainfall exceeding 25mm at Frankley and Saltley gauges (rainfall data was provided by the EA and the location of the gauges is provided in Appendix B3), and

- STW's "x-x" diagrams – These illustrate the minimum return periods that cause surcharging and flooding of the piped network, and have been obtained or produced by re-running the respective models to produce Geographical Information System (GIS) layers that highlight which lengths of pipe flood in storm events greater than a 1 in 10 but less than a 1 in 50 chance of occurring in any year. With a buffer of 10m applied to the pipes, the data has been used to provide an indication of which receptors (e.g. residential properties) may be at risk from surface water flooding from the sewer system. Whilst this approach is rather coarse it has been deemed appropriate for the level of assessment at which it is being used.

3.4.3. The Potential for Flood Alleviation through the Re-Development Process – Data and Scoring Method

To assess how much potential for flood alleviation through the re-development process there is across Birmingham, this strategic assessment has determined how many of the potential re-development sites would be deemed to be at risk using the FMfSW maps, and calculated how much of the catchment is covered by a potential redevelopment area or allocation. Due to Birmingham's already developed landscape and limited land supply, these locations are also where it is anticipated population growth will be greatest (Policy SP2 in the Draft Core Strategy) and do then serve to account for both the future flood risk of unabated storm and foul flows entering or exiting the drainage and river systems. The following sets of data provided by BCC have been used as the re-development layer:

- Strategic Housing and Land Allocation Assessment (SHLAA), and

- Draft Core Strategy:

    - Strategic allocations

    - Core employment areas 2010

    - Sustainable urban neighbourhoods

These were then summed per catchment and then divided by the density of the urban fabric of the catchment to generate a score.

3.4.4. The Scoring Matrix

Once the respective data sets had been interrogated, the results were put into a matrix so that the following could be accounted for:

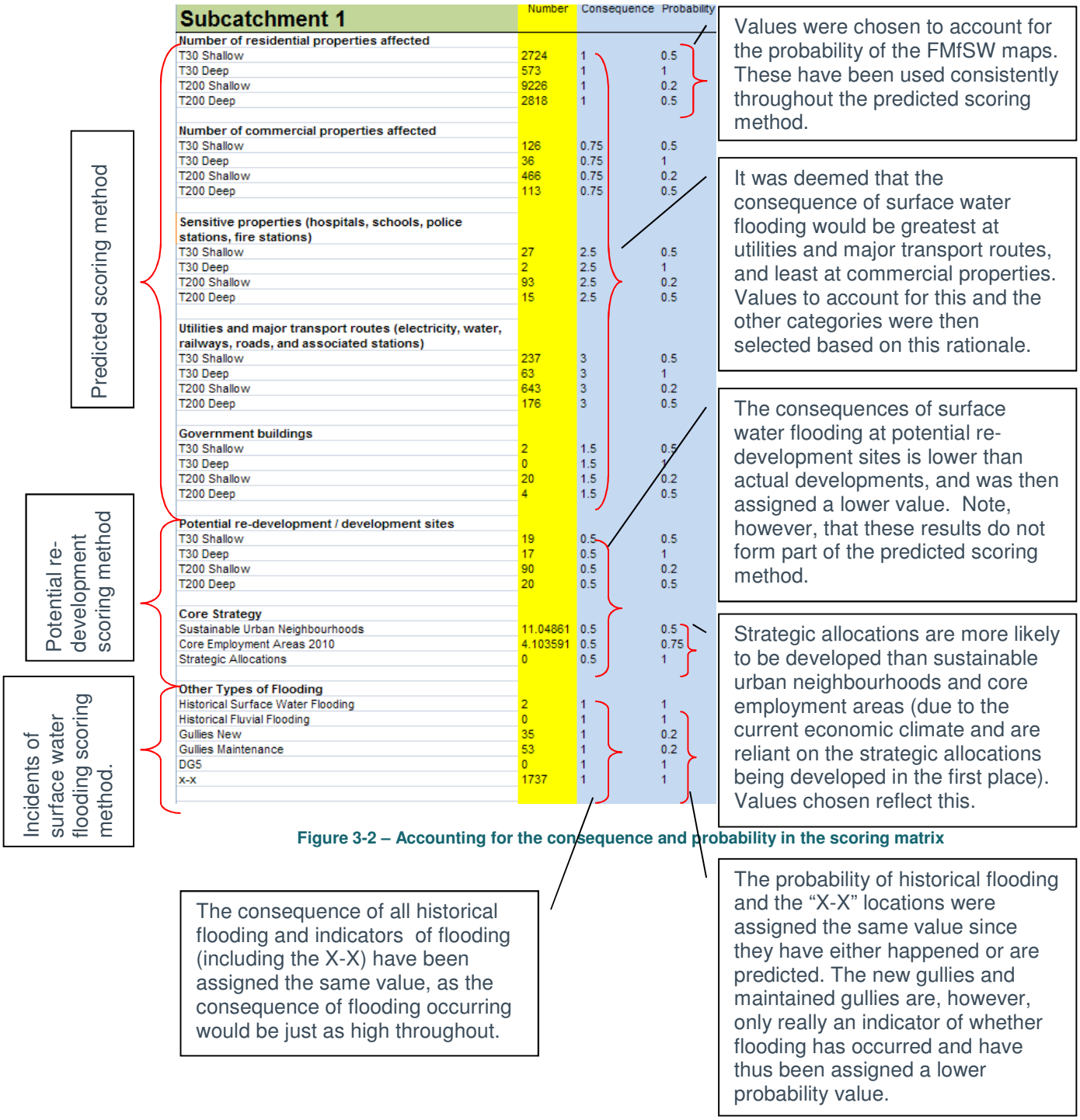
- The probability and consequence of the risk of surface water flooding, and

- The confidence and reliability of the method.

In instances where the final scores would not generate enough, or too much, of a score to influence the total score, for example historical surface water flooding locations, a "control measure" or weighting was used. The factors which have been accounted for in the scoring matrix are discussed in detail under the respective headings below (note: the final score for each of the scoring methods is the sum of both factors).

3.4.5. Accounting for the Probability and Consequence of the Risk

The values used in the scoring matrix were decided upon in conjunction with the partners and were used consistently for each of the catchments assessed. In Figure 3.2, explanation is provided for each of the values used for accounting for the consequence and probability of the results in the scoring matrix.



Subcatchment 1	Number	Consequence	Probability
Number of residential properties affected			
T30 Shallow	2724	1	0.5
T30 Deep	573	1	1
T200 Shallow	9226	1	0.2
T200 Deep	2818	1	0.5
Number of commercial properties affected			
T30 Shallow	126	0.75	0.5
T30 Deep	36	0.75	1
T200 Shallow	466	0.75	0.2
T200 Deep	113	0.75	0.5
Sensitive properties (hospitals, schools, police stations, fire stations)			
T30 Shallow	27	2.5	0.5
T30 Deep	2	2.5	1
T200 Shallow	93	2.5	0.2
T200 Deep	15	2.5	0.5
Utilities and major transport routes (electricity, water, railways, roads, and associated stations)			
T30 Shallow	237	3	0.5
T30 Deep	63	3	1
T200 Shallow	643	3	0.2
T200 Deep	176	3	0.5
Government buildings			
T30 Shallow	2	1.5	0.5
T30 Deep	0	1.5	1
T200 Shallow	20	1.5	0.2
T200 Deep	4	1.5	0.5
Potential re-development / development sites			
T30 Shallow	19	0.5	0.5
T30 Deep	17	0.5	1
T200 Shallow	90	0.5	0.2
T200 Deep	20	0.5	0.5
Core Strategy			
Sustainable Urban Neighbourhoods	11.04861	0.5	0.5
Core Employment Areas 2010	4.103591	0.5	0.75
Strategic Allocations	0	0.5	1
Other Types of Flooding			
Historical Surface Water Flooding	2	1	1
Historical Fluvial Flooding	0	1	1
Gullies New	35	1	0.2
Gullies Maintenance	53	1	0.2
DG5	0	1	1
x-x	1737	1	1

Figure 3-2 – Accounting for the consequence and probability in the scoring matrix

3.4.6. Accounting for the Confidence in the Data and Reliability of the Method

To account for how certain, or uncertain, the results are and how reliable, or unreliable, the method used to generate the results is, values have been included in the scoring matrix in the same way they have been for the probability and consequence of the risk. These values were again decided upon in conjunction with the partners and were used consistently for each of the catchments assessed. In Figure 3.3, an explanation is provided for each of the values used for accounting for the confidence and the reliability of the method in the scoring matrix.

	A	B	C	D	E	F	G	H
1	**Subcatchment 1**	Number	Consequence	Probability	Confidence in data	Reliability of method	Control measure	Score
2	**Number of residential properties affected**							
3	T30 Shallow	2724	1	0.5	1	1	1	1362.00
4	T30 Deep	573	1	1	1	1	1	573.00
5	T200 Shallow	9226	1	0.2	1	1	1	1845.20
6	T200 Deep	2818	1	0.5	1	1	1	1409.00
7								
8	**Number of commercial properties affected**							
9	T30 Shallow	126	0.75	0.5	1	1	1	47.25
10	T30 Deep	36	0.75	1	1	1	1	27.00
11	T200 Shallow	466	0.75	0.2	1	1	1	69.90
12	T200 Deep	113	0.75	0.5	1	1	1	42.38
13								
14	**Sensitive properties (hospitals, schools, police stations, fire stations)**							
15	T30 Shallow	27	2.5	0.5	1	1	1	33.75
16	T30 Deep	2	2.5	1	1	1	1	5.00
17	T200 Shallow	93	2.5	0.2	1	1	1	46.50
18	T200 Deep	15	2.5	0.5	1	1	1	18.75
19								
20	**Utilities and major transport routes (electricity, water, railways, roads, and associated stations)**							
21	T30 Shallow	237	3	0.5	1	0.9	1	319.95
22	T30 Deep	63	3	1	1	0.9	1	170.10
23	T200 Shallow	643	3	0.2	1	0.9	1	347.22
24	T200 Deep	176	3	0.5	1	0.9	1	237.60
25								
26	**Government buildings**							
27	T30 Shallow	2	1.5	0.5	1	1	0.5	0.75
28	T30 Deep	0	1.5	1	1	1	0.5	0.00
29	T200 Shallow	20	1.5	0.2	1	1	0.5	3.00
30	T200 Deep	4	1.5	0.5	1	1	0.5	1.50
31								
32	**Potential re-development / development sites**							
33	T30 Shallow	19	0.5	0.5	1	1	0.5	2.38
34	T30 Deep	17	0.5	1	1	1	0.5	4.25
35	T200 Shallow	90	0.5	0.2	1	1	0.5	4.50
36	T200 Deep	20	0.5	0.5	1	1	0.5	2.50
37								
38	**Core Strategy**							
39	Sustainable Urban Neighbourhoods	11.04861	0.5	0.5	1	1	1	2.76
40	Core Employment Areas 2010	4.103591	0.5	0.75	1	1	1	1.54
41	Strategic Allocations	0	0.5	1	1	1	1	0.00
42								
43	**Other Types of Flooding**							
44	Historical Surface Water Flooding	2	1	1	1	0.5	100	100.00
45	Historical Fluvial Flooding	0	1	1	1	0.45	100	0.00
46	Gullies New	35	1	0.2	1	0.75	1	5.25
47	Gullies Maintenance	53	1	0.2	1	0.75	2	15.90
48	DG5	0	1	1	1	1	100	0.00
49	x-x	1737	1	1	0.5	0.3	0.5	130.28
50								
51								

All values have been assigned the same value apart from the “x-x” diagrams, as there are many limitations with the results it provides (e.g. whether or not the model has been verified).

Due to the buffering of the roads and the fact that the FMfSW map in instances may over estimate the afflux at bridges or openings through railways, the reliability of the method has been reduced.

It was deemed that the DG5 surface water records were the most reliable in terms of the method for accounting for them, and the “x-x” diagrams would be the least (due to detail and currency of the model etc.).

Since residents will only report the elements of the flood that they witness or affect them directly, the associated values for the historical flooding data have been reduced accordingly.

The method for determining the gullies is deemed to be fairly robust and has consequently been assigned a relatively higher value.

Figure 3-3 – Accounting for the confidence and the reliab

4. Strategic Assessment – Assessment of Surface Water Flood Risk

4.1. Introduction

This Section of the report summarises the results of the methods used to undertake the Strategic SWMP assessment by putting them into context with all of the catchments defined for the purposes for this assessment (refer to Section 3.3). The respective scoring matrices for each of the catchments are provided in Appendix A3.

4.2. Overview

Using the approach and scoring methods outlined in Section 3, it is estimated that there are between 6,000 and 70,000 properties at risk due to surface water flooding (Table 4.1), with the approximate number of people at risk between 12,000 and 138,000. The difference between our figures and that produced by the EA using the FMfSW is due to the use of different NRD versions, and changes to the methodology applied to the cross referencing of OS Address Layer 2 and the MasterMap Building Layer.

Receptor	T30 Shallow	T30 Deep	T200 Shallow	T200 Deep
Residential	19713	5255	58761	19663
Commercial	3779	880	10273	3381
Sensitive Properties	168	31	444	131
Utilities and Major Transport Routes (e.g. a train station)	4	1	14	5
Government Buildings	38	9	109	35
Total	**23702**	**6176**	**69601**	**23215**
Approximate No. Of People at risk	46128	12297	137501	46011
Total properties at risk (AStSWF maps & method)	-	-	-	*31900*
Total properties at risk (FMfSW maps & method)	-	-	-	*29300*

Table 4-1 – Properties at Risk of Surface Water Flooding

To help understand the detail of this, and also to help in the prioritisation of other studies (e.g. resilience and adaptation studies), the total number of properties at risk of surface water flooding for the respective sub-categories that make up the categories presented in Table 4.1 have been provided in Appendix A4. The figures in Appendix A4 are the sums of T30 shallow, T30 deep, T200 shallow and T200 Deep in an attempt to "weight" the impact on properties at risk of frequent flooding as an aid to identifying the most vulnerable areas. The numbers are not absolute values of the numbers of properties at risk.

4.2.1. The Predicted Risk of Surface Water Flooding

In Table 4.2 (below) the respective catchments are ranked in regards to how many properties (residential, commercial, sensitive, utilities and major transport routes, and governmental buildings) are at risk per the density of the urban fabric (catchment area divided by the total number of MasterMap buildings in the catchment). To help appreciate which catchments are most at risk, the top 7 catchments (the upper 50%) have been highlighted in red. As can be seen, catchments 10, 13, 7, 9, 6, 5, and 2 are predicted to be most at risk from surface water flooding.

Catchment	Rank
1 (Sheldon)	11
2 (Upper Cole)	5
3 (Lower Cole)	9
4 (Middle Rea & The Bourn)	10
5 (Bourn Brook)	6
6 (Upper Rea)	3
7 (Lower Rea)	2
8 (Hockley Brook)	8
9 (Upper Tame)	4
10 (Plants Brook)	1
11 (North Sutton)	13
12 (East Sutton)	12
13 (Middle Tame)	7
14 (Washwood Heath)	14

Table 4-2 – Ranking of catchments based on the predicted risk of surface water flooding (FMfSW)

4.2.2. The Incidence of Flooding

In Table 4.3 the respective catchments are ranked in regards to how many incidents of flooding (refer to Section 2.3.2) have occurred in the catchment per the density of the urban fabric (catchment area divided by the total number of MasterMap buildings in the catchment). To help appreciate which catchments have suffered the most incidents of flooding, the top 7 catchments (the upper 50%) have been highlighted in red. As can be seen, catchments 10, 9, 7, 6, 5, 4, and 2 have been most at risk from surface water flooding.

Catchment	Rank
1 (Sheldon)	12
2 (Upper Cole)	6
3 (Lower Cole)	13

Catchment	Rank
4 (Middle Rea & The Bourn)	4
5 (Bourn Brook)	5
6 (Upper Rea)	1
7 (Lower Rea)	7
8 (Hockley Brook)	10
9 (Upper Tame)	3
10 (Plants Brook)	2
11 (North Sutton)	8
12 (East Sutton)	11
13 (Middle Tame)	9
14 (Washwood Heath)	14

Table 4-3 – Ranking of catchments based on incidents of flooding

4.2.3. The Potential for Flood Alleviation through the Re-development Process

With much of the Birmingham landscape already developed and land in limited supply, one of the greatest gains in regards to flood alleviation could be through the redevelopment process. Roughly 40% of the SHLAA sites do not have a planning status and the core strategy allocations cover such large areas that they will inevitably include areas at risk.

In Table 4.4 the respective catchments are ranked in regards to how much re-development opportunity there is per urban fabric density (catchment area divided by the total number of MasterMap buildings in the catchment). To help appreciate which catchments offer the greatest opportunity for flood alleviation through the re-development process, the top 7 catchments (the upper 50%) have been highlighted in red. As can be seen, catchments 12, 10, 8, 7, 6, 5, and 2 offer the greatest potential for flood alleviation through the re-development process.

Catchment	Rank
1 (Sheldon)	12
2 (Upper Cole)	4
3 (Lower Cole)	10
4 (Middle Rea & The Bourn)	11
5 (Bourn Brook)	5
6 (Upper Rea)	3
7 (Lower Rea)	1
8 (Hockley Brook)	2

Catchment	Rank
9 (Upper Tame)	8
10 (Plants Brook)	6
11 (North Sutton)	14
12 (East Sutton)	7
13 (Middle Tame)	9
14 (Washwood Heath)	13

Table 4-4 – Ranking of catchments based on the potential for flood alleviation through the re-development process

5. Strategic Assessment – Prioritisation

5.1. Introduction

This Section of the report outlines how and why each of the respective catchments has been prioritised for further assessment. The approach used to do this is outlined in Section 3.3.

5.2. Priority Catchments

In Table 5.1 the results of each of the scoring methods presented in Section 3 is provided along with reasoning as to why, or not, the catchment has been taken forward to the next level of SWMP assessment (the Intermediate phase). In instances where a catchment has not been taken forward further work will be undertaken to identify actions to be applied to these catchments to ensure the risks of surface water flooding are appropriately managed. These actions will be outlined in the action plan developed as part of the SWMP study.

Catchment	Predicted Flood Risk Rank	Development Opportunity Rank	Historical Flooding Rank	Action & Reasoning
1 (Sheldon)	11	12	12	**Not to be taken forward** due to relatively low risk, records of historical flooding and opportunity to alleviate flood risk during the planning process.
2 (Upper Cole)	5	4	6	**Not to be taken forward**, as the River Cole Local Flood Risk Management Plan (LFRMP) already covers the majority of this catchment in a high level of detail.
3 (Lower Cole)	9	10	13	**Not to be taken forward** due to relatively low predicted risk, records of historical flooding and opportunity to alleviate flood risk during the planning process.
4 (Middle Rea and The Bourn)	10	11	4	**To be taken forward** due to the high incidence of historic flooding.
5 (Bourn Brook)	6	5	5	**To be taken forward** due to relatively high rankings in all categories.
6 (Upper Rea)	3	3	1	**To be taken forward** due to relatively high rankings in all categories.
7 (Lower Rea)	2	1	7	**To be taken forward**, as the catchment offers the greatest opportunity to alleviate flood risk during the planning process.
8 (Hockley Brook)	8	2	10	**To be taken forward**, as this catchment offers a great deal of opportunity to alleviate flood risk during the planning process and the current Flood Zone maps currently restrict development from occurring in areas where it is believed not to be problematic.
9 (Upper Tame)	4	8	3	**To be taken forward** due to relatively high rankings in all categories.
10 (Plants Brook)	1	6	2	**To be taken forward** due to relatively high rankings in all categories.
11 (North Sutton)	13	14	8	**Not to be taken forward** due to relatively low predicted risk, records of historical flooding and opportunity to alleviate flood risk during the planning process.
12 (East Sutton)	12	7	11	**Not to be taken forward** due to relatively low predicted risk, records of historical flooding and opportunity to alleviate flood risk during the planning process.
13 (Middle Tame)	7	9	9	**Not to be taken forward** due to relatively low predicted risk, records of historical flooding and opportunity to alleviate flood risk during the planning process.
14 (Washwood Heath)	14	13	14	**Not to be taken forward** due to relatively low predicted risk, records of historical flooding and opportunity to alleviate flood risk during the planning process.

Figure 5-1 – Prioritisation of catchments

In summary, the following catchments will be taken forward into the Intermediate phase of the SWMP (refer to Appendix B4):

- Catchment 4 – Middle Rea & The Bourn
- Catchment 5 – Bourn Brook
- Catchment 6 – Upper Rea
- Catchment 7 – Lower Rea
- Catchment 8 – Hockley Brook
- Catchment 9 – Upper Tame, and
- Catchment 10 – Plants Brook.

5.3. Next Steps

It was agreed at a stakeholder meeting that the next phase of the assessment was to appraise the priority catchments to identify locations where:

- there would be “quick wins” (e.g. increasing capacity to remove a “pinch point”)
- detailed study would be required/undertaken
- long term measures would be required to alleviate the flood risk (e.g. as part of the re-development process), and
- alleviation of the risk would not be feasible or viable (note: these locations could, however, be programmed into the re-development process).

6. Strategic Assessment – Sensitivity Tests

6.1. Introduction

This Section of the report summarises the sensitivity tests undertaken to determine how sensitive the method adopted for the strategic SWMP assessment is to parameters and values used. Tests were performed individually.

6.2. NRD Property Points Sensitivity Test

To test how sensitive the predicted risks of surface water flooding scoring method was to the approach used to develop the vulnerability layers (e.g. the buildings layer), the scoring matrices were re-populated by retaining all of the property points (keeping those not within a building polygon). As can be seen in Table 6.1, although some of the rankings do change, the catchments that appear in the top 7 (upper 50%) do not. This means that the same catchments would still have been taken forward if all the property points were retained. This demonstrates that the prioritisation process is not highly sensitive to the approach used to develop the vulnerability layers (e.g. buildings layer).

Catchment	Predicted Rank	Predicted Rank (sensitivity)	Prioritisation Action
1 (Sheldon)	11	11	Not to be taken forward
2 (Upper Cole)	6	6	Not to be taken forward
3 (Lower Cole)	8	8	Not to be taken forward
4 (Middle Rea & The Bourn)	10	10	Taken forward
5 (Bourn Brook)	5	5	Taken forward
6 (Upper Rea)	2	2	Taken forward
7 (Lower Rea)	4	4	Taken forward
8 (Hockley Brook)	9	9	Taken forward
9 (Upper Tame)	3	3	Taken forward
10 (Plants Brook)	1	1	Taken forward
11 (North Sutton)	13	13	Not to be taken forward
12 (East Sutton)	12	12	Not to be taken forward
13 (Middle Tame)	7	7	Not to be taken forward
14 (Washwood Heath)	14	14	Not to be taken forward

Table 6-1 – Property point sensitivity test

6.3. Consequence Sensitivity Test

To test how sensitive the scoring matrices were to the weightings given to the consequences of surface water flooding, all of the values used were increased and reduced by 50%. As can be seen in the matrices and summary tables provided in Appendix A5, the scoring methods are not sensitive to the weightings given to the respective categories.

6.4. Probability Sensitivity Test

To test how sensitive the scoring matrices were to the weightings given to the probability of surface water flooding, all of the values used were increased and reduced by 50%. As can be seen in the matrices and summary tables provided in Appendix A6, the scoring methods are not sensitivity to the weightings given to the respective categories.

7. Strategic Assessment – Conclusions & Recommendations

7.1. Introduction

This Section of the report outlines the conclusions and recommendations of the strategic assessment.

7.2. Conclusions

The strategic SWMP assessment has the following conclusions:

- With roughly 40% of the SHLAA sites not having a planning status and the core strategy allocations covering such large areas that they will inevitably include areas at risk, the greatest gains in regards to flood alleviation may be through the re-development process.
- Using the three scoring methods developed for this assessment, and by accounting for local knowledge, the following catchments have been deemed to be the highest priority and will be taken forward to the next phase of the SWMP:
    - Catchment 4 –Middle Rea & The Bourn
    - Catchment 5 – Bourn Brook
    - Catchment 6 – Upper Rea
    - Catchment 7 – Lower Rea
    - Catchment 8 – Hockley Brook
    - Catchment 9 – Upper Tame
    - Catchment 10 – Plants Brook
- The scoring method used to prioritise the areas of Birmingham is not sensitive to the approach used to define the receptors (NRD property points), or the consequence, probability, confidence and reliability values assigned to the results within the scoring matrices.

8. Intermediate Assessment – Objectives, Methodology and Data Review

8.1. Introduction

This Section of the report outlines the objectives of the Intermediate phase of the SWMP, the methodology applied in identifying the local flood risk areas and the data review undertaken as part of the Intermediate phase of the SWMP.

8.2. Intermediate Assessment Objectives

The broad aims of the Intermediate Phase were to improve understanding of surface water flooding within the priority catchments, and by identifying local flood risk areas focus the detailed assessment to areas of highest risk to ensure value for money.

The objectives of the Intermediate Phase assessment were to:

- Identify the key local flood risk areas within the priority catchments as agreed during the Strategic Phase, using existing information and applying relatively simple techniques
- Identify a prioritised list of local flood risk areas to consider for detailed assessment
- Scope the key requirements for the areas requiring more detailed assessment
- Undertake a high level options appraisal for these risk areas and identify immediate mitigation measures which can be implemented, and
- Develop a suite of actions to be applied at the Local Authority and sub-catchment level which will form part of the SWMP Action Plan.

8.3. Approach

8.3.1. Identification of Local Flood Risk Areas

In order to identify the local flood risk areas within the priority catchments they were split into two grids (500m by 500m and 100m by 100m) and the flood risk within each grid square assessed based on a number of indicators: the flood risk score, the numbers and types of properties at risk, and the numbers of people at risk. Figure 8-1 shows the priority sub-catchments split into the 500m by 500m grid.

To align the SWMP with the PFRA the FMfSW 1 in 200 year event (shallow) flood outlines were used to generate the flood risk scores, property and people counts for each grid square. However, the FMfSW 1 in 30 or 1 in 200 year event (deep) flood outlines were assessed and used to refine and confirm the local flood risk areas.

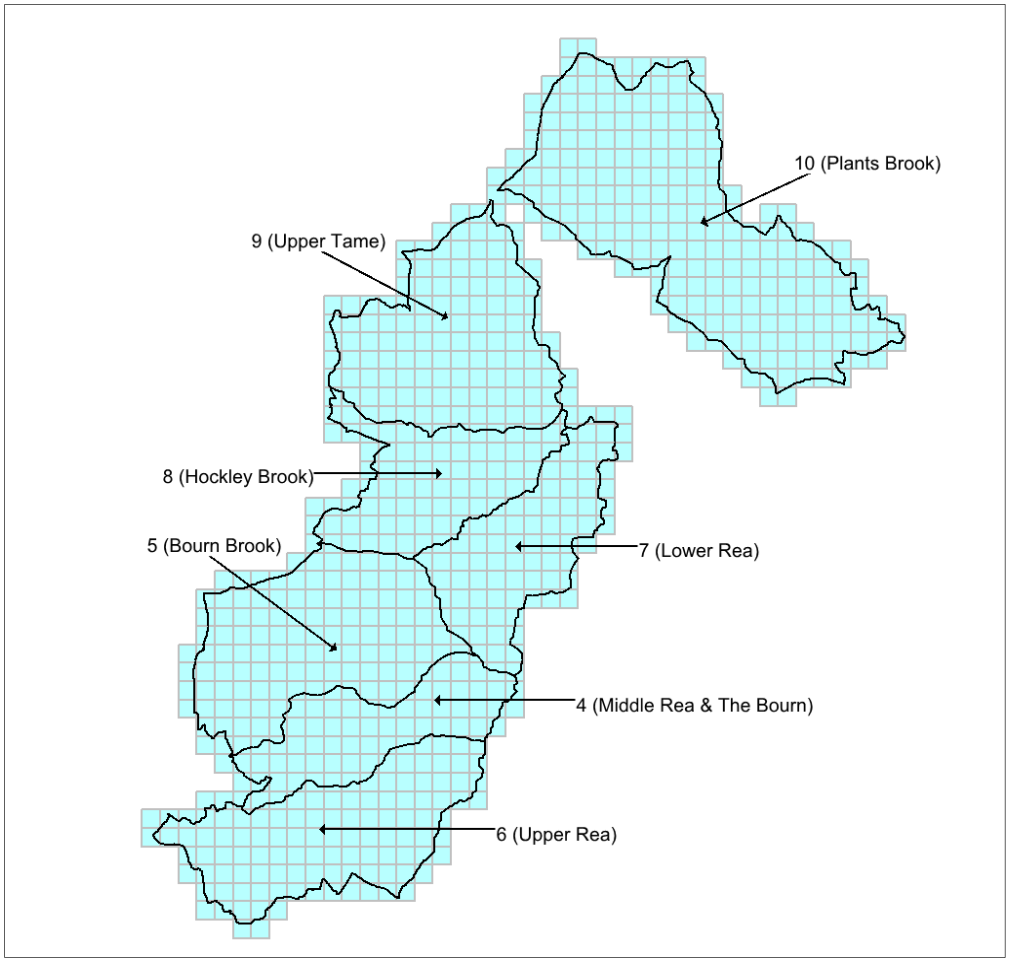


Figure 8-1 - 500m by 500m grid squares for the priority sub-catchments

For consistency, the scoring and weighting methodology developed during the Strategic Assessment has been applied, based on a combination of data including the FMfSW, historic flooding records, and maintenance records. The scoring method does however exclude the following:

- Transport links are not included within the flood risk score due to the potential for double counting across grid squares. It was also considered that they would overestimate flood risk since the entire length of road or rail link would be included in the score, even if only a small proportion was within the FMfSW 1 in 200 year event (shallow) flood outline. The transport links at risk were assessed once the initial local flood risk areas have been identified to confirm and refine the extents; and,

- Future development areas were not included in the grid square scores but will be considered as part of the assessment of local flood risk areas.

Figure 8-2 Illustrates the process followed in identifying the local flood risk areas. Once the flood risk scores, numbers of properties and people at risk within each grid square were calculated, each grid was classified into a 'High', 'Medium' or 'Low' risk rank. These ranked areas were checked against the FMfSW 1 in 30 year event outline, at risk transport links and development areas, and then refined based on these factors and the 100m grid scores.

Finally, the preliminary local flood risk areas rated as 'High' or 'Medium' risk were screened to determine what further work, if any, was justified.

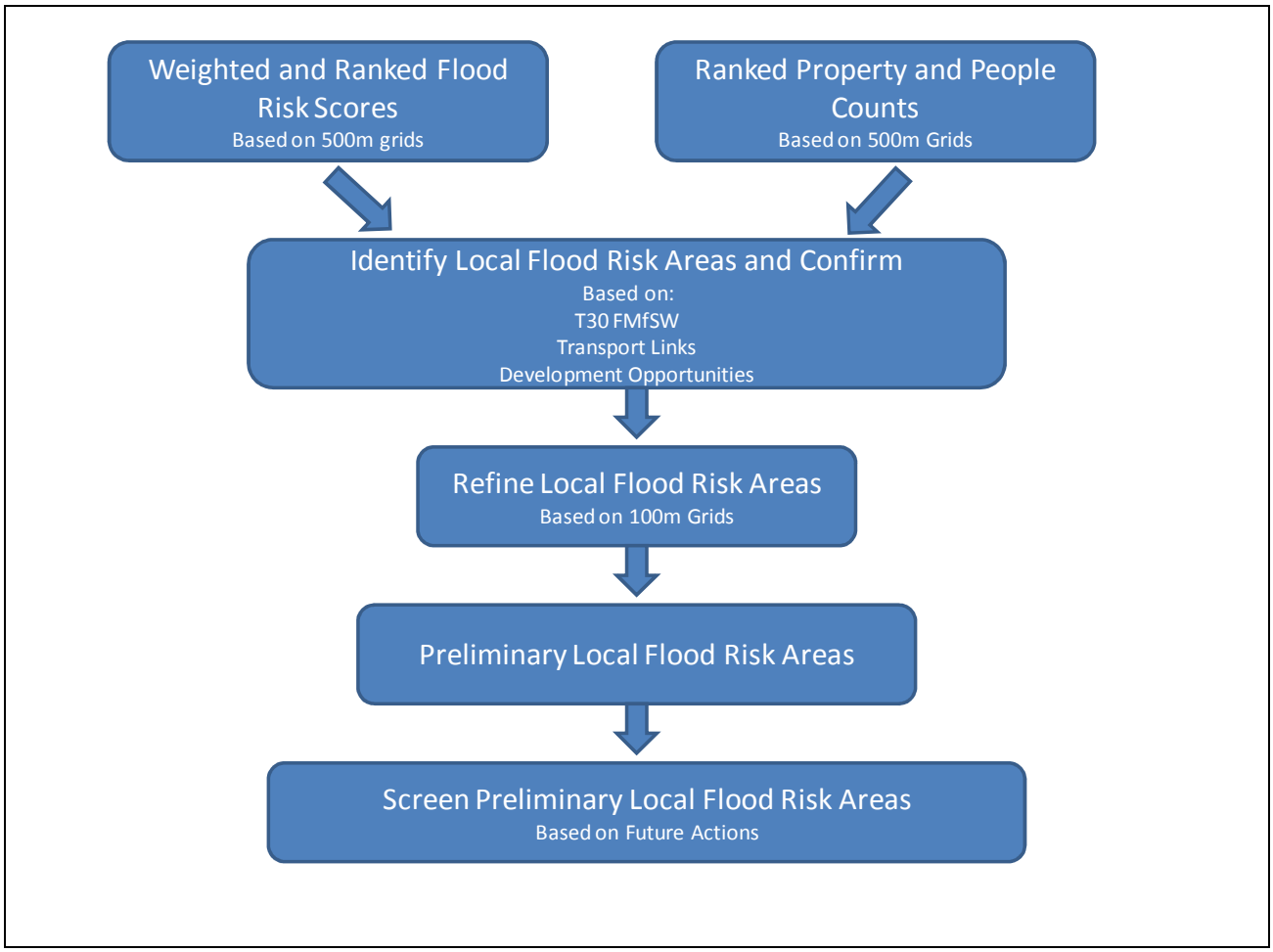


Figure 8-2 - Identification of local flood risk areas

8.4. Data Review

Additional data was provided on the River Tame, Severn Trent Water's proposed schemes, highway gully maintenance, green infrastructure and the index of multiple deprivation. All additional data provided as part of the Intermediate phase was added to the Data Register supplied in Appendix A1.

The accuracy and applicability of the FMfSW to the study area was also assessed by:

- Using the methodology outlined in the EA Guidance Note "What is the Flood Map for Surface Water"[3] to assess how representative the outlines are, and
- Comparison of the recorded locations of surface water flooding against the FMfSW to give a percentage score for each catchment based on the number of recorded historic flood incidents within the FMfSW against the total number of recorded incidents within the catchment.

It had been intended to assess the location of trees adjacent highways and any maintenance regimes in place to manage them to help identify areas where gully blockages were an issue and maintenance regimes could be improved. However, no data has been forthcoming concerning tree density and location, or maintenance regimes relating to trees and foliage.

[3] Environment Agency (2010): What is the Flood Map for Surface Water. Guidance for Local Resilience Forums, regional Resilience Teams, Local Planning Authorities and Lead Local Flood Authorities v1 November 2010

8.4.1. Additional Data

8.4.1.1. Environment Agency Data – River Tame

The EA provided information on the River Tame Flood Risk Management Strategy and maintenance regimes for the River Tame.

The only priority catchments potentially affected by the River Tame Strategy are:

- Catchment 9 (Upper Tame): coincides with Reach 5 Perry Barr and Witton, where a combination of embankments and walls are proposed to protect over 850 properties, providing a 1 in 200 year event Standard of Protection. These will be constructed alongside Regina Drive in Perry Barr, and Tameside Drive in Witton. These proposed works are not located within the identified local flood risk areas; and,

- Catchment 10 (Plants Brook): the proposed actions of increasing defence height and removing flow restrictions in Bromford Industrial Estate are on the boundary of the Plants Brook and will not impact on the identified local flood risk areas.

In summary, the capital works proposed under the EA's River Tame Flood Risk Management Strategy will not impact on the identified local flood risk areas, and are unlikely to provide opportunities for collaborative working. Opportunities may be identified during subsequent stages of this study.

8.4.2. Severn Trent Water Data

STW provided information regarding their future capital schemes within the BCC administrative boundaries. Discussions with STW indicated that those schemes already at or past Stage 3 in the development cycle were too advanced for any collaboration opportunities with BCC to provide flood risk mitigation measures to be explored effectively. The locations of the STW schemes are shown in Appendix B5.

There were 21 proposed schemes that had not reached Stage 3, of which 9 were located in the priority catchments to be considered in the Intermediate phase. The only information available for these schemes relates to their current stage of development within STW's works programme and a summary of the problem at the particular location.

8.4.3. Amey Data (Highways)

Amey, who maintain and manage the public highway network on behalf of BCC provided information for planned highway gully cleansing in the study area. The information was provided for each road name but is not geo-referenced.

The sheer volume of data provided, along with the lack of geo-referencing meant that at this stage of the study it is considered a more appropriate use of resources to analyse this information during the detailed phase, when the assessment can be targeted to smaller, specific areas. It is therefore proposed to geo-reference and analyse this data for the local flood risk areas in the detailed phase, to identify if any changes to the gully cleansing regime could help alleviate surface water flooding if there is an obvious solution.

8.4.4. Green Infrastructure and Open Space Data

BCC provided the GIS layers listed in the table below to assist in identifying potential opportunities and constraints to flood risk management actions within the study area.

Description	
Reed Beds	Open Space
Fen	Private Open Space

Description	
Coastal and Floodplain Grazing Marsh	Private Playing Field
Educational Playing field	Public Open Space
Golf Courses	Public Playing Field
Statutory Common Land	

Table 8-1 – Green Infrastructure and Open Space GIS layers

8.4.5. Index of Multiple Deprivation

BCC provided the Index of Multiple Deprivation in GIS format to enable a comparison of the vulnerability to flooding between the local flood risk areas.

8.4.6. Assessment of the FMfSW

8.4.6.1. "What is the Flood Map for Surface Water Report" Method

The accuracy of the FMfSW was assessed using the guidance on page 23 of the EA "What is the Flood Map for Surface Water" report. The recommended approach provides a broad indication of how representative the FMfSW is for the study area. It does not examine the outlines in detail, for example assessing the validity of flow paths or the influence of structure blockages on flood risk.

Table 8-2 – FMfSW validation results illustrates the results of this assessment in which the total number of flood incidents recorded within each catchment was compared to the number predicted by the FMfSW, based on the 1 in 200 year event (deep) flood outline. The oldest recorded flood incident is from 1993, hence the selection of an 18-year record length.

Catchment	Total No. Of Properties	No. of flood incidents expected over 18 year period	No. of flood incidents for which details were recorded over 18 year period	Relative probability of properties in flood extents being more likely to flood than properties outside flood extents
4 (Middle Rea and The Bourn)	38339	81	64	10
5 (Bourn Brook)	64654	180	44	41
6 (Upper Rea)	60341	225	168	5
7 (Lower Rea)	32002	72	4	39
8 (Hockley Brook)	41033	90	2	0
9 (Upper Tame)	79231	207	74	0
10 (Plants Brook)	50920	162	24	27
Total	**328181**	**936**	**316**	**19**

Table 8-2 – FMfSW validation results

The assessment indicated that the FMfSW overestimated the total number of incidents over the 18-year period, by a factor of approximately 3. This is consistent with other results quoted in the EA guidance report. The relative probabilities show that across the priority catchments properties are 19 times more likely to flood if they are within the FMfSW outline compared to those outside the FMfSW outline. This suggests that the FMfSW is predicting the spatial patterns of flooding in the study area fairly well.

It should be noted that these figures are based on a number of assumptions (as stated in the EA guidance report). These should therefore only be used as a broad indication of how representative the FMfSW is for a study area.

8.4.6.2. Percentage Method

A more simplistic assessment was completed comparing the recorded locations of surface water flooding against the FMfSW. A percentage score for each catchment was calculated based on the number of recorded historic flooding incidents within the FMfSW against the total number of recorded incidents within the catchment Table 8-3 – FMfSW accuracy assessment shows the percentage of historic flood incidents within the FMfSW for each of the priority catchments.

Catchment	Total No. of Historic Flooding Incidents	No. of Historic Flood Incidents within FMfSW (1 in 200 year deep)	%
4 (Middle Rea and The Bourn)	64	12	19%
5 (Bourn Brook)	44	25	57%
6 (Upper Rea)	168	32	19%
7 (Lower Rea)	4	2	50%
8 (Hockley Brook)	2	0	0%
9 (Upper Tame)	74	1	1%
10 (Plants Brook)	24	12	50%
Total	**316**	**72**	**23%**

Table 8-3 – FMfSW accuracy assessment

This indicated that the FMfSW is predicting with some degree of accuracy within catchments 5, 7 and 10, but less so within catchments 6, 8 and 9. However, since only two events have been recorded in catchment 8 a score of 0% is not unexpected.

8.4.7. Summary

Given the broad scale nature of the modelling used for the FMfSW, these assessments show that the performance of the FMfSW is reasonable within the study area when compared with recorded historic flood events. It does suggest however that the FMfSW should be used in combination with other data sources, and if used in isolation should be treated with caution.

9. Intermediate Assessment – Identification of Local Flood Risk Areas

9.1. Introduction

This Section of the report outlines the how the local flood risk areas were identified.

9.2. Identification of Local Flood Risk Areas

9.2.1. Initial Results

9.2.1.1. Influence of DG5 Records

It was noted that the DG5 records (recorded sewer flooding) were heavily influencing the number and distribution of the local flood risk areas. The grid scores are more sensitive to the presence of DG5 records as these have a weighting factor of 100 (as agreed during the Strategic phase).

When including the DG5 records in the grid scores the number of 'high' ranking local flood risk areas was substantially greater than if they were excluded; and was more than doubling the number of 'high' risk areas depending on the thresholds set for the 'High', 'Medium' and 'Low' risk bands. These additional 'high' risk areas were due solely to the presence of the DG5 records, and were predominantly located in catchments 5 (Bourn Brook) and 10 (Plants Brook).

A test was undertaken to assess the impact on the number and distribution of local flood risk areas if the weighting applied to the DG5 records was reduced by 50%. The test indicated that whilst there was a slight reduction in the number of risk areas the results were broadly the same. This was due to the large weighting factor applied to the DG5 records.

Since the maximum design standard of STW assets is a 1 in 30 year event, which would be vastly exceeded by the 1 in 200 year event, and to ensure the study focused on areas where wider scale works would be effective with BCC as the lead partner, it was considered appropriate to remove the DG5 records from the grid scores. The local flood risk areas would otherwise have been selected primarily on the basis of DG5 records, which would have distorted the results.

9.2.1.2. Influence of Historical Flooding Records

Records of historic incidents of fluvial and surface water flooding were also found to have a strong influence on the number and distribution of local flood risk areas. This was attributed to the high weighting factors applied to these records, of 45 for fluvial events and 50 for surface water events.

A sensitivity test was undertaken to assess the impact on the local flood risk areas if the weighting factor applied to the historical flooding incidents were reduced by 50%. The test indicated that whilst there were small changes in the number of risk areas the results were broadly similar. The main changes were shifts from a high risk rank to a medium risk rank as the reduced weighting factor resulted in a lower flood risk score.

Following discussions it was not felt appropriate to remove or adjust the weighting of the historical flood incidents since this was considered to be a valuable source of information on real flooding events. The exclusion of this data would have left the assessment of local flood risk reliant on the broadscale modelling completed for the FMfSW.

However, it should be noted that in defining the local flood risk areas consideration was given to the relative contribution to the score of historic events related to Main River flooding.

9.2.1.3. Flood Risk Band Thresholds

It was recognised that the process of determining the local flood risk areas would be sensitive to the flood risk score thresholds selected for the 'High', 'Medium' and 'Low' risk bands. Three different ranking bands were therefore tested (excluding the DG5 records) to assess how these impacted on the number and distribution of the local flood risk areas. The results of this are displayed in Table 9-1.

Ranking Tolerance	Rank Score	No. of Risk Areas	No. of Grid Squares	% of Total Properties in catchments
Low	High >75	18	32	13%
	Medium 25-75	32	74	30%
	Low <25	N/A	638	57%
Medium	High >100	13	26	9%
	Medium 40-100	21	30	14%
	Low <40	N/A	688	76%
High	High >150	10	20	6%
	Medium 60-150	17	22	12%
	Low <60	N/A	702	83%

Table 9-1 – Flood risk band thresholds considered

It was decided to proceed with the 'Medium' ranking classification system as it was considered that this gave the most appropriate distribution of 'High' and 'Medium' flood risk areas. By comparison the 'Low' or 'High' classifications would give too many and too few local flood risk areas respectively.

9.2.1.4. Summary

Based on the initial analysis the following decisions were made:

- The 'Medium' ranking thresholds classification system would be applied
- DG5 records would be excluded from the flood risk scores
- Records of historical flooding would be included in the flood risk scores, and
- Whilst the 100m grids were reviewed they did not result in any alterations to the boundaries of the preliminary local flood risk areas based on the 500m grids.

9.2.2. Preliminary Local Flood Risk Areas

Table 9-2 shows the preliminary local flood risk areas based on the approach outlined in Section 9, taking into account both the flood risk scores and the property and people counts. Those highlighted in the red are considered to be 'high' risk.

Further details concerning these areas are shown in Appendix A8, including information on development opportunities, green infrastructure and predominant flooding sources for each location. Figures illustrating their location can be found in Appendix B6. It was proposed to combine a number of these areas during the detailed phase of works to deliver efficiency savings and ensure catchment wide opportunities can be explored effectively.

No.	Local Flood Risk Area Name	Approx. Area (km²)	Flood Risk Score	No. of Properties at risk	Flood Risk Rank
1	Lodge Hill, California, Selly Oak and Bourn Brook	3	1814	1267	High and Medium
2	Kitwell	0.25	160	48	High
3	Bourn Brook - River Rea Confluence	0.25	778	51	High
4	Woodgate Valley	0.25	83	137	Medium
5	East Harborne	0.25	73	200	Medium
6	Frankley	0.5	2675	270	High
7	Central Sub Catchment 6	3	5102	1395	High and Medium
8	Kings Norton	0.25	137	7	High
9	Rednal	0.25	45	223	Medium
10	Cotteridge	0.25	70	98	Medium
11	Frankley West	0.25	96	30	Medium
12	Balsall Heath	0.5	140	442	Medium
13	Saltley	0.5	107	212	Medium
14	Bearwood	0.25	68	75	Medium
15	East Handsworth	0.5	151	427	High and Medium
16	Birchfield	1.5	3352	1544	High and Medium
17	Handsworth Wood	0.75	182	692	Medium
18	Kingstanding	0.5	133	616	Medium
19	Perry Park	0.25	230	24	High
20	Four Oaks Park	0.25	52	29	Medium
21	Maney	0.25	66	109	Medium
22	Merritts Hill		59	58	Medium
23	Griffins Brook		368	43	High
24	Hay Green Lane		205	117	High
25	Weoley Castle/Wood Brook		401	87	High
26	Selly Park/Ten Acres		1461	964	High and Medium
27	South Cannon Hill Park		780	54	High

Table 9-2 – Key characteristics of the preliminary local flood risk areas

10. Intermediate Assessment – High Level Appraisal and Screening of Flood Risk Areas

10.1. Introduction

This Section of the report outlines the approach adopted for appraising and screening the initial local flood risk areas identified in the previous Section.

10.2. Approach

Making use of the information collated as part of the Strategic and Intermediate Phases, and local knowledge of the catchment areas a high level, qualitative assessment of the potential suitability of flood risk management options was undertaken for those areas identified as requiring more detailed assessment in Section 9.

The flood risk management options to be appraised were discussed and agreed with the project partners, and were split into eight categories:

Flood Risk Management Option Categories	
Land Management (e.g. afforestation)	Planning Activities (e.g. Development Masterplanning)
Attenuation / Retention (e.g. floodplain storage)	Resilience (e.g. flood awareness)
Increased Channel Conveyance (e.g. raised defences)	Monitoring / Advise / Survey (e.g. flood warning)
Other Infrastructure Improvements (e.g. improve capacity of piped networks)	Further Assessment (e.g. detailed modelling)

Table 10-1 – Flood risk management categories

Appendix A9 contains the full list of flood risk management options assessed.

Finally, each local flood risk area was classified into one of the following groups:

- Quick wins
- Detailed study
- Long term needs, and
- Those beyond the scope of this study.

10.3. High Level Appraisal

Without the aid of detailed modelling or assessment to determine the key flooding mechanisms and sources, or the viability of options, it was not possible to preclude many options at this stage of the SWMP. However, this appraisal formed a useful basis for the detailed phase, and can be built upon as knowledge of the local flood risk areas is developed and improved.

Appendix A9 contains the results of the high level appraisal, illustrating the potentially viable options for each local flood risk area.

10.4. Classification of Local Flood Risk Areas

Table 10-2 below shows the classifications in terms of future work for the local flood risk areas defined as 'High' or 'Medium' risk. All low risk areas, or areas with DG5 records are classified as "beyond the scope of this study". At this stage no quick wins were identified.

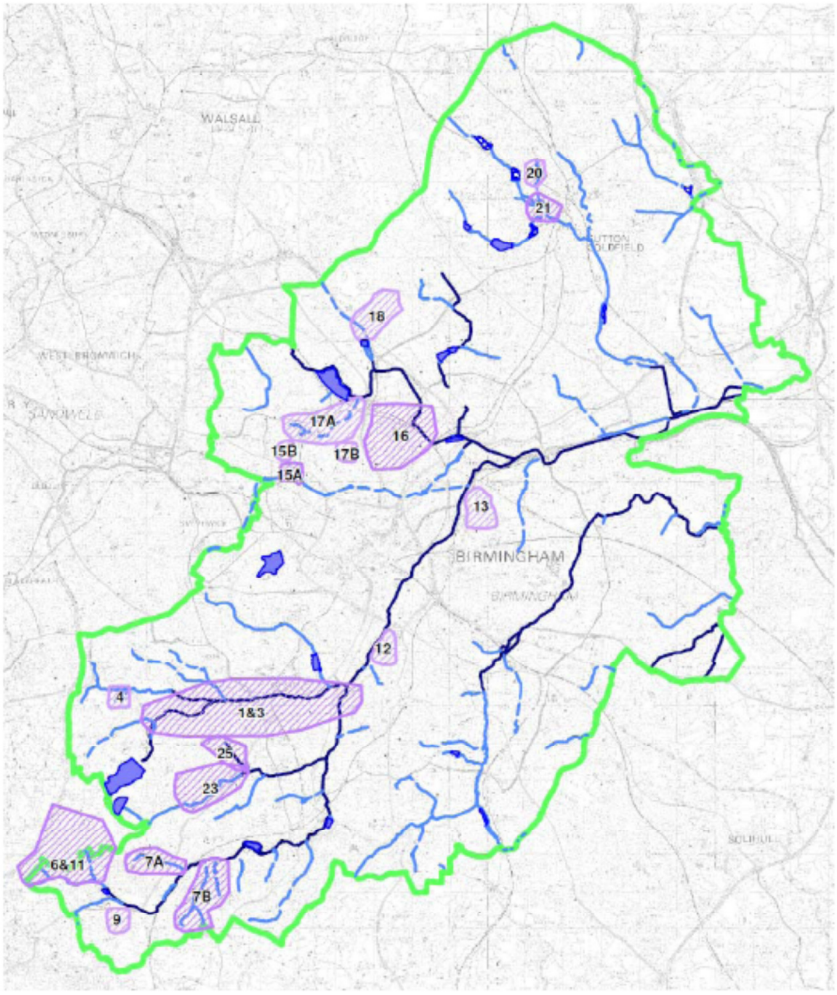
No.	Local Flood Risk Area	Action	Classification
1	Lodge Hill, California, Selly Oak and Bourn Brook	Take Forward to Detailed Stage for modelling of the Bourn Brook	Detailed Study
2	Kitwell	Assess surface water flooding record	Detailed Study
3	Bourn Brook - River Rea Confluence	Assess fluvial flooding record and link in with Bourn Brook Modelling	Detailed Study
4	Woodgate Valley	Take Forward as part of Detailed Stage for modelling of the Bourn Brook	Detailed Study
5	East Harborne	Screen Out	Long Term Needs
6	Frankley	Take Forward to Detailed Stage for modelling of the River Rea catchment	Detailed Study
7	Longbridge and Northfield	Take Forward to Detailed Stage for modelling of the River Rea catchment	Detailed Study
8	Kings Norton	Screen Out	Long Term Needs
9	Rednal	Take Forward to Detailed Stage for modelling of the River Rea catchment	Detailed Study
10	Cotteridge	Screen Out	Long Term Needs
11	Frankley West	Take Forward to Detailed Stage for modelling of the River Rea	Detailed Study
12	Balsall Heath	Assess validity of FMfSW in this location	Detailed Study
13	Saltley		
14	Bearwood	Screen Out	Long Term Needs
15	East Handsworth	Potential to include as part of Birchfield / Handsworth study OR Assess validity of FMfSW in this location	Detailed Study

No.	Local Flood Risk Area	Action	Classification
16	Birchfield	Take Forward to Detailed Stage and explore potential for update of STW DAP model	Detailed Study
17	Handsworth Wood	Assess validity of FMfSW in this location OR explore potential for update of STW DAP model	Detailed Study
18	Kingstanding	Assess validity of FMfSW in this location	Detailed Study
19	Perry Park	Assess fluvial flooding record	Detailed Study
20	Four Oaks Park		
21	Maney		
22	Merritts Hill	Screen Out	Long Term Needs
23	Griffins Brook	Take Forward to Detailed Stage for modelling of the River Rea catchment	Detailed Study
24	Hay Green Lane	Screen Out	Long Term Needs
25	Weoley Castle/Wood Brook	Initial Assessment already undertaken, build on existing work	Detailed Study
26	Selly Park/Ten Acres	Screen Out	Long Term Needs
27	South Cannon Hill Park	Screen Out	Long Term Needs

Table 10-2 – Classification of local flood risk areas

10.4.1. Screened Local Flood Risk Areas

Following the screening and appraisal of the preliminary local flood risk areas, it was determined that it would be more beneficial to link some areas together and split some areas, this resulted in 18 areas that were identified to be taken forward to the detailed assessment stage of the study (as shown in Figure 10-1 below).



Areas 1 & 3: Bourn Brook

Area 4: Woodgate Valley

Areas 6 & 11: Frankley

Area 7A: Hanging Brook

Area 7B: West Heath/Turves Green Brook

Areas 9: Rednal

Areas 12: Balsall Heath

Area 13: Saltley

Area 15A: Hockley Brook

Area 15B: Hockley

Area 16: Birchfield and Witton

Area 17A: Handsworth Brook

Area 17B: Handsworth

Area 18: Kingstanding

Area 20: Four Oaks

Area 21: Plants Brook

Area 23: Griffins Brook

Area 25: Weoley Castle/Wood Brook

Figure 10-1 Screened Flood Risk Areas

11. Intermediate Assessment – Conclusion & Recommendations

11.1. Introduction

This Section of the report contains the conclusions and recommendations of the Intermediate phase of the SWMP.

11.2. Conclusions

The following conclusions were drawn from the Intermediate phase of the SWMP:

- The grid approach utilising the scoring methodology developed in the Strategic phase enabled the identification of local flood risk areas within the priority catchments.
- Using this approach the areas identified as being at highest risk were located in the following catchments:
    - Catchment 5 – Bourn Brook
    - Catchment 6 – Upper Rea
    - Catchment 9 – Upper Tame
- The high level options appraisal completed for the identified local flood risk areas assessed the potential viability of flood risk management options for each location. This information will be used as a basis for option development during the detailed phase.

11.3. Recommendations

The Intermediate phase of the SWMP has the following recommendations:

- Further analysis and detailed modelling for the screened local flood risk areas should be undertaken
- Due to budgetary constraints on all partners the majority of opportunities to provide benefits will be through the development process, these should be explored.
- The respective stakeholders should look to identify any efficiencies of further joint working, including the STW Minworth Strategy and SMP, the proposed STW capital schemes, the EA River Rea Master Plan and
- As part of the detailed phase the potential for developing a set of catchment wide actions and policies amongst the stakeholders should be investigated.

12. Detailed Assessment - Approach

12.1. Introduction

This Section outlines the approach taken at the detailed assessment stage

12.2. Detailed Assessment Objectives

The broad aim of the Detailed Phase was to better understand the flood risk in the screened local flood risk areas.

The objectives of the Detailed Phase assessment were to:

- Select a modelling approach to undertake the risk assessment
- Develop the selected modelling approach and validate and verify the model, and
- Quantify annualised average damages for the current and future time horizons.

12.3. Detailed Modelling

The SWMP guidance states that the scope of the modelling work to be undertaken during the detailed assessment stage should include:

- The scale of modelling required
- The sources, pathways and receptors to be included and how they might be represented, and
- An outline of the dominant flood mechanisms in the study area (where known).

12.3.1. The Scale of Modelling Required

An assessment of the locations of screened local flood risk areas determined that it would be more appropriate to develop catchment scale models to assess the flood risk rather than a number of smaller models as shown in Figure 12-1. The catchments to be modelled have been identified as:

- River Rea
- Plants Brook
- Hockley Brook & Birchfield

In line with the River Cole which was being modelled as part of the Cole local Flood Risk Management Plan, it was envisaged that fully integrated 2D models of the drainage systems were be built to identify the causes of flooding, and subsequently to identify potential alleviation options. Existing models were to be utilised where appropriate.

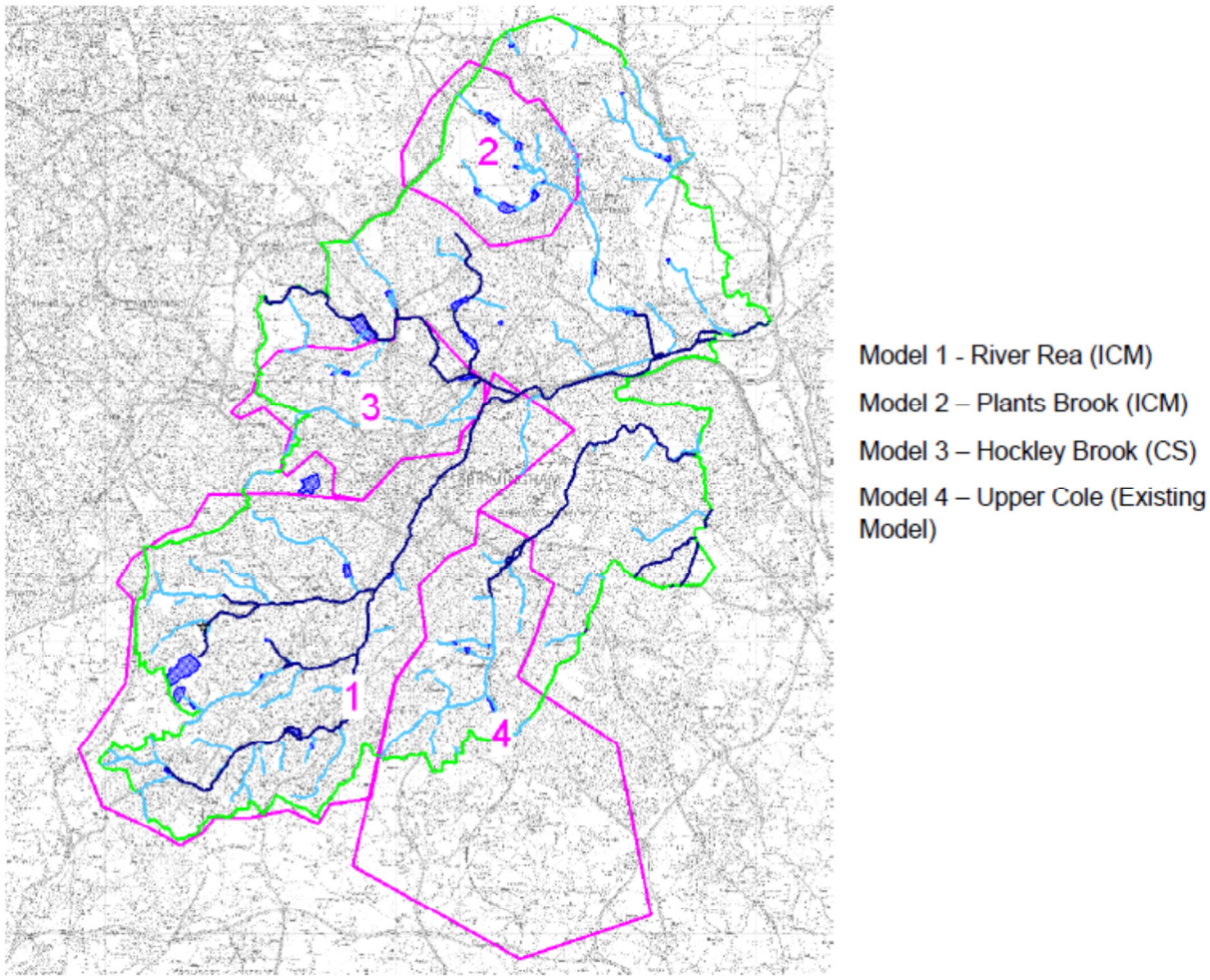


Figure 12-1 Summary of Catchment Scale Models

12.3.2. Sources, Pathways and Receptors

The advantage of an integrated 2D model is that all the relevant sources, pathways and receptors can be modelled, without having to make assumptions in advance about the mechanisms involved, in particular the overland flow elements.

Overland flow has been modelled using the “bare earth” DTM with no explicit representation of buildings, roads etc in line with EA practice to show risk independent of any artificial obstructions. It is recognised that this does not reflect localised detail, but is considered a suitable approach for a strategic study, shortens model run times and simplifies interpretation. More detailed ground modelling would be required for the design of any risk alleviation works.

All sewers and watercourses, including ancillary structures in the relevant areas are modelled, with each catchment split into appropriate sub-catchments to contribute flows at the appropriate locations. All buildings, roads and open spaces are represented as NRD points, based on OS background maps. This means that all potential receptors are included, and any impact of flooding can be identified.

12.3.3. Dominant Flood Mechanisms

The purpose of the modelling will be to identify the flood mechanisms, quantify the risks and make recommendations for actions to alleviate them.

13. Detailed Assessment - Modelling

13.1. Introduction

This section outlines how the catchments were modelled and verified. It should be noted that the potential STW schemes referred to in 8.4.2 were not specifically added to the models due to the uncertainty as to whether they would be implemented.

13.2. River Rea Catchment

An InfoWorks ICM (Integrated Catchment Modelling) integrated model was built based on surveys of the watercourses concerned, Severn Trent Water's relevant Drainage Area Plan (DAP) models and data gathered from site visits. This model initially extended as far downstream as adjacent to Cannon Hill Park and Edgbaston Cricket Ground.

The scope of the model was subsequently extended on behalf of the Environment Agency to the confluence with the River Tame to allow flood risk in the Digbeth area to be re-assessed in the light of proposals to re-develop the area, and to allow options for alleviating flood risk to be assessed in detail.

The model is considered to be adequately verified for an overall flood risk assessment and consideration of outline alleviation options. Further flow surveys and refinements are recommended if it is intended to use the model to design flood alleviation options in the future, to give sufficient confidence on which to base investment decisions. The model has been externally reviewed on behalf of EA, which found the model to be a "good representation of the catchment", and made recommendations for improvement, most of which have since been implemented where practical.

1236 properties are identified as being at risk in a 200 year (0.5% AEP) event. Note that no allowance has been made for climate change, and the implications of the Water Framework Directive (WFD) have not specifically been considered. It is, however, known that the EA are considering some WFD-related actions in the catchment, and it is possible that these could be combined with flood risk alleviation works to achieve multiple benefits.

13.2.1. Modelled flood risk

The 100 and 200 year 60, 120, 180, 240, 360, 720 and 840 minute duration events were run on the model and maximum flood extents determined. It is not practical to show the extents in this section, but large-scale plans are included in Appendix B. The extents of the 2D zones used in detailed modelling are shown on the large scale plans. Sample extracts are shown in Figure 13.1 – 13.3. These also show the EA's Areas Susceptible to Surface Water Flooding (purple shading) (ASSWF) and the EA fluvial flood maps (dark green and cyan outlines), and the key conclusion to note is that the modelled extents (in blue) are generally less, as in Figure 13.1. This is due to the explicit modelling of the combined and surface water systems, which are represented in the EA model as generalised losses. Note, however, that only the areas identified for detailed assessment were modelled using 2D overland flow. Outside these areas, it is not possible to be categorical about the flood extents.

1236 properties are identified as being at risk in a 200 year (0.5% AEP) event. More details are given in Section 15 and on the plans in Appendix B.

Note that no sensitivity testing has been performed on the flood risk analysis. It assumes a system in clean condition with no blockages, which is taken as a "normal" condition. There are too many potential variables to make a sensitivity analysis useful for assessing flood risk at the catchment level.

Note also that the extracts were prepared in 2012, and EA data may have been updated since then. The SWMP models may also be updated, but figures in this report will not necessarily be updated to match.

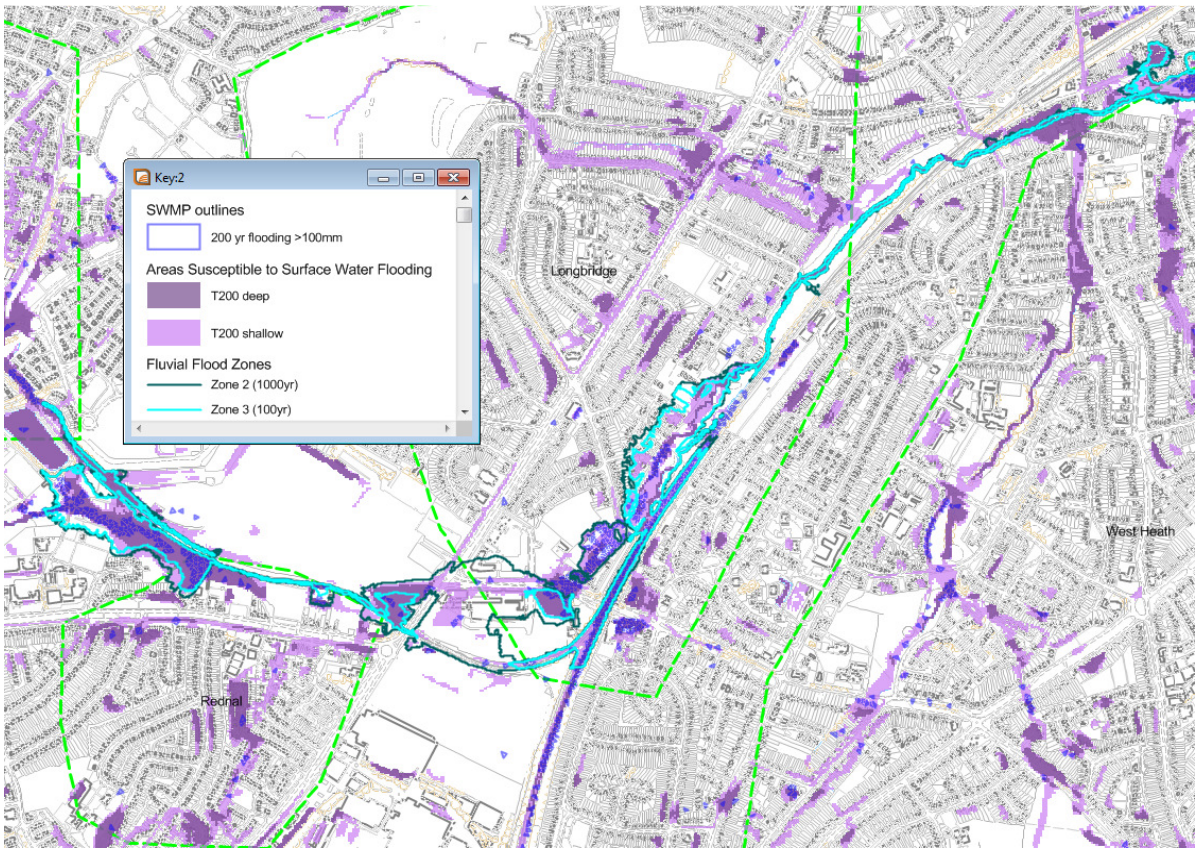


Figure 13-1 – Modelled extents less than ASSWF

A significant exception is at the confluence of the Rea and Bourn Brook (Figure 13.2), where additional flooded areas are modelled. A large part is in open areas, but the extent of modelled flooding in the known problem area around Sir Johns Road is well reproduced. The modelled flooding is heavily influenced by the Bourn Brook Bridge under Pershore Road, which may warrant a survey and refinement in the model as necessary.

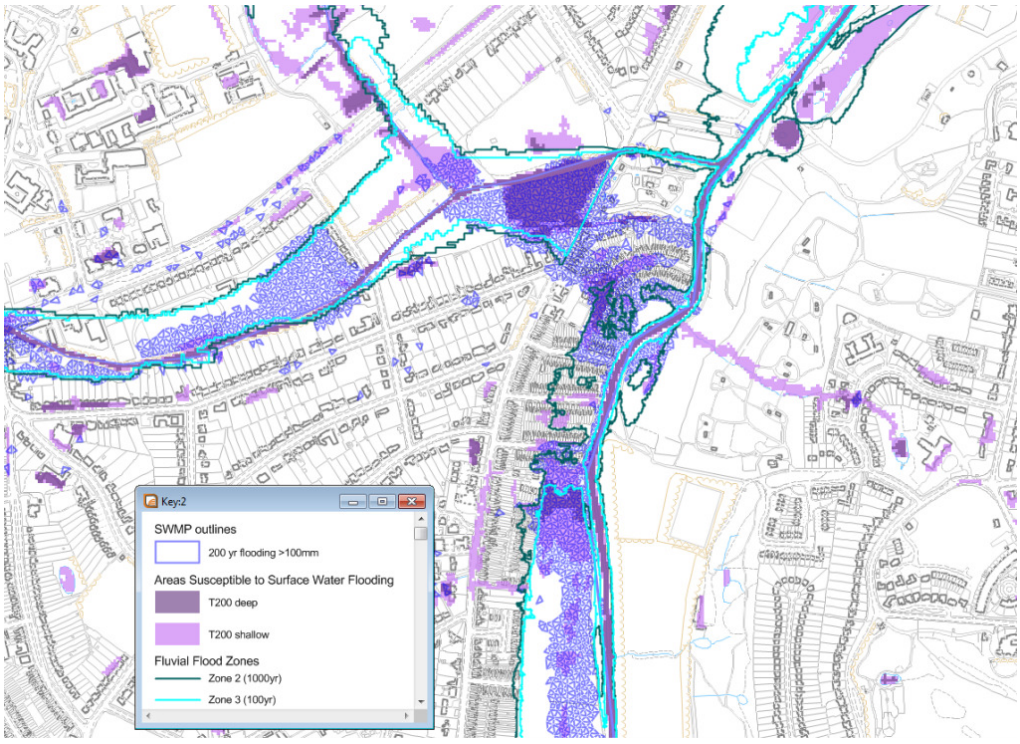


Figure 13-2 – Modelled extents greater than ASSWF

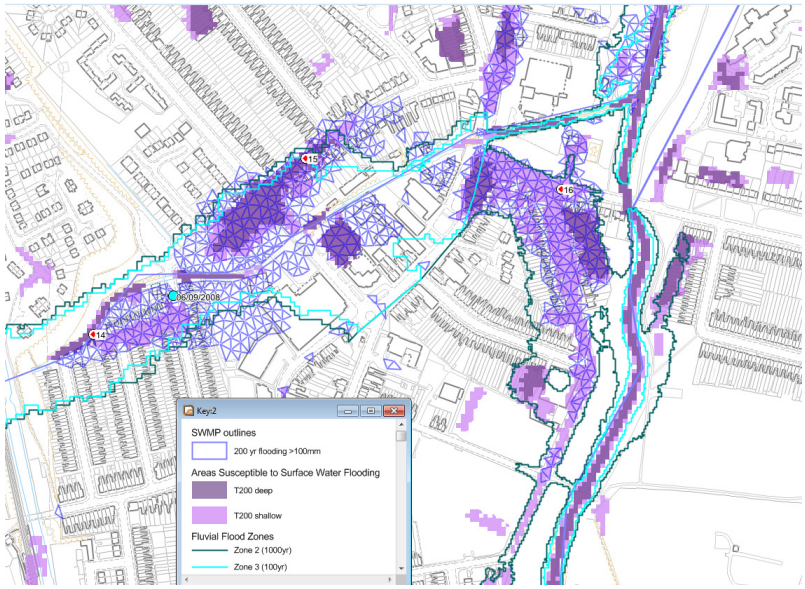


Figure 13-3 – Modelled extents greater than ASSWF

Similarly, in Selly Park North, known flooding problems in the Ripple Road area are modelled as shown in Figure 13.3. Flooding may be over-predicted, at least as far as the contribution of The Bourn is concerned. This is based on observations during the event of 28th June 2012, for which rainfall records are available. The model predicts surcharging of the Pershore Road bridge, but none was observed (visual only, no monitors in place).

13.3. Hockley Brook Catchment

In order to produce updated flood outlines for the Hockley Brook, an InfoWorks CS integrated model was built, based on record drawings of the culverted Hockley Brook, Severn Trent Water's relevant Drainage Area Plan models and data gathered from site visits. "Fluvial only" flooding was modelled by only setting nodes on the brook to "2D" type flooding, with flood volumes elsewhere being stored at nodes. This represents the routing of flows through the piped systems, but allows flooding out of the brook to be clearly identified.

The model uses open channel and culvert data extracted from old as-built plans with limited level data, and incomplete records of subsequent alterations. Some additional data has been obtained from a condition survey in March 2011 (often by estimating dimensions from photographs) and from the installation of flow monitors. A detailed survey was commissioned, but been delayed by resources constraints and weather-related health and safety issues, which made it difficult to plan safe working. The modelling and map production for this study were therefore completed without this information.

The model has been verified by a short term flow survey in the brook itself, and is considered to be conservative. Further flow surveys and refinements are recommended if it is intended to use the model to design flood alleviation options in the future, to give sufficient confidence on which to base investment decisions.

The model has been externally reviewed and comments made have been dealt with.

The outcome is that there is limited risk of flooding on a 1% AEP (100 year return period) event. On a 0.5% AEP (200 year return period) storm events, significant flooding is modelled in three areas, but the model is considered to be conservative because of the assumptions made and based on the verification data obtained. This conclusion is considered credible based on the recorded and observed size of the brook in relation to its catchment. The culverting works were clearly carried out to a high standard and allow adequate capacity in terms of conveyance and storage.

The model was subsequently extended to include the Birchfield and Handsworth catchments, to form the Birchfield model. This should be updated once detailed survey information is available, and the flood risk re-assessed.

13.4. Birchfield Catchment

The combined model has been used to produce flood risk and hazard maps, assess potential damages and identify alleviation options in outline, as covered in this report. The information gained and the options studied have allowed Action Plan elements for the catchment to be developed.

Since the study was completed, the survey of Hockley Brook has been completed (September 2013), verification repeated and flood risk simulation re-run. No significant differences were noted, but the flood extents are generally marginally less. There is therefore no immediate need to amend the outputs of this study.

The model is considered to be adequately verified for an overall flood risk assessment and consideration of outline alleviation options by a second flow survey in the piped network. Further flow surveys and refinements are recommended if it is intended to use the model to design flood alleviation options in the future, to give sufficient confidence on which to base investment decisions.

922 properties are identified as being at risk in a 200 year (0.5% AEP) event. Note that no allowance has been made for climate change, and the implications of the Water Framework directive have not specifically been considered.

13.5. Plants Brook Catchment

In order to produce updated flood outlines for the Plants Brook catchment as part of the Birmingham Surface Water Management Plan, an InfoWorks ICM (Integrated Catchment Modelling) integrated model was built, based on surveys of the watercourses concerned and Severn Trent Water's relevant sewer records.

The model is considered to be adequately verified for an overall flood risk assessment and consideration of outline alleviation options. Further flow surveys and refinements are recommended if it is intended to use the model to design flood alleviation options in the future, to give sufficient confidence on which to base investment decisions.

14 properties are identified as being at risk in a 200 year (0.5% AEP) event. Note that no allowance has been made for climate change, and the implications of the Water Framework directive have not specifically been considered

13.6. Modelling Reports

The modelling and associated work has been completed and is described in detail in four separate Flood Risk Reports:

- River Rea catchment, including Bourn Brook
- Hockley Brook catchment
- Birchfield catchment, an extension of the Hockley Brook work
- Plants Brook catchment

The Flood Risk Reports also give details of the alleviation options modelled, and identify the subsequent work identified for the Action Plan stage. The main conclusions of these are summarised in this Section. They are intended to be read as an appendix to this Birmingham Surface Water Management Plan Project Report, and are summarised below for information. Please refer to the Flood Risk Reports themselves for details.

The main areas at risk of flooding from all sources have been identified and summarised as the Action Plan Sites in Section 16. Outline options have been tested for alleviating that risk where possible. These have been put forward along with other potential actions for further consideration at Action Plan stage.

14. Options Stage – Approach

14.1. Introduction

This Section of the report outlines the approach taken to identifying and assessing options

14.2. Options Stage Objectives

The broad aim of the Options Phase was to review the Local Flood Risk Areas and develop a range of options that could be tested and reviewed.

The objectives of the Detailed Phase assessment were to:

- Review areas of highest flood risk and determine Final Local Flood Risk areas;
- Identify a range of measures and options to mitigate surface water flooding and short-list those which should be taken forward
- Undertake the assessment of shortlisted options; and
- Agree the preferred options to be taken forward into the SWMP Action Plan.

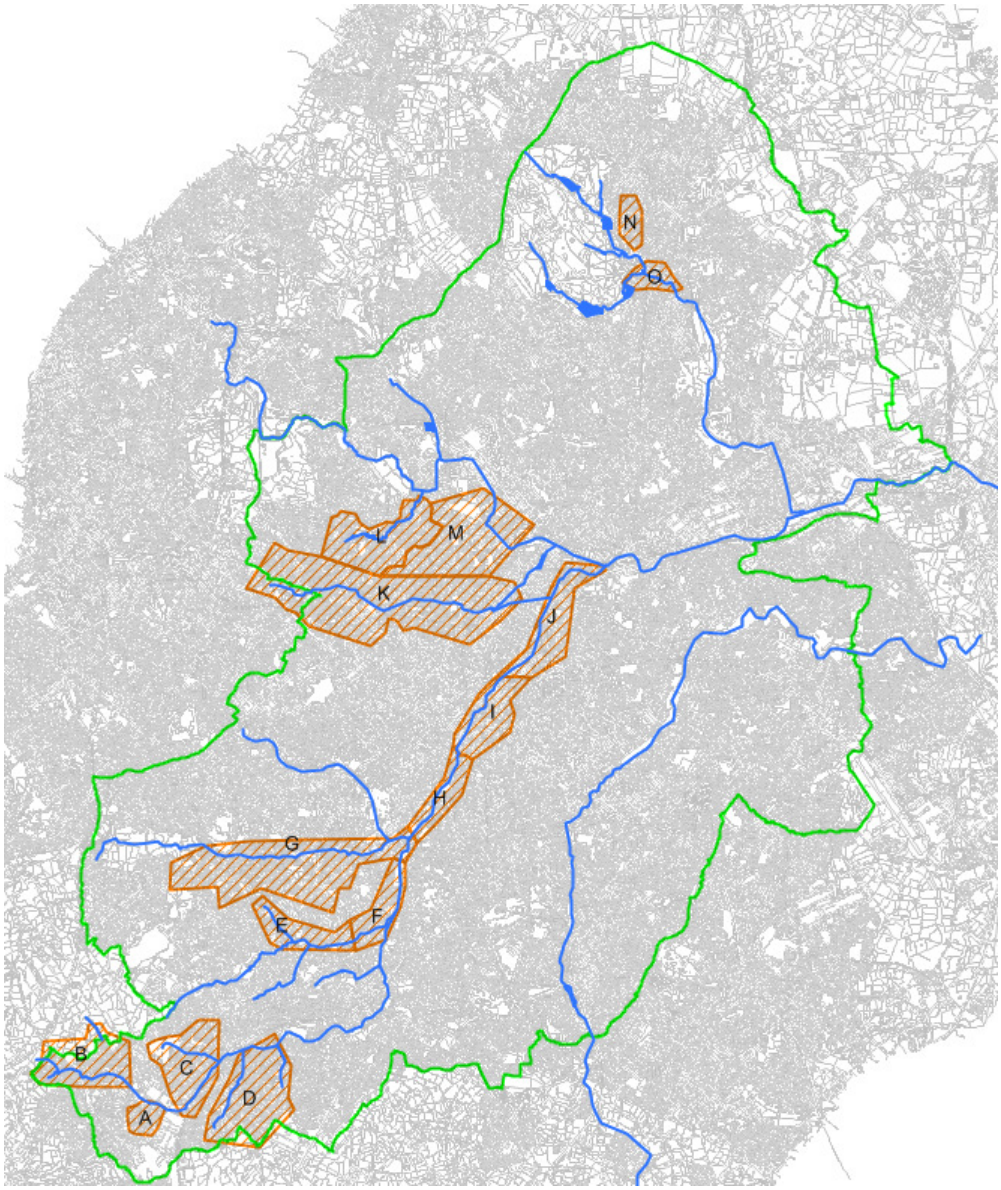
15. Options Stage - Identifying Measures

15.1. Introduction

This Section of the report outlines the approach taken to identifying options.

15.2. Final Local Flood Risk Areas

Following completion of the Detailed Assessment, the screened Local Flood Risk Areas were reassessed to ensure that the most significant areas of surface water flood risk were covered. From this exercise, the Final Local Flood Risk Area (LFRA) boundaries were produced as shown below in Figure 15-1 – Options stage LFRAs.



A – Rednal
B – Frankley
C – Longbridge
D - West Heath
E – Bournville
F – Selly Park
G – Selly Oak
H – Edgbaston
I – Digbeth
J – Saltley
K - Hockley
L – Handsworth
M – Birchfield
N – Four Oaks
O – Sutton Coldfield

Figure 15-1 – Options stage LFRAs

Of the above, areas A to J are covered by the River Rea model, K to M by the Hockley/ Birchfield model and N to O by the Plants Brook model. At this stage it was determined that Local Flood Risk areas and options for the River Cole catchment would be considered once the EA have considered their strategy for the fluvial flood risk element .

15.3. Identifying Measures

In collaboration with project partners a range of measures were identified which could be taken to manage surface water flood risk as shown in Table 15.1 below.

Generic Measure	Detailed Measure
1. Land Management	Afforestation
	Agricultural processes on the urban fringe
	Use of Green Infrastructure
2. Attenuation/retention	Floodplain storage
	Wetland creation/river restoration
	SUDS -new/retrospective
3. Increased channel conveyance	Carry on existing maintenance regime
	De-Culverting
	Increase maintenance regime
	River engineering i.e. channelisation
	Diversion channels
	Raised Defences
4. Other Infrastructure Improvement	Pumping
	Managing exceedance flows
	Green Roofs
	Improve capacity of piped networks
	On-line storage (existing/new)
	Off-line storage (existing/new)
	Continue existing maintenance of networks / gullies
	Increased maintenance regime for networks / gullies
5. Planning Activities	Development Control
	SUDS Strategy
	Blue Development Corridors
	New development Masterplanning

Generic Measure	Detailed Measure
6. Resilience	Flood awareness
	Emergency & disaster planning/response
	Property Level Protection / Building Resilience
7. Monitoring / Advice / Survey	Asset inspection
	Flood warning & forecasting
	Improve Hydrometric network
8. Further Assessment	Investigation of past flooding
	Survey of affected areas (e.g. condition surveys)
	Detailed Modelling

Table 15.1 – Potential Flood Risk Management Measures

15.4. Shortlisted Options - Modelling

At this stage in the SWMP it was not possible to assess all Local Flood Risk areas in detail, therefore it was decided that a number of modelled options would be identified to be taken forward to the assessment stage. Table 15.2 summarises the option types identified for each LFRA

Area Name	Option Stage LFRA Ref	Comments	Option 1	Option 2	Option 3
Catchment as a whole		For development control	SHLAAs set to greenfield		
Selly Park	F	Significant damages	Storage on Griffins Brook		
Selly Oak	G	Significant damages	Surveys and model refinement e.g. Quinton Rd/ Arosa Drive culvert, Exeter Road areas	Storage in Country Park and Harborne Golf Course/ other locations	Storage in Barcheston Road Rec/ Alwold Rd path
Edgbaston	H	Some SW damages	Road realignment		
Hockley	K	Significant damages – surface water rather than fluvial	Surveys and model refinement inc. Ensure SW flows can enter river.		
Handsworth	L	Some damages – surface water rather than fluvial	Local capacity increases		

Area Name	Option Stage LFRA Ref	Comments	Option 1	Option 2	Option 3
Birchfield	M	Significant damages – surface water rather than fluvial	Local capacity increases		

Table 15.2 - Options to model

Note that there was insufficient data on gully cleaning to implement the proposal in 8.4.3 to identify areas where improved maintanance might contribute to alleviating flood risk. As gullies are not modelled individually, it is not possible to assess the impact of partial blockage at this strategic level. With sufficient survey data, it would be possible to do so in future at a detailed level for particular areas if it were considered beneficial.

15.5. Shortlisted Options – Site Assessment

In addition to the modelling of options, every cluster of at risk properties within the Final Local Flood Risk Areas was assessed on site to determine whether the modelled output represented the likely flooding machanism that could occur on site and to assess the locations where there may be flooding but there isn't a risk to property due to threshold levels. Actions were then applied to each cluster of at risk properties within the Local Flood Risk areas that could be developed into the SWMP Action Plan.

16. Options Stage - Assessing Modelled Options

16.1. Introduction

This Section of the report outlines how the assessment of shortlisted options was undertaken and the cost benefit analysis of these options.

16.2. Modelling Approach

In order to translate the short-listed options into practicable models, two options were modelled and evaluated in each catchment. The first was the “SHLAA (Strategic Housing Land Availability Assessment) Option”, the second was the “Works Option”, which included all the elements listed in Table 15.2. Because of the run times involved, it was not practical to simulate them individually, but it was still possible to assess their local impacts qualitatively, as well as the catchment-wide quantitative assessment based on the damages assessment.

The elements of the Works Option were selected largely using engineering judgement and experience as to actions that were liable to produce the desired results at reasonable cost and acceptability, and were grouped together in the model to test their combined impact. Modelling each individually was not considered to be feasible in the time available or particularly useful for a strategic study. The selection process could not be exhaustive or rigorous due to time constraints, but options were refined iteratively in an attempt to optimise overall impact and cost. It should be stressed that this process does not constitute a feasibility study, but is an indication of the scale of plausible flood risk alleviation works and their effect.

16.3. SHLAA Option

A TAB file showing the current SHLAA sites was provided by BCC. It was necessary to translate this into amended model sub-catchments to replicate greenfield runoff from these sites. As the sites did not correlate exactly with the sub-catchments, and they were too numerous to modify individually, various attempts were made to identify a reasonable equivalent. The optimum in terms of corresponding total areas and geographical spread was found by selecting storm or combined system sub-catchments with an overlap greater than or equal to 30% with any SHLAA site, as illustrated by the typical extract in Figure 16.1. All contributing surfaces on these were then set to permeable, to reflect the aim of reducing runoff to greenfield values, i.e. the rate that would occur from the natural soil.

SHLAA sites are shown as green square hatching. The selected sub-catchments are highlighted in red. It can be seen that there are overlaps and omissions, but overall the areas selected correspond reasonably well.

No attempt was made to model any storage or other measures that might be taken to achieve this, or to determine whether they might be feasible in any case.

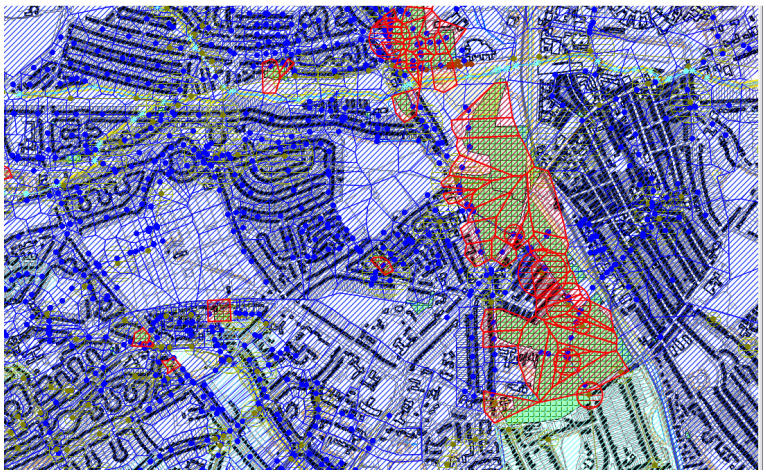


Figure 16-1 – Typical SHLAA site selection

The full extent of SHLAA sub-catchments is highlighted in Figure 16.2. The impact of implementing this policy is highly location-specific, but in general terms it removes 159 properties from the 100 year flood risk envelope. Looked at another way, it reduces the numbers of properties at risk in a 200 year event to the number for a 100 year event, while climate change projections indicate that what is currently a 200 year event will become a 100 year event within the foreseeable future. The policy could be seen as a way of at least containing if not actually alleviating the effects of climate change in the long term. Further details are given in the individual reports.

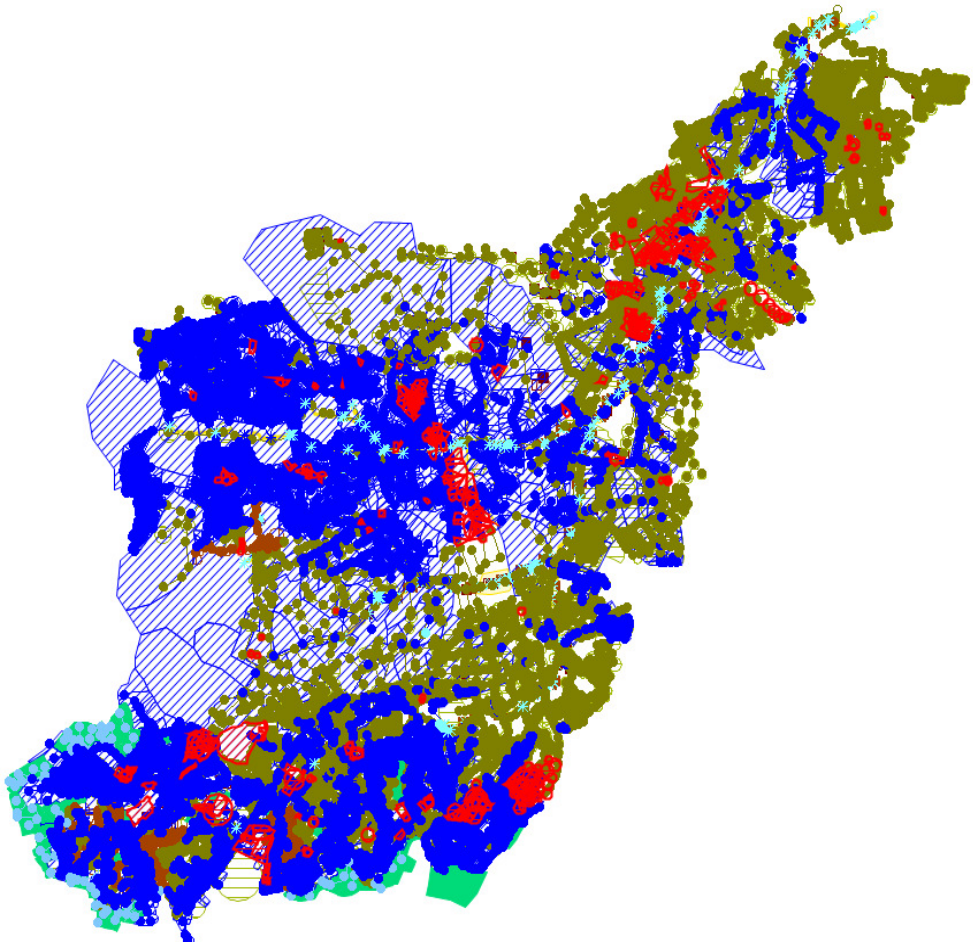


Figure 16-2 – SHLAA sub-catchments

16.4. Works Options

The options modelled are described in brief in Table 15.1 and in more detail in the individual reports.

	Option	Option Stage LFRA Ref	Location	Description
Rea Catchment				
1	GC wall	G/H	Harborne Golf Course	Bund and flow control
2	HarborneGCWestWall	G/H	Harborne Golf Course	Bund and flow control
3	Cemetery	G/H	Lodge Hill Cemetery	Bund and flow control
4	Weoley Ave TRA	G/H	Weoley Avenue/ Woolacombe Lodge Road junction	Kerb
5	BournWall1	G/H	Eastern Road to Rea confluence	Defences provided/ maintained
6	BournWall2	G/H	Worcs and Birmingham Canal to Bournbrook Road	Defences provided/ maintained
7	ReaWall1	G/H	Priory Avenue to Third Avenue (off Pershore Road)	Defences provided/ maintained
8	ReaKerb1	G/H	Pershore Road/ Priory Avenue junction	Kerb
9	West Boulevard throttle	G/H	Woodgate Valley Country Park – West Boulevard Bridge	Flow control in/ upstream of bridge
10	Manor Park Farm Wall	E/F	Off Middlepark Drive/ New House Farm Drive	Bund/ wall and flow control in bridge on New House Farm Drive
11	Bournville Lane Wall	E/F	Off Bournville Lane/ Charfield Close	Bund/ wall and flow control in bridge on Bournville Lane
12	Woodbrooke Road Wall	E/F	Off Woodbrooke Road/ Meadow Rise	Bund/ wall and flow control in bridge on Woodbrooke Road
Birchfield Catchment				
1	Perrott Street Throttle	K	Culvert of Hockley Brook under railway, through allotment gardens off Perrott Street	Flow control in upstream of culvert
2	Flap Valve 1	M/L	SP08912053 nr Holford Way	Flap Valve on Outfall to River Tame
3	Flap Valve 2	M/L	SP08902859 off Brookvale Road	Flap Valve on Outfall to River Tame
4	Flap Valve 3	M/L	SP08900651 nr Witton Road	Flap Valve on Outfall to River Tame
5	Flap Valve 4	M/L	SP08900552 nr Witton Road	Flap Valve on Outfall to River Tame
6	Flap Valve 5	M/L	SP08900551 nr Witton Road	Flap Valve on Outfall to River Tame
7	Flap Valve 6	M/L	SP08901451 nr Station Road	Flap Valve on Outfall to River Tame
8	Flap Valve 7	M/L	SP08902351 nr Tame Road	Flap Valve on Outfall to River Tame
9	Flap Valve 8	M/L	SP08903153 nr Village Road	Flap Valve on Outfall to River Tame
10	Flap Valve 9	M/L	SP08903154 nr Tame Road	Flap Valve on Outfall to River Tame
11	Flap Valve 10	M/L	SP08895954 nr Electric Avenue	Flap Valve on Outfall to River Tame
12	Flap Valve 11	M/L	SP08895953 nr Electric Avenue	Flap Valve on Outfall to River Tame
13	Flap Valve 12	M/L	SP08905061 nr Electric Avenue	Flap Valve on Outfall to River Tame
14	Flap Valve 13	M/L	SP08906053 nr Electric Avenue	Flap Valve on Outfall to River Tame
15	Flap Valve 14	M/L	SP08907263 nr Dulverton Road	Flap Valve on Outfall to drain which connects to River Tame
16	Flap Valve 15	M/L	SP08907264 nr Dulverton Road	Flap Valve on Outfall to drain which connects to River Tame
17	Flap Valve 16	M/L	SP08907253 nr Dulverton Road	Flap Valve on Outfall to drain which connects to River Tame
Plants Brook Catchment				
	None			

Table 16.1 – Options Modelled

Note that the lengths of bunds/ walls are approximate and conservative. In many cases, they will incorporate existing structures, road embankments and the like, or only involve minor additions to them.

The sites have been viewed on the MAGIC Website. None appear to be environmentally designated in any way. Neither are they affected by existing Public Rights of Way in any way that would affect viability. Utilities checks have not been carried out, but would be needed to confirm feasibility, as would site investigation (soils).

16.5. Cost Benefit Analysis

The costs and benefits of the proposed Works Options are summarised in Table 15.2. Costs have not been allocated to individual LFRAs as the actions have impacts in LFRAs other than those in which they are taken, making it difficult to meaningfully split the costs and benefits at this stage. Full details are given in the respective Flood Risk Reports.

	Works Options Properties protected	Works Options damages saved	Works Options costs
Rea Catchment			
Rednal	0	£0	£0
Frankley	0	£0	£0
Longbridge	0	£0	£0
West Heath	0	£0	£0
Bournville	10	£388,000	£8,710,136
Selly Park	161	£4,099,200	
Selly Oak	127	£3,258,400	
Edgbaston	42	£1,182,400	
Digbeth	47	£3,020,400	
Saltley	5	£220,000	
Birchfield Catchment			
Hockley Brook	224	£5,560,800	£1,143,850
Handsworth Brook	0	£0	0
Birchfield	58	£2,073,600	£79,520
TOTAL	**427**	**19,582,800**	**£9,933,506**

Table 16.2 – Options Costs and Benefits

17. Options Stage – Site Assessment

17.1. Introduction

The following section describes the sites in each Local Flood Risk Area that were identified as potentially being at significant risk of flooding, the assessment that was made on site and whether they were put forward for inclusion in the Action Plan stage of the SWMP.

17.2. Individual Site Assessment

A – Rednal

1. Cliff Rock Road

Modelling Predicts: One residential property at risk.

Site investigation: No risk of internal flooding due to threshold level.

Take forward to Action Plan: No, not considered a viable site for investment.

2. Bristol Road South

Modelling Predicts: The superseded version of the model predicted one commercial property at risk of flooding.

Site investigation: No risk of internal flooding as there are alternative flow routes past the building.

Take forward to Action Plan: No, not considered to be a viable site for investment

B – Frankley

3. Boleyn Road/ Ormond Road

Modelling Predicts: One property (Home for the Elderly) at risk.

Site investigation: Road clearly drains down Ormond Road, not into the Home for the Elderly. Protected by kerbs and gullies. On site drainage appears lacking, refer to housing.

Take forward to Action Plan:. No, not considered a viable site for investment.

4. Cotswold Close to Miranda Close

Modelling Predicts: Model shows that recent schemes have alleviated flood risk, three properties remain at nominal risk.

Site investigation: Recent property level protection and highway drainage works have addressed historical flooding issues.

Take forward to Action Plan:. Yes, ongoing maintenance is needed to ensure property protection and highway drainage works remain effective.

5. Wyre Close

Modelling Predicts: 6 properties at risk. Surface water sewers have not been modelled due to lack of records, which may be affecting the risk modelled.

Site investigation: There is clearly scope for providing storage in Balaam's Wood or property level protection, however both of these options would be unviable to low level of risk.

Take forward to Action Plan:. No

C – Longbridge

6. Former MG Rover site, Longbridge Lane

Modelling Predicts: 6 properties at risk of flooding from culverted section of River Rea and sewers.

Site investigation: Flood risk to the west of the railway is largely from the Rea. To the east, combined sewer exceedance is the cause.

Take forward to Action Plan: Yes, further investigation needed as the area is currently being re-developed.

7. Coombes Lane/Grayswood Close

Modelling Predicts: 3 properties may be at risk.

Site investigation: Junction of Coombes Lane and Hewell Close is well provided with gullies, but properties appear to be low in relation to road. Properties in Grayswood Road are well above road level, and the slope of the road is away from the properties towards Turves Green Brook.

Take forward to Action Plan: Yes, further investigation suggested of Coombes Lane before developing further options.

D - West Heath

8. Exe Croft

Modelling Predicts: Flooding from watercourse.

Site investigation: Highway drainage works in Exe Croft and Rednal Road have addressed historic flooding issue.

Take forward to Action Plan:. Yes, ongoing maintenance is needed to ensure highway drainage works remain effective.

9. Pitclose Road

Modelling Predicts: 8 properties may be at risk.

Site investigation: Highway drainage works in Pitclose have addressed historic flooding issue.

Take forward to Action Plan:. Yes, ongoing maintenance is needed to ensure highway drainage works remain effective.

10. Houldey Road

Modelling Predicts: A block of flats may be at risk.

Site investigation: Only basement parking is at risk.

Take forward to Action Plan:. No, not considered a viable site for investment.

E – Bournville

11. Bushwood Road

Modelling Predicts: 12 properties may be at risk.

Site investigation: Scheme in place to provide exceedence pathway through Senneleys Park

Take forward to Action Plan: Yes, ongoing maintenance is needed to ensure exceedance pathway remains effective.

12. Bristol Road (Wood Brook)

Modelling Predicts: 4 properties in Bristol Road, Fox Hill, Witherford Way, Middle Park Road affected by flooding in 2008. Well replicated by model. No option modelled.

Site investigation: Previous modelling showed that the capacity of the culvert under Bristol Road is inadequate. No feasible storage/ attenuation options were identified. Flooding also affects Bristol Road, creating a traffic hazard.

Take forward to Action Plan: Yes, further investigation of potential storage options on The Bourn, Wood Brook and Griffins Brook should be considered as part of the EA project for Rea Catchment.

13. The Bourn (Woodbrooke Road to Cadburys)

Modelling Predicts: 8 properties may be at risk.

Site investigation: Storage options may be available as modelled.

Take forward to Action Plan: Yes, further investigation of potential storage options on The Bourn, Wood Brook and Griffins Brook should be considered as part of the EA project for Rea Catchment.

F – Selly Park

14. Oxford Street, Bond Street

Modelling Predicts: 40 properties modelled as at risk, however only one recorded historic incident.

Site investigation: Model may be over-predicting. Properties immediately adjacent to the bridge are low-lying relative to the bank. It has not been possible to make an assessment of properties further upstream, but they also appear to be low-lying and only protected from the river by a variety of walls and fences of unknown construction.

Take forward to Action Plan: Yes, further investigation of potential storage options on The Bourn, Wood Brook and Griffins Brook should be considered as part of the EA project for Rea Catchment. Inspection and maintenance of defence wall required.

15. Ribblesdale Road

Modelling Predicts: 30 properties modelled as at risk, thought to be related to bare earth DTM.

Site investigation: Property threshold levels are high.

Take forward to Action Plan: Yes, further investigation of potential storage options on The Bourn, Wood Brook and Griffins Brook should be considered as part of the EA project for Rea Catchment. The upstream storage option modelled eliminates flooding in this area.

16. Ripple Road, Pershore Road

Modelling Predicts: Known flooding location, 60 properties at risk.

Site investigation: Severn Trent Water have undertaken schem to provide storage and upsize sewers

Take forward to Action Plan: Yes, ongoing maintenance is needed to ensure storage tank and sewer system remains effective and ultimately assess any remaining flood risk.

17. Selly Park South

Modelling Predicts: 30 properties at risk.

Site investigation: Potential storage upstream of Dogpool Lane and on Pebble Mill Playing Fields. The upstream storage and walls option modelled significantly reduces flooding in this area. As the model is conservative, this may be refined into an effective solution.

Take forward to Action Plan: Yes, further investigation of potential storage options should be considered as part of the EA project for Rea Catchment.

G – Selly Oak

18. Stonehouse Brook

Modelling Predicts: 17 residential properties and a council depot are at risk.

Site investigation: Storage upstream in Senneleys Park may be an option, also potential to remove restrictive structure downstream.

Take forward to Action Plan: Yes, further investigation of potential storage options and capacity improvements should be considered as part of the EA project for Rea Catchment.

19. Bourn Brook Corridor (Woodgate Valley Park)

Modelling Predicts: 7 downstream properties at risk.

Site investigation: Site investigation suggests restricting flows at the B4121 culvert to create attenuation area within the grounds of Woodgate Valley Park would be unviable.

Take forward to Action Plan: No, not considered a viable site for investment.

20. Harts Green Brook (Harborne Golf Course)

Modelling Predicts: 7 downstream properties at risk.

Site investigation: This is a potential location for storage to relieve flooding further downstream.

Take forward to Action Plan: Yes, the storage option modelled significantly reduces flooding. Further investigation of potential storage options and capacity improvements should be considered as part of the EA project for Rea Catchment.

21. Welches Brook (Harborne Municipal Golf Course)

Modelling Predicts: 7 downstream properties at risk.

Site investigation: This is a potential location for storage to relieve flooding further downstream, however site inspection recommended before developing further.

Take forward to Action Plan: Yes, the storage option modelled significantly reduces flooding. Further investigation of potential storage options and capacity improvements should be considered as part of the EA project for Rea Catchment. Regular inspection and maintenance of the Arosa Drive culvert required.

22. Bourn Brook Corridor (Reservoir Road)

Modelling Predicts: 7 properties at risk.

Site investigation: Storage locations tested do provide some alleviation. No works were modelled at this location, but there is clearly scope to make use of the storage available off Harborne Lane as an alternative or additional option.

Take forward to Action Plan: Yes, further investigation to assess the current standard of protection offered by Harborne Lane attenuation area and investigate potential for additional storage should be considered as part of the EA project for Rea Catchment.

23. Alwold Road/Corisande Road/Weoley Avenue

Modelling Predicts: 35 properties at risk.

Site investigation: There is a definite low spot with no viable overland flow route away. The modelling shows that part of the flooding is from the foul/ combined system. Flows arrive from across Lodge Hill Cemetery and down Weoley Avenue. The mechanism has been broadly confirmed by report and photos from a member of the public. The low spot is real enough in spite of visible inconsistencies in the DTM. Alternative approaches to flood risk alleviation would be upstream/ local storage/ attenuation, upsize/ duplicate surface water sewer or property level protection.

Take forward to Action Plan: Yes, further investigation required to assess potential scheme in partnership with Severn Trent Water.

24. Lodge Hill Cemetery

Modelling Predicts: Exceedance flows from the cemetery contribute to flooding in Alwold Close/ Corisande Road/ Weoley Avenue.

Site investigation: Maintenance of the Lodge Hill Cemetery drainage system will help prevent unnecessary overland flows. Storage/ infiltration of exceedance flows may form part of the solution.

Take forward to Action Plan: Yes, regular maintenance and inspection of drainage in Lodge Hill Cemetery.

25. Castle Road/ Brockton Road

Modelling Predicts: 6 properties at risk.

Site investigation: Site inspection shows that thresholds are high enough for the risk of internal flooding to be minimal. The main overland flow route would be across Castle Road and through Lodge Hill Cemetery.

Take forward to Action Plan: No.

26. Gibbins Road/Harborne Lane

Modelling Predicts: 16 properties at risk.

Site investigation: An area of flood risk is identified by the model in this location, but the model does not represent all detail in this area. Direct runoff from gardens and the sports field behind may also have contributed, possibly via the short length of open watercourse in rear gardens shown on the map, which probably connects to the surface water sewers. There is a low spot in Fladbury Crescent where flooding is modelled. Low lying properties and sparse provision of gullies, with no clear overland flow route away, suggest that properties may be at a (low to medium) risk of flooding.

Take forward to Action Plan: Yes, additional gullies/ kerb drains may be recommended, however further investigation is required.

27. Exeter Road, Tiverton Road etc

Modelling Predicts: 102 properties modelled as at risk, but no recorded flooding.

Site investigation: The model probably over-predicts flooding but highlights that properties around the low spots in Hubert Road and Tiverton Road are at risk in the event of sewer exceedance. There are no obviously cost-effective upsizing or storage options available, so property level protection may be the only viable option.

Take forward to Action Plan: Yes, further investigation of surface water sewer capacity required by Severn Trent Water.

28. Eastern Road

Modelling Predicts: 32 properties modelled as at risk, but no recorded flooding.

Site investigation: Model may be over-predicting flows. The upstream storage option modelled significantly reduces flooding in this area.

Take forward to Action Plan: Yes, assessment of both upstream and downstream effects of reprofiling Eastern Road Bridge and increasing its capacity should be considered as part of the EA project for Rea Catchment.

29. Selly Park North

Modelling Predicts: 50 properties at risk. Known flooding location.

Site investigation: The flooding mechanism is initially by sewer exceedance, then by spills from Bourn Brook It has been noted that the Bourn Brook part of the model appears to be over-predicting flows and/ or impacts. Potential actions should be investigated together to optimise costs and benefits for the corridor as a whole.

Take forward to Action Plan: Yes, assessment of actions needed to prevent flooding of Selly Park from overland flow routes derived from spills of the Bourn Brook should be considered as part of the EA project for Rea Catchment.

30. Cheddar Road & Court Road

Modelling Predicts: 53 properties at risk.

Site investigation: The main option identified for this area, apart from maintaining the drainage assets, was Road Re-alignment, with the intention of encouraging flows to run off onto Calthorpe Park. A site visit showed that this was impractical due to raised ground levels in the park, but that a scheme had already been completed to provide raised kerbs in Court Road to protect low thresholds from flooding.

Take forward to Action Plan: Yes, regular inspection and maintenance of the highway scheme in Cheddar Road should be undertaken.

H – Edgbaston

31. Belgrave Road area

Modelling Predicts: 8 properties at risk.

Site investigation: The entire area is covered by the EA's Zone 2 and 3 flood extents, which are well in excess of flooding predicted by the SWMP Integrated model, which is presumed to be due to the ICM model routing flows to the watercourses more slowly via the piped network and overland. There is scope for refining the model to improve understanding of flood risk and identify cost-effective alleviation options.

Take forward to Action Plan: Yes, improved data on surface water network required to allow further investigation to be undertaken. Options identified by the EA should be considered as part of the project for Rea Catchment, including; further investigation into Calthorpe Park storage area, options for topping up bank at Eastwood Road, evaluation of potential to remove/reprofile three restrictive access bridges, whilst utilising ponds within Cannon Hill Park for additional storage.

I – Digbeth

32. Southern Gateway Area

Modelling Predicts: 8 properties at risk, although the whole area is covered by the EA's Zone 2 and 3 flood extents.

Site investigation: Proposed re-development presents an opportunity to improve the river corridor. The options modelled have little impact on flooding in this area, as sewer exceedance is the main cause. Slightly lower river levels may allow freer discharge from sewers.

Take forward to Action Plan: Yes, strategic approach is needed to the planning of this area, this should be set out in planning policy, possibly through an area action plan. Options identified by the EA should be considered as part of the project for Rea Catchment and include opening up the River Rea channel and improve accessibility through to Digbeth.

33. Glover Street

Modelling Predicts: 3 properties at risk, although the whole area is covered by the EA's Zone 2 and 3 flood extents.

Site investigation: The surface water sewer system is coarsely modelled in this area and upstream due to lack of records. There is some uncertainty as to the value of the outlines – they may be over or under-predicted.

Take forward to Action Plan: Yes, improved data is required on the surface water network in this area so that the modelling can be improved.

34. Lawley Middleway, Landor Street

Modelling Predicts: 7 properties at risk.

Site investigation: Coarse coverage of the surface water sewers may be an issue.

Take forward to Action Plan: Yes, improved data is required on the surface water network in this area so that the modelling can be improved.

J – Saltley

35. Network Park, Crawford Street

Modelling Predicts: 2 properties at risk.

Site investigation: Coarse coverage of the surface water sewers may be an issue.

Take forward to Action Plan: Yes, improved data is required on the surface water network in this area so that the modelling can be improved.

K – Hockley

36. Upstream of Ninevah Road

Modelling Predicts: 80 properties at risk.

Site investigation: Flooding is modelled from sewers (Surface water and combined) on extreme events, but the overland flow route is not realistic due to the use of the “bare earth” DTM. A site visit found that the route modelled is not likely to occur, with exceedance flows from sewers being directed along highways and open space. Properties adjacent to this route may still be at risk, particularly around the corner of Watt Street and Alexandra Road.

Take forward to Action Plan: Yes, improved data is required on the surface water network in this area so that the modelling can be improved.

37. Upstream of Ninevah Road (Sandwell)

Modelling Predicts: 11 properties at risk.

Site investigation: Flooding is modelled from sewers (Surface water and combined) and from Hockley Brook on extreme events, but the overland flow route is not realistic due to the use of the “bare earth” DTM. Overland flow routes along highways appear to be available, so the model probably over-estimates flood risk in this area.

Take forward to Action Plan: Yes, improved data is required on the surface water network in this area so that the modelling can be improved and Sandwell MBC are carrying out modelling work on the Thimblemill Brook and their own SWMP, which could usefully be added to the Birmingham model along with updated modelling by STW to clarify the actual flood risk in this area.

38. Ninevah Road & Grasmere Road

Modelling Predicts: 50 properties at risk.

Site investigation: Flooding is modelled from sewers (Surface water and combined) and from Hockley Brook on extreme events, but the overland flow route is not realistic due to the use of the “bare earth” DTM. In particular, overland flows from the west are not likely to occur for this, so the model is over-predicting flooding in this area. Exceedance flows in Grasmere Road will be directed along highways and Ashwin Subway, affecting Site 39 in turn.

Take forward to Action Plan: Yes, refine model to reflect conditions on site.

39. Factory Road

Modelling Predicts: 50 properties at risk

Site investigation: Flooding is modelled from sewers (Surface water and combined) and Hockley Brook on extreme events, but the overland flow route is not realistic due to the use of the “bare earth” DTM. Flows along Ashwin Subway (see site 38) add to those generated locally. Ashwin Road, however, slopes generally towards Factory Road, is well provided with gullies, seemingly as part of fairly recent highway works, and is not considered to be at significant risk. There are low thresholds in Newton Place, and the low spot on Factory Road is not well provided with gullies for extreme events.

Take forward to Action Plan: Yes, refine model to reflect conditions on site and reassess surface water flood risk.

40. Burbery Park/Farm Croft

Modelling Predicts: 33 properties at risk.

Site investigation: Flooding is modelled from sewers (Surface water and combined) and Hockley Brook on extreme events, but the overland flow route is not realistic due to the use of the “bare earth” DTM.

Take forward to Action Plan: Yes, refine model to reflect conditions on site and reassess surface water flood risk.

41. Hockley Brook

Modelling Predicts: A total of over 200 properties adjacent to Hockley Brook at risk.

Site investigation: Maintenance of the channel capacity of Hockley Brook is essential to minimise risk to properties in the catchment, however much of the channel is in deep canalised or culverted sections with restricted views and access.

Take forward to Action Plan: Yes, establish a 5 yearly inspection and maintenance regime. Improve maintenance access where possible.

L – Handsworth

42. Douglas Road & Chantry Road

Modelling Predicts: 4 properties at risk.

Site investigation: There is a low spot in the affected area. Thresholds are not high, but highway, detached garages and gardens rather than properties are considered to be at risk.

Take forward to Action Plan: No.

43. Church Hill Road

Modelling Predicts: 13 properties at risk.

Site investigation: There is a low spot in the road here, and no clear drainage route for exceedance flows. Thresholds are generally reasonably high, and only one property is considered to be at significant risk.

Take forward to Action Plan: Yes, further investigation of surface water sewer capacity required, alternatively consider property level protection.

44. Hutton Road

Modelling Predicts: 25 properties at risk.

Site investigation: Properties modelled as flooding appear to have sufficiently high thresholds above road level) and are not considered to be at risk. Local drainage details are not represented in the model, and may prevent flooding – kerbs appear adequate to limit inundation from the road, which generally slopes to the north-east. On the other hand, properties on the east side of Westminster Road are at low level and are considered to be at risk in extreme events.

Take forward to Action Plan: No, properties in Westminster road only considered at risk in extreme event and therefore a property protection scheme would not be viable.

45. Grosvenor Road

Modelling Predicts: 13 properties at risk.

Site investigation: There is a clear route for exceedance flows along Grosvenor Road, and properties modelled as flooding appear to have sufficiently high thresholds to not be at significant risk.

Take forward to Action Plan: No, properties in Grosvenor Road only considered at risk in extreme event and therefore a property protection scheme would not be viable.

M – Birchfield

46. off Broadway & Witton Road

Modelling Predicts: 42 properties at risk.

Site investigation: Sewer exceedance is modelled and will occur during severe and extreme events.. Inspection of the area found adequate kerbs and thresholds to direct floodwater along highways and towards Aston Lane and the bridge under the railway at Witton Road.

Take forward to Action Plan: No.

47. Witton Road & Tame Road

Modelling Predicts: 90 properties at risk.

Site investigation: 65 properties on Deykin Avenue, Tame Road, Electric Avenue, Brantley Road, Westwood Road suffered internal flooding in 2007. Property level protection has been fitted in the areas affected. Sewer exceedance is modelled and will occur during severe and extreme events. Modelled flooding in Yew Tree Road is not considered likely to enter properties as there are good kerbs and adequate gradient, although thresholds are low. The main source of flooding of properties is, however, the River Tame, which itself floods and also restricts the ability of sewers to discharge when levels are high, affecting Witton Road and the bridge under the railway and adjacent roads.

Take forward to Action Plan: Yes, to ensure that the Environment Agency Tame Flood Alleviation Scheme considers residual surface water flood risk.

N – Four Oaks

48. Knowles Drive, Blackroot Road & Anderson Close

Modelling Predicts: 6 properties at risk.

Site investigation: Exceedance of the culverts on the watercourse is modelled and will occur during severe and extreme events. No viable alleviation options have been identified, as the culvert below the railway is not considered to be economical to upsize and any works upstream would simply transfer flooding to other properties. Property level protection is the most likely option however this isn't cost-beneficial for this ara and would need to be privately funded

Take forward to Action Plan: Yes, culverts under the railway and roads should be regularly inspected and desilted to maintain current performance.

O – Sutton Coldfield

49. Clifton Road

Modelling Predicts: 0 properties at risk.

Site investigation: No deficiencies have been identified that would lead to the flooding under clean network conditions. Operational issues (silt, blockages, etc) are suspected of causing the flooding.

Take forward to Action Plan: Yes, the bridge under Clifton Road and the culvert under the railway line should be regularly inspected and desilted to maintain current performance and Riparian owners should be encouraged to meet their obligations to maintain the watercourse.

17.3. Catchment Wide Actions

In addition to the development of actions for the identified individual sites within the Local Flood Risk Areas, it was agreed with project stakeholders that a high level option appraisal would be undertaken on catchment wide actions to apply City-wide. The following measures were identified that should be considered as 'catchment wide' actions, to be applied across the BCC administrative area:

- Increasing flood awareness;
- New development masterplanning.
- Maintenance activities, and
- Future opportunities for investigation and collaborative working.

18. Action Plan

18.1. Introduction

This section outlines how the Action plan was developed and the consultation that took place with project partners and stakeholders.

18.2. Draft Action Plan

Following on from the options assessment phase, a draft Action Plan was developed to bring together all of the modelling work and site assessment undertaken into a defined set of actions to mange surface water flood risk in Birmingham in the long term.

18.3. Consultation

All project partners were consulted on the draft Action Plan and once agreed in principal consultation was undertaken with other key local stakeholders at two events.

On Thursday 28th February 2013 a workshop was held with stakeholders to outline the work undertaken on the Birmingham Surface Water Management Plan (SWMP). This workshop covered the approach taken to identifying the areas of highest flood risk and outlined the actions proposed to manage this risk into the future. It was used to gauge opinion on how best to share the plan and communicate this risk with the wider community.

The workshop was well attended by over 20 delegates. The event was well received by the stakeholders that attended and many commented on how good it was to see such a wide variety of stakeholders involved. Good feedback was received during the event and a number of further comments were also sent following the workshop.

Further stakeholder engagement took place with emergency responders at a meeting of the Birmingham Resilience Group on Thursday 4th April 2013.

The following stakeholders were identified as having an interest in the development of the plan but also as having experience of working with and/or experiencing flood risk issues first hand and as a result being able to bring an informed view point to any consultation or engagement.

- Members of Parliament and Local Elected Members
- Highways Agency
- Network Rail
- Canal and River Trust
- Land owners and developers
- Flood Action Groups
- Emergency responders

The aim of the stakeholder consultation was to:

- Seek stakeholders views on the approach taken to determining the highest areas of flood risk
- Seek views on the options being taken forward to the action plan
- Identify further options that could be included in the action plan

- Determine if the risk could be communicated in a way that would assist emergency responders in their role of planning for and responding to surface water flooding, and

- Seek views on how to communicate the risk to the wider community.

The feedback from the consultation events has been used to refine the long-term action plan and develop an approach to communicating the risk and plan to the Birmingham community. The brief note and response to comments raised during the consultation is included in Appendix A9.

18.4. Final Action Plan

The Final SWMP Action Plan is included in Appendix A10. This is considered a living document and will be updated over time as the actions are undertaken. It will also be updated with new actions where other studies identify surface water management opportunities.

18.5. Next Steps

The final stage in the SWMP process is to produce a public facing version of the SWMP Action Plan which will set out:

- The objectives of the SWMP study

- Actions and programmes of work for each partner/stakeholder, including proposed timing and manner of implementing the actions

- A programme of further work or follow up actions, and

- When the SWMP will be reviewed and updated, and how implementation will be monitored.

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20. Glossary of Terms

Term	Meaning / Definition
AStSWF	Areas Susceptible to Surface Water Flooding
BCC	Birmingham City Council
CSO	Combined Sewer Overflow
DAP	Drainage Area Plan (STW strategic document)
DEFRA	Department for Environment, Food and Rural Affairs
DG5	A water-company held register of properties which have experienced sewer flooding (either internal or external flooding) due to hydraulic overload, or properties which are 'at risk' of sewer flooding more frequently than once in 20 years.
DTM	Digital Terrain Model
EA	Environment Agency
FEH	Flood Estimation Handbook
FMfSW	Flood Map for Surface Water
FRA	Flood Risk Assessment
ISIS	Hydraulic modelling software package developed by Halcrow
IUD	Integrated Urban Drainage
IWCS	InfoWorks CS modelling package developed by MWHSoft (now Innovyze)
ICM	InfoWorks ICM (Integrated Catchment Modelling) package developed by MWHSoft (now Innovyze)
LFRMP	Local Flood Risk Management Plan
LiDAR	Light Detection And Ranging is an airborne terrain mapping technique which uses laser pulses to measure the distance between the aircraft/satellite and the ground
MAGIC	www.magic.gov.uk The MAGIC website provides geographic information about the natural environment from across government
NRD	National Receptor Database

Term	Meaning / Definition
OS	Ordnance Survey
PFI	Private Finance Initiative
PPS 25	Planning Policy Statement 25
PFRA	Preliminary Flood Risk Assessment
SFRA	Strategic Flood Risk Assessment
SHLAA	Strategic Housing and Land Allocation Assessment
SMP	Sewerage Management Plan
STW	Severn Trent Water
Sustainable Urban Drainage Systems (SuDS)	A sequence of management practices and control structures that are designed to drain surface water in a more sustainable manner.
SWMP	Surface Water Management Plan
UKCP09	United Kingdom Climate Projections 2009
WFD	Water Framework Directive
X-X	The minimum return periods in years that caused surcharging and flooding respectively

Appendices

Appendix A. Tables

A.1. Project Data Register

Data Set	Description	Media	Source	Date Received (Date Issued if BCC Data)	Data Quality Score
Flood Warning	Blythe	Shapefile	Environment Agency	22/07/2009	1
	Rea	Shapefile	Environment Agency	22/07/2009	1
	Cole	Shapefile	Environment Agency	22/07/2009	1
	Tame	Shapefile	Environment Agency	22/07/2009	1
Flood Zones	Flood Zone 2	Shapefile	Environment Agency	22/07/2009	2
	Flood Zone 3	Shapefile	Environment Agency	22/07/2009	2
Historic Levels	Actual Node Measurement	Shapefile	Environment Agency	22/07/2009	2
LiDAR Extents	LiDAR Extents June 08	Shapefile	Environment Agency	22/07/2009	1
Main Rivers	Main River Birmingham outline	Shapefile	Environment Agency	22/07/2009	1
Model Levels	Model levels	Shapefile	Environment Agency	22/07/2009	2
Model outlines	1000 Year Outline	Shapefile	Environment Agency	22/07/2009	2
	1000yr UD Tame	Shapefile	Environment Agency	22/07/2009	2
	100 Year Outline	Shapefile	Environment Agency	22/07/2009	2
	100 Year + CC Outline	Shapefile	Environment Agency	22/07/2009	2
	100yr UD Tame	Shapefile	Environment Agency	22/07/2009	2
	200 Year Outline	Shapefile	Environment Agency	22/07/2009	2
	25 Year Outline	Shapefile	Environment Agency	22/07/2009	2
	50 Year Outline	Shapefile	Environment Agency	22/07/2009	2
	75 Year Outline	Shapefile	Environment Agency	22/07/2009	2
	Rea1000D	Shapefile	Environment Agency	22/07/2009	2
	Rea100D	Shapefile	Environment Agency	22/07/2009	2
	Rea100UD	Shapefile	Environment Agency	22/07/2009	2
Rea x-sections	Rea x-sections	Shapefile	Environment Agency	22/07/2009	1
Areas Susceptible to Surface Water Flooding	Less	MapInfo TAB	Infoterra/Environment Agency	05/08/2009	2
	More	MapInfo TAB	Infoterra/Environment Agency	05/08/2009	2
	Intermediate	MapInfo TAB	Infoterra/Environment Agency	05/08/2009	2
Ordnance Survey Data	MasterMap 2009	MapInfo TAB	Birmingham City Council	05/08/2009	1
	Street Gazetteer 2009	MapInfo TAB	Birmingham City Council	05/08/2009	1
	1:10,000	MapInfo TAB	Birmingham City	05/08/2009	1

Data Set	Description	Media	Source	Date Received (Date Issued if BCC Data)	Data Quality Score
			Council		
	1:50,000	MapInfo TAB	Birmingham City Council	05/08/2009	1
National Soil Resources Institute	NATMAP vector	Shapefile	Cranfield University	05/08/2009	1
	SOILSERIES hydrology	Shapefile	Cranfield University	05/08/2009	1
	NATMAP host	Shapefile	Cranfield University	05/08/2009	1
	HORIZON hydraulics	Shapefile	Cranfield University	05/08/2009	1
	SOILSCAPES	Shapefile	Cranfield University	05/08/2009	1
BCC Boundary Data	Birmingham City Boundary	MapInfo TAB	Birmingham City Council	05/08/2009	1
	Planning Boundaries	MapInfo TAB	Birmingham City Council	05/08/2009	1
	Development Sites	MapInfo TAB	Birmingham City Council	05/08/2009	2
	Constituencies	MapInfo TAB	Birmingham City Council	26/08/2009	1
Historic Flooding Records Post 98 Data	Watercourse Flooding	MapInfo TAB	Birmingham City Council	05/08/2009	1
	Groundwater Flooding	MapInfo TAB	Birmingham City Council	05/08/2009	1
	Surface Water Flooding	MapInfo TAB	Birmingham City Council	05/08/2009	1
	Other Flooding	MapInfo TAB	Birmingham City Council	05/08/2009	1
SFRA Flooded Sites Postcode Data	Sept 2008 Other	MapInfo TAB	Birmingham City Council	05/08/2009	1
	Sept 2008 Surface Water	MapInfo TAB	Birmingham City Council	05/08/2009	1
	Sept 2008 Watercourse	MapInfo TAB	Birmingham City Council	05/08/2009	1
	July 2007 Other	MapInfo TAB	Birmingham City Council	05/08/2009	1
	July 2007 Surface Water	MapInfo TAB	Birmingham City Council	05/08/2009	1
	July 2007 Watercourse	MapInfo TAB	Birmingham City Council	05/08/2009	1
	June 2007 Surface Water	MapInfo TAB	Birmingham City Council	05/08/2009	1
	June 2007 Watercourse	MapInfo TAB	Birmingham City Council	05/08/2009	1
	June 2005 Other	MapInfo TAB	Birmingham City	06/08/2009	1

Data Set	Description	Media	Source	Date Received (Date Issued if BCC Data)	Data Quality Score
			Council		
	June 2005 Surface Water	MapInfo TAB	Birmingham City Council	06/08/2009	1
	June 2005 Watercourse	MapInfo TAB	Birmingham City Council	06/08/2009	1
	1998/2000 Other	MapInfo TAB	Birmingham City Council	06/08/2009	1
	1998/2000 Surface Water	MapInfo TAB	Birmingham City Council	06/08/2009	1
	1998/2000 Watercourse	MapInfo TAB	Birmingham City Council	06/08/2009	1
	Frankley Surface Water	MapInfo TAB	Birmingham City Council	21/08/2009	1
	Frankley Watercourse	MapInfo TAB	Birmingham City Council	21/08/2009	1
	Witton Watercourse	MapInfo TAB	Birmingham City Council	21/08/2009	1
Water Company Data	DG5 Register	Excel Spreadsheet	Severn Trent Water	20/08/2009	2
	DAP Polygons	MapInfo TAB	Severn Trent Water	20/08/2009	1
Groundwater	Groundwater Susceptibility Data	MapInfo TAB	British Geological Society	07/09/2009	2
Water Features Layers	Ordinary Watercourse Open Channel	MapInfo TAB	Birmingham City Council	04/09/2008	1
	Ordinary Watercourse Culvert	MapInfo TAB	Birmingham City Council	04/09/2009	1
	Canals	MapInfo TAB	Birmingham City Council	04/09/2009	1
	Canal Tunnel	MapInfo TAB	Birmingham City Council	04/09/2009	1
	Canal Feeder	MapInfo TAB	Birmingham City Council	04/09/2009	1
	Canal Feeder Tunnel	MapInfo TAB	Birmingham City Council	04/09/2009	1
	Reservoirs	MapInfo TAB	Birmingham City Council	04/09/2009	1
	Covered Reservoirs	MapInfo TAB	Birmingham City Council	04/09/2009	1
	Pools	MapInfo TAB	Birmingham City Council	04/09/2009	1
Canal Data	Canal Breach Locations	Map	British Waterways	09/09/2009	1
Core Strategy	Sustainable Urban Neighbourhoods	MapInfo TAB	Birmingham City Council	27/09/2010	1

Data Set	Description	Media	Source	Date Received (Date Issued if BCC Data)	Data Quality Score
	Core Employment Areas	MapInfo TAB	Birmingham City Council	27/09/2010	1
	Strategic Allocations	MapInfo TAB	Birmingham City Council	27/09/2010	1
	SHLAA 2010	MapInfo TAB	Birmingham City Council	27/09/2010	1
Rainfall gauge locations	National Grid reference locations for Environment Agency Rain Gauges	MapInfo TAB	Environment Agency	27/09/2010	1
National Receptor Database	GIS layers of buildings, transport, utilities etc.	MapInfo TAB	Environment Agency	29/09/2010	1
Canal Breach and Overtopping records	Historic flooding records of breach and overtopping of canals	Shapefile	British Waterways	12/10/2010	1
Canal Features	Digital mapping of canal features within Birmingham administrative boundary, including locks, weirs and sluices.	Shapefile	British Waterways	12/10/2010	1
Spring Locations	Layer showing locations of springs	MapInfo TAB	Birmingham City Council	13/10/2010	1
New gully locations	All the locations where new gullies have been installed between 1999-2010, as a means of highlighting where surface water flooding is/has been problematic	MapInfo TAB	Birmingham City Council	15/10/2010	1
Gully maintenance records	All the locations where gullies have been cleaned within two working days of a daily gauged rainfall exceeding 25mm at Frankley and Saltley gauges	MapInfo TAB	Birmingham City Council	29/10/2010	2
Road Classifications	Traffic sensitive roads within Birmingham: • Winter Gritting Route 07:00-19:00, 7 days a week; • Winter Gritting and Christmas Embargo Route 24 Hours a day 7 days; and Tourist Route 24 Hours a Day, 7 days a week	MapInfo TAB	Birmingham City Council	17/11/2010	1
Flood Map for Surface Water	Second generation national mapping outline	MapInfo TAB	Environment Agency	07/12/2010	2

Data Set	Description	Media	Source	Date Received (Date Issued if BCC Data)	Data Quality Score
Green Infrastructure	Green infrastructure Report for BCC	Report	Birmingham City Council	02/02/2011	1
Open Space	Information on Open Spaces within BCC boundary	MapInfo TAB	Birmingham City Council	04/02/2011	1
River Tame maintenance schedule	Environment Agency maintenance schedule on the River Tame	Excel	Environment Agency	14/02/2011	1
River Tame Strategy	Environment Agency River Tame Flood Risk Management Strategy	Report	Environment Agency	21/02/2011	1
Amey maintenance records	Highway gullies maintenance records	Excel	Birmingham City Council	08/03/2011	2
Index of Multiple Deprivation	Ward level data containing deprivation indices	MapInfo TAB	Birmingham City Council	14/03/2011	1
Severn Trent Water proposed schemes	Proposed works / schemes within the BCC boundary by Severn Trent Water	MapInfo TAB	Severn Trent Water	23/03/2011	1

Table B.1 – Data Register

A.2. OS Classes Defined for Categories

OS Class	Category	Sub Category
COACH DEPOT	Utilities and Major Transport Routes	Transport
RAILWAY STATION	Utilities and Major Transport Routes	Transport
BUS STATION	Utilities and Major Transport Routes	Transport
FIRE STATION	Sensitive Property	Fire Stations
POLICE SERVICES	Sensitive Property	Police Stations
POLICE - OFFICE	Sensitive Property	Police Stations
POLICE - GENERAL COMMERCIAL	Sensitive Property	Police Stations
POLICE STATION	Sensitive Property	Police Stations
POLICE HOUSE	Sensitive Property	Police Stations
PRE SCHOOL EDUCATION	Sensitive Property	Education
SECONDARY SCHOOL	Sensitive Property	Education
HIGHER EDUCATION	Sensitive Property	Education
INFANT SCHOOL	Sensitive Property	Education
FURTHER EDUCATION COLLEGE	Sensitive Property	Education
PRIMARY SCHOOL	Sensitive Property	Education
JUNIOR SCHOOL	Sensitive Property	Education
SPECIAL SCHOOL	Sensitive Property	Education
SCHOOL	Sensitive Property	Education
RESEARCH	Sensitive Property	Education
CHILDRENS NURSERY	Sensitive Property	Education
LANGUAGE STUDIES	Sensitive Property	Education
VEHICLE DRIVER TRAINING	Sensitive Property	Education
CHILDRENS NURSERY	Sensitive Property	Education
TRAINING	Sensitive Property	Education
UNIVERSITY	Sensitive Property	Education
TECHNOLOGY STUDIES	Sensitive Property	Education
HIGH SCHOOL	Sensitive Property	Education
MIDDLE SCHOOL	Sensitive Property	Education
EDUCATION	Sensitive Property	Education
PRIVATE PRIMARY SCHOOL	Sensitive Property	Education
FIRST SCHOOL	Sensitive Property	Education
SIXTH FORM COLLEGE	Sensitive Property	Education
ART STUDIES	Sensitive Property	Education
CLINIC	Sensitive Property	Health
HEALTH CENTRE	Sensitive Property	Health
SURGERY	Sensitive Property	Health
VETERINARY SURGERY	Sensitive Property	Health
DENTAL SURGERY	Sensitive Property	Health
HOSPITAL	Sensitive Property	Health
MENTAL HEALTH CENTRE	Sensitive Property	Health
AMBULANCE STATION	Sensitive Property	Health
WATER DISTRIBUTION	Utilities and Major Transport Routes	STW
WATER FILTRATION	Utilities and Major Transport Routes	STW
SEWAGE TREATMENT	Utilities and Major Transport Routes	STW
SEWAGE PUMPING	Utilities and Major Transport Routes	STW
SEWAGE STORAGE	Utilities and Major Transport Routes	STW
WATER REGULATING	Utilities and Major Transport Routes	STW

PUMPING	Utilities and Major Transport Routes	STW
VALVE HOUSE	Utilities and Major Transport Routes	STW
ELECTRICITY SUB STATION	Utilities and Major Transport Routes	Electricity
ELECTRICITY GENERATING	Utilities and Major Transport Routes	Electricity
DWELLING	Residential Property	Residential
ABATTOIR	Commercial Property	Commercial
AMUSEMENT ARCADE	Commercial Property	Commercial
ANIMAL FEED FACTORY	Commercial Property	Commercial
AQUARIUM	Commercial Property	Commercial
ART CENTRE	Commercial Property	Commercial
ART GALLERY	Commercial Property	Commercial
BAKERY	Commercial Property	Commercial
BANK	Commercial Property	Commercial
BAR	Commercial Property	Commercial
BETTING OFFICE	Commercial Property	Commercial
BINGO HALL	Commercial Property	Commercial
BOAT YARD	Commercial Property	Commercial
BREWERY	Commercial Property	Commercial
BRITISH LEGION CLUB	Commercial Property	Commercial
BUILDERS	Commercial Property	Commercial
BUILDERS MERCHANT	Commercial Property	Commercial
BUILDING SOCIETY	Commercial Property	Commercial
CAFÉ	Commercial Property	Commercial
CANTEEN	Commercial Property	Commercial
CAR DEALER	Commercial Property	Commercial
CAR HIRE	Commercial Property	Commercial
CAR WASH	Commercial Property	Commercial
CASH AND CARRY	Commercial Property	Commercial
CASINO	Commercial Property	Commercial
CATTERY	Commercial Property	Commercial
CEMENT WORKS	Commercial Property	Commercial
CHEMICAL WORKS	Commercial Property	Commercial
CHEMIST	Commercial Property	Commercial
CHILD DAY CARE	Commercial Property	Commercial
CHILDRENS HOME	Commercial Property	Commercial
CINEMA	Commercial Property	Commercial
CLEANING	Commercial Property	Commercial
CLUB	Commercial Property	Commercial
CLUB HOUSE	Commercial Property	Commercial
CONCRETE WORKS	Commercial Property	Commercial
CONFERENCE CENTRE	Commercial Property	Commercial
CONTAINER STORAGE	Commercial Property	Commercial
CONTRACTORS YARD	Commercial Property	Commercial
COUNTRY CLUB	Commercial Property	Commercial
CRAFT WORKSHOPS	Commercial Property	Commercial
DAIRY	Commercial Property	Commercial
DANCING	Commercial Property	Commercial
DAY CARE	Commercial Property	Commercial
DEPARTMENT STORE	Commercial Property	Commercial
DISTRIBUTION	Commercial Property	Commercial
DRY CLEANERS	Commercial Property	Commercial
EMPLOYMENT AGENCY	Commercial Property	Commercial
ENGINEERING WORKS	Commercial Property	Commercial
ENTERTAINMENT CENTRE	Commercial Property	Commercial
ESTATE AGENCY	Commercial Property	Commercial

EXHIBITION CENTRE	Commercial Property	Commercial
FACTORY	Commercial Property	Commercial
FILLING STATION	Commercial Property	Commercial
FINANCIAL AND PROFESSIONAL SERVICES	Commercial Property	Commercial
FITNESS CLUB	Commercial Property	Commercial
FOOD AND DRINK MANUFACTURE	Commercial Property	Commercial
FORGE	Commercial Property	Commercial
FOUNDRY	Commercial Property	Commercial
FUEL DEPOT	Commercial Property	Commercial
GARDEN CENTRE	Commercial Property	Commercial
GENERAL COMMERCIAL	Commercial Property	Commercial
GO-KARTING	Commercial Property	Commercial
GUEST HOUSE	Commercial Property	Commercial
GYMNASIUM	Commercial Property	Commercial
HAIRDRESSER	Commercial Property	Commercial
HEALTH CLUB	Commercial Property	Commercial
HIRE SHOP	Commercial Property	Commercial
HORTICULTURAL NURSERY	Commercial Property	Commercial
HOSTEL	Commercial Property	Commercial
HOTEL	Commercial Property	Commercial
INDUSTRY AND BUSINESS SERVICES	Commercial Property	Commercial
INN	Commercial Property	Commercial
INSURANCE BROKER	Commercial Property	Commercial
IRON WORKS	Commercial Property	Commercial
JOB CENTRE	Commercial Property	Commercial
JOINERY	Commercial Property	Commercial
KENNELS	Commercial Property	Commercial
LAUNDERETTE	Commercial Property	Commercial
LAUNDRY	Commercial Property	Commercial
LEISURE CENTRE	Commercial Property	Commercial
MANUFACTURING	Commercial Property	Commercial
MARKET	Commercial Property	Commercial
MOTEL	Commercial Property	Commercial
MOTOR CYCLE DEALER	Commercial Property	Commercial
NIGHTCLUB	Commercial Property	Commercial
OFFICE	Commercial Property	Commercial
PACKING	Commercial Property	Commercial
PERFORMING ARTS STUDIES	Commercial Property	Commercial
PIGGERY	Commercial Property	Commercial
POST OFFICE	Commercial Property	Commercial
POSTAL DISTRIBUTION	Commercial Property	Commercial
POUULTRY FARMING	Commercial Property	Commercial
PRINTING WORKS	Commercial Property	Commercial
PUBLIC CONVENIENCE	Commercial Property	Commercial
PUBLIC HOUSE	Commercial Property	Commercial
RADIO COMMUNICATIONS	Commercial Property	Commercial
RECYCLING	Commercial Property	Commercial
REPAIR CENTRE	Commercial Property	Commercial
RESTAURANT	Commercial Property	Commercial
RETAIL PARK	Commercial Property	Commercial
RETAIL WAREHOUSE	Commercial Property	Commercial
RIFLE RANGE	Commercial Property	Commercial
ROAD HAULIER	Commercial Property	Commercial
ROLLER SKATING	Commercial Property	Commercial
RUGBY FOOTBALL	Commercial Property	Commercial
SAILING	Commercial Property	Commercial

SAND EXTRACTION	Commercial Property	Commercial
SANDWICH BAR	Commercial Property	Commercial
SCRAP METAL HANDLING	Commercial Property	Commercial
SERVICE STATION	Commercial Property	Commercial
SHIP FREIGHT	Commercial Property	Commercial
SHOPPING	Commercial Property	Commercial
SHOPPING CENTRE	Commercial Property	Commercial
SMITHY	Commercial Property	Commercial
SNOOKER	Commercial Property	Commercial
SOCIAL CLUB	Commercial Property	Commercial
SPORTS CLUB	Commercial Property	Commercial
STABLES	Commercial Property	Commercial
STEEL STORAGE	Commercial Property	Commercial
STEEL WORKS	Commercial Property	Commercial
STONE STORAGE	Commercial Property	Commercial
STONEMASONS	Commercial Property	Commercial
STORAGE	Commercial Property	Commercial
SUPERMARKET	Commercial Property	Commercial
SUPERSTORE	Commercial Property	Commercial
SWIMMING	Commercial Property	Commercial
TAKE AWAY	Commercial Property	Commercial
TAXI BUSINESS	Commercial Property	Commercial
TELECOMMUNICATIONS	Commercial Property	Commercial
TELEPHONE EXCHANGE	Commercial Property	Commercial
TELEVISION COMMUNICATIONS	Commercial Property	Commercial
TELEVISION STUDIO	Commercial Property	Commercial
TERRITORIAL ARMY	Commercial Property	Commercial
THEATRE	Commercial Property	Commercial
TIMBER STORAGE	Commercial Property	Commercial
TOURIST INFORMATION	Commercial Property	Commercial
TRADE DISTRIBUTION	Commercial Property	Commercial
TRAVEL AGENCY	Commercial Property	Commercial
TYRE DEPOT	Commercial Property	Commercial
UNDERTAKERS	Commercial Property	Commercial
VEHICLE TESTING	Commercial Property	Commercial
VINEYARD	Commercial Property	Commercial
VISITOR INFORMATION	Commercial Property	Commercial
WASTE DISPOSAL	Commercial Property	Commercial
WASTE PULVERISATION	Commercial Property	Commercial
WHOLESALE MARKET	Commercial Property	Commercial
WORKS	Commercial Property	Commercial
CENTRAL GOVERNMENT OFFICE	Government Property	Government
CIVIC HALL	Government Property	Government
COMMUNITY CENTRE	Government Property	Government
COMMUNITY HALL	Government Property	Government
COMMUNITY OFFICE	Government Property	Government
CORONERS COURT	Government Property	Government
COUNCIL DEPOT	Government Property	Government
COUNTY COURT	Government Property	Government
CROWN COURT	Government Property	Government
GOVERNMENT OFFICE	Government Property	Government
HALL	Government Property	Government
HM PRISON	Government Property	Government
LOCAL GOVERNMENT OFFICE	Government Property	Government
MAGISTRATES COURT	Government Property	Government
PROBATION CENTRE	Government Property	Government
SOCIAL SERVICES	Government Property	Government
WELFARE SERVICES	Government Property	Government
YOUTH CENTRE	Government Property	Government

A.3. Scoring Matrices

Subcatchment 14	Number	Consequence	Probability	Confidence in data	Reliability of method	Control Measure	Score	Comments (mandatory if adjusted)
Number of residential properties affected								
T30 Shallow	1054	1	0.5	1	1	1	527	
T30 Deep	272	1	1	1	1	1	272	
T200 Shallow	3583	1	0.2	1	1	1	716.6	
T200 Deep	1267	1	0.5	1	1	1	633.5	
Number of commercial properties affected								
T30 Shallow	60	0.75	0.5	1	1	1	22.5	
T30 Deep	10	0.75	1	1	1	1	7.5	
T200 Shallow	148	0.75	0.2	1	1	1	22.2	
T200 Deep	39	0.75	0.5	1	1	1	14.625	
Sensitive properties (hospitals, schools, police stations, fire stations)								
T30 Shallow	10	2.5	0.5	1	1	1	12.5	
T30 Deep	2	2.5	1	1	1	1	5	
T200 Shallow	30	2.5	0.2	1	1	1	15	
T200 Deep	12	2.5	0.5	1	1	1	15	
Utilities and major transport routes (electricity, water, railways, roads, and associated stations)								
T30 Shallow	175	3	0.5	1	0.9	1	236.25	
T30 Deep	26	3	1	1	0.9	1	70.2	
T200 Shallow	281	3	0.2	1	0.9	1	151.74	
T200 Deep	90	3	0.5	1	0.9	1	121.5	
Government buildings								
T30 Shallow	0	1.5	0.5	1	1	0.5	0	
T30 Deep	0	1.5	1	1	1	0.5	0	
T200 Shallow	1	1.5	0.2	1	1	0.5	0.15	
T200 Deep	0	1.5	0.5	1	1	0.5	0	
Potential re-development / development sites								
T30 Shallow	18	0.5	0.5	1	1	0.5	2.25	
T30 Deep	7	0.5	1	1	1	0.5	1.75	
T200 Shallow	59	0.5	0.2	1	1	0.5	2.95	
T200 Deep	13	0.5	0.5	1	1	0.5	1.625	
Core Strategy								
Sustainable Urban Neighbourhoods	1.868448	0.5	0.5	1	1	1	0.46711206	
Core Employment Areas 2010	8.7327	0.5	0.75	1	1	1	3.27476233	
Strategic Allocations	7.614748	0.5	1	1	1	1	3.80737403	
Other Types of Flooding								
Historical Surface Water Flooding	0	1	1	1	0.5	100	0	
Historical Fluvial Flooding	0	1	1	1	0.45	100	0	
Gullies New	6	1	0.2	1	0.75	1	0.9	
Gullies Maintenance	46	1	0.2	1	0.75	2	13.8	
DG5	1	1	1	1	1	100	100	
x-x	1462	1	1	0.5	0.3	0.5	109.65	
						No. buildings	**22852**	
						Area (km2)	**6.7**	
						Urban density	**3410.74627**	
						Predicted score	**2843.265**	
						Predicted Score/Buildings	0.12442084	
						Predicted Score/Area	424.36791	
						Predicted Score/Urban Density	0.83361962	
						Re-development/Core Strategy Score	**16.1242484**	
						Re-development/Core Strategy/Buildings	0.00070559	
						Re-development/Core Strategy/Area	2.40660424	
						Re-development/Core Strategy/Urban Density	0.00472748	
						Historical flooding Score	**224.35**	
						Historical flooding Score/Buildings	0.00981752	
						Historical flooding Score/Area	33.4850746	
						Historical flooding Score/Urban Density	0.06577739	

A.4. Detail of Scoring Matrices

Catchment	Transport (stations)	Transport (roads)	Transport (railways)	Fire Stations	Police Stations	Education	Health	STW	Electricity	Residential	Commercial	Government
1 (Sheldon)	0	803	165	1	0	113	23	0	151	15341	741	26
2 (Upper Cole)	0	1432	1264	0	0	160	50	5	31	20158	1806	28
3 (Lower Cole)	0	1124	378	9	13	164	7	0	34	16122	985	24
4 (Middle Rea and The Bourn)	0	749	292	0	7	85	22	2	3	8537	402	52
5 (Bourn Brook)	0	1171	256	0	0	119	50	0	16	16090	787	72
6 (Upper Rea)	0	1499	859	0	2	144	40	0	45	17627	1026	36
7 (Lower Rea)	0	1806	1663	9	20	130	53	0	35	5766	2865	54
8 (Hockley Brook)	0	1192	667	3	8	103	24	10	53	6978	2698	25
9 (Upper Tame)	1	1475	821	0	17	225	60	2	51	19638	1734	39
10 (Plants Brook)	0	1106	1270	0	0	124	76	15	30	17802	1512	27
11 (North Sutton)	0	74	180	0	0	0	4	0	0	2895	22	0
12 (East Sutton)	0	180	0	0	0	21	1	1	5	2397	17	0
13 (Middle Tame)	3	1385	531	6	9	119	24	15	64	18583	1460	32
14 (Washwood Heath)	0	271	289	6	14	20	14	0	12	6176	257	1
Total	**4**	**13860**	**8635**	**34**	**90**	**1527**	**448**	**50**	**530**	**174110**	**16312**	**416**

A.5. Consequence Sensitivity Testing

Consequence sensitivity									
Catchment	Predicted	Predicted +50%	Predicted -50%	Re-development	Re-development +50%	Re-development -50%	Incidents of flooding	Incidents of flooding +50%	Incidents of flooding -50%
1	10	10	10	12	12	12	12	12	12
2	6	6	6	4	4	4	6	6	6
3	8	8	8	10	10	10	13	13	13
4	11	11	11	11	11	11	4	4	4
5	5	5	5	5	5	5	5	5	5
6	2	2	2	3	3	3	1	1	1
7	3	3	3	1	1	1	7	7	7
8	9	9	9	2	2	2	10	10	10
9	4	4	4	8	8	8	3	3	3
10	1	1	1	6	6	6	2	2	2
11	13	13	13	14	14	14	8	8	8
12	12	12	12	7	7	7	11	11	11
13	7	7	7	9	9	9	9	9	9
14	14	14	14	13	13	13	14	14	14

A.6. Probability Sensitivity Testing

Probability sensitivity									
Catchment	Predicted	Predicted +50%	Predicted -50%	Re-development	Re-development +50%	Re-development -50%	Incidents of flooding	Incidents of flooding +50%	Incidents of flooding -50%
1	10	10	10	12	12	12	12	12	12
2	6	6	6	4	4	4	6	6	6
3	8	8	8	10	10	10	13	13	13
4	11	11	11	11	11	11	4	4	4
5	5	5	5	5	5	5	5	5	5
6	2	2	2	3	3	3	1	1	1
7	3	3	3	1	1	1	7	7	7
8	9	9	9	2	2	2	10	10	10
9	4	4	4	8	8	8	3	3	3
10	1	1	1	6	6	6	2	2	2
11	13	13	13	14	14	14	8	8	8
12	12	12	12	7	7	7	11	11	11
13	7	7	7	9	9	9	9	9	9
14	14	14	14	13	13	13	14	14	14

A.7. Preliminary Local Flood Risk Areas

Preliminary Local Flood Risk Areas

No.	Sub-Catchment	Name / Reference / Location	Approx. Area (km²)	Assets at risk (score, people, properties, transport)		Approx. Event Damages (£)	Flooding Source	Average Social Vulnerability: IMD Score / Rank	Other Comments (e.g. designated sites, Green Infrastructure, development opportunities, proposed schemes)	Rank (H/M)	Superficial / Drift Geology	Indicative Soilscapes Classification	Justification for taking forward / removing	Action	High Level Options Appraisal?
1	5	a) Lodge Hill, California, Selly Oak and Bournbrook	3	>10 roads (some major) and mainline rail links at risk.		£6,832,931	Fluvial and Surface water records - minimal contribution from FMfSW	29 / 10242	Whilst some of these grid squares are not connected/directly adjacent it was thought appropriate to group them since the Bourn Brook links them. Re-development opportunities between Selly Oak and Bourn Brook. Significant areas of Public Open Space available. No designated sites.	High and Medium	Mixture of: Alluvium - clay, silt, sand and gravel. Till - Diamicton. Glaciolacustrine deposits - clay and silt.Glaciofluvial deposits - sand and gravel.	Slowly permeable seasonally wet slightly acid but base rich loamy and clayey soils	This is a high risk area with both surface water and fluvial flooding records, along with high numbers of property predicted to be at risk within the T200 outlines, and significant development opportunities; and should therefore be taken forward for more detailed assessment.	Take Forward to Detailed Stage for modelling of the Bourn Brook.	Yes
				Props:	1267										
				People:	2792										
				Historical Score:	1500										
				Score:	1814										
2	5	b) Kitwell	0.25	<5 minor roads at risk		£258,864	Historical Surface Water Flooding Record	44 / 3712	Grid is on the edge of the catchment area, and is included due to Historical Surface Water Flooding Record. No designated sites or development opportunities.	High	Till - diamicton	Slightly acid loamy and clayey soils with impeded drainage	High Risk ranking is based on 1 surface water flooding record (3 Internal) and is restricted to one grid square. Given location on edge of LA boundary, remote from other risk areas it was not thought appropriate to carry this forward.	Assess surface water flooding record	No
				Props:	48										
				People:	98										
				Historical Score:	150										
				Score:	160										
3	5	C) Bourn Brook - River Rea Confluence	0.25	<5 minor roads at risk		£275,043	Fluvial historic records - from the Bourn Brook	19 / 14559	Cannon Hill Park Public Open Space adjacent.	High	Alluvium - clay, silt, sand and gravel.	Slowly permeable seasonally wet slightly acid but base rich loamy and clayey soils	High risk ranking is restricted to one grid square, and due largely to the presence of 2 fluvial flooding records. However, there is a potential for linking to upstream works hence should be taken forward.	Assess fluvial flooding record and link in with Bourn Brook Modelling.	Yes
				Props:	51										
				People:	117										
				Historical Score:	765										
				Score:	778										
4	5	d) Woodgate Valley	0.25	<5 minor roads at risk		£738,841	Surface Water Historic record and FMfSW	49 / 2751	Small area of floodplain grazing marsh alongside watercourse. Majority of risk area is a public open space.	Medium	Combination of: Alluvium - clay, silt, sand and gravel, and Till - Diamicton	Slowly permeable seasonally wet slightly acid but base rich loamy and clayey soils	Medium ranking restricted to one grid square, and is due to one SW flooding record for one property. It would be recommended to screen this area out, but it can be taken forward as part of the Bourn Brook modelling.	Take Forward as part of Detailed Stage for modelling of the Bourn Brook.	Yes
				Props:	137										
				People:	321										
				Historical Score:	50										
				Score:	83										
5	5	e) East Harborne	0.25	>5 minor roads at risk		£1,078,600	Surface Water (FMfSW)	19 / 15876	None	Medium	Combination of: Glaciofluvial deposits - sand and gravel, and Till - diamicton.	Slowly permeable seasonally wet slightly acid but base rich loamy and clayey soils	Medium ranking restricted to one grid square and based solely on FMfSW, and should therefore be screened out. But potential for linking to Bourn Brook modelling stage should be explored.	Screen Out	No
				Props:	200										
				People:	412										
				Historical Score:	0										
				Score:	73										
6	6	a) Frankley	0.5	>10 minor roads at risk		£1,456,110	Majority is Surface Water Historical Score	42 / 4467	Some small areas of Public Open Space within risk area. Open heath/hill adjacent risk area (outside of catchment area)	High	Combination of: Alluvium - clay, silt, sand and gravel, and Till - Diamicton	Slightly acid loamy and clayey soils with impeded drainage	Relatively high social vulnerability. Combination of surface water flooding records and predicted flooding, along with development opportunities suggest this should be taken forward as part of the Central sub-catchment modelling of the River Rea.	Take Forward to Detailed Stage for modelling of the River Rea.	Yes
				Props:	270										
				People:	614										
				Historical Score:	2620										
				Score:	2675										
7	6	b) Central Sub Catchment 6	3	>20 minor and major roads and mainline railway at risk.		£7,523,235	Combination of historical fluvial and surface water, and FMfSW.	32 / 8932	Golf course on western border of the risk area (potential for attenuating flow?). Fairly large areas of public open space in or adjacent to the risk area. Development opportunities available (On Golf Course land?). Floodplain grazing marsh alongside watercourse. Noted during Stakeholder workshop that significant development opportunities exist at Longbridge.	High and Medium	Combination of: Mudstone. Till - Diamicton. Note: large areas of this area have no superficial geology record.	Combination of freely draining slightly acid loamy soils and slightly acid loamy and clayey soils with impeded drainage	Large risk area, based on historical records, DG5s and predicted risk, and significant development opportunities indicate that this area should be taken forward for detailed modelling of the River Rea (along with Frankley risk area).	Take Forward to Detailed Stage for modelling of the River Rea.	Yes
				Props:	1395										
				People:	3131										
				Historical Score:	4820										
				Score:	5102										
8	6	c) Kings Norton	0.25	A441 at risk		£37,751	Historic fluvial record	19 / 14984	Bulk of area is Public Open Space. Floodplain grazing marsh alongside watercourse	High	Till - diamicton	Slowly permeable seasonally wet slightly acid but base rich loamy and clayey soils	High risk ranking restricted to one grid square based entirely on presence of one flvuial flooding record of 3 properties; area is not adjacent to other risk areas.	Take Forward to Detailed Stage for modelling of the River Rea.	Yes
				Props:	7										
				People:	5										
				Historical Score:	135										
				Score:	137										
9	6	d) Rednal	0.25	>5 minor roads at risk		£1,202,639	Surface Water (FMfSW)	31 / 7923	None	Medium	Bulk of area has no superficial deposits recorded. River terrace deposits - sand and gravel. Sandstone	Freely draining slightly acid loamy soils	Medium risk area restricted to one grid square and based entirely on predicted score from FMfSW, since it is remote from other risk areas we would recommend screening this area out; however this area can be included as part of the River Rea	Take Forward to Detailed Stage for modelling of the River Rea.	Yes
				Props:	223										
				People:	498										
				Historical Score:	0										

No.	Sub-Catchment	Name / Reference / Location	Approx. Area (km²)	Assets at risk (score, people, properties, transport)		Approx. Event Damages (£)	Flooding Source	Average Social Vulnerability: IMD Score / Rank	Other Comments (e.g. designated sites, Green Infrastructure, development opportunities, proposed schemes)	Rank (H/M)	Superficial / Drift Geology	Indicative Soilscapes Classification	Justification for taking forward / removing	Action	High Level Options Appraisal?
				Score:	45								modelling.		
10	6	e) Cotteridge	0.25	<5 minor roads at risk		£528,514	Surface Water Historic record and FMfSW	21 / 13825	Large area of Public Open Space within risk area.	Medium	Till - diamicton	Slowly permeable seasonally wet slightly acid but base rich loamy and clayey soils	Medium risk area restricted to one grid square and is remote from other risk areas. Medium ranking is based predominantly on presence of SW flood record of one property; it is therefore recommended that this area is excluded.	Screen Out	No
				Props:	98										
				People:	229										
				Historical Score:	50										
				Score:	70										
11	6	f) Frankley West	0.25	<5 minor roads at risk		£161,790	Fluvial Historic records and FMfSW	55 / 1514	Agricultural land / fields at northern end of risk area (outside of BCC boundary)	Medium	Till - diamicton	Slowly permeable seasonally wet slightly acid but base rich loamy and clayey soils	Medium risk area restricted to one grid square, remote from other risk areas and on the edge of the LA boundary. Medium classification is due to presence of fluvial flood record of two properties. This area can be included as part of the River Rea modelling.	Take Forward to Detailed Stage for modelling of the River Rea.	Yes
				Props:	30										
				People:	70										
				Historical Score:	90										
				Score:	96										
12	7	a) Balsall Heath	0.5	>5 minor roads at risk		£2,383,706	Surface Water (FMfSW)	55 / 1820	Limited development opportunities available. Some public open space in this risk area.	Medium	Combination of: Alluvium - clay, silt, sand and gravel, and River Terrace deposits - Sand and gravel.	Loamy and clayey floodplains soils with naturall high groundwater	Relatively high social vulnerability and some development opportunities, but score entirely based on FMfSW. No historical records of flooding but further assessment required.	Assess validity of FMfSW in this location	No
				Props:	442										
				People:	887										
				Historical Score:	0										
				Score:	140										
13	7	b) Saltley	0.5	<5 minor roads at risk		£1,143,316	Surface Water (FMfSW)	65 / 483	Small area of Public Open Space in this area. Small Private playing field in this area.	Medium	Combination of: Glaciofluvial deposits - sand and gravel, and Till - diamicton.	Loamy soils with naturally high groundwater	Relatively high social vulnerability, but score entirely based on FMfSW. No historical records of flooding but further assessment required.	Assess validity of FMfSW in this location	No
				Props:	212										
				People:	366										
				Historical Score:	0										
				Score:	107										
14	8	a) Bearwood	0.25	<5 minor roads at risk		£404,475	Surface Water Historic record and FMfSW	33 / 7156	Private and educational playing fields are within risk area. Very small area of development within risk area.	Medium	Till, diamicton, sand and gravel	Slowly permeable seasonally wet slightly acid but base rich loamy and clayey soils	Medium risk ranking for one grid square, remote from other risk areas and due entirely to presence of one SW historical record for one property; recommended that this square is excluded.	Screen Out	No
				Props:	75										
				People:	176										
				Historical Score:	50										
				Score:	68										
15	8 / 9	b) East Handsworth	0.5	>10 major and minor roads at risk, along with mainline railway		£2,302,811	Surface Water Historic record and FMfSW	59 / 1302	Limited development opportunities available. Some public open space in this risk area.	High and Medium	Glaciofluvial deposits - sand and gravel	Slowly permeable seasonally wet slightly acid but base rich loamy and clayey soils	High and Medium risk area based on combination of SW historic and FMfSW, relatively high social vulnerability. High risk grid in Catchment 8 will be covered by the Hockley Brook Modelling. The potential to include the Medium risk grid in the Handsworth / Birchfield work will be explored.	Potential to include as part of Birchfield / Handsworth study OR Assess validity of FMfSW in this location	Yes
				Props:	427										
				People:	918										
				Historical Score:	50										
				Score:	151										
16	9	a) Birchfield	1.5	>15 major and minor roads at risk, along with mainline railway		£8,326,792	Historic fluvial record and FMfSW	53 / 2220	Development opportunities available. Large area of public open space directly south of the risk area.	High and Medium	Combination of: Glaciofluvial deposits - sand and gravel, River Terrace deposits - sand and gravel, and Alluvium - clay, sand, gravel, silt deposits.	Combination of Slowly permeable seasonally wet slightly acid but base rich loamy and clayey soils and loamy soils with naturally high groundwater	Large risk area, based on historical records and predicted risk, along with development opportunities indicates that this area should be taken forward for more detailed assessment and explore potential to update STW DAP model.	Take Forward to Detailed Stage and explore potential for update of STW DAP model	Yes
				Props:	1544										
				People:	3290										
				Historical Score:	2925										
				Score:	3352										
17	9	b) Handsworth Wood	0.75	>5 minor roads at risk		£3,731,956	Surface Water (FMfSW)	56 / 1752	Small area of Public Open Space in this area. Small area of land identified as development opportunity.	Medium	Glaciofluvial deposits - sand and gravel.	Slowly permeable seasonally wet slightly acid but base rich loamy and clayey soils	Medium risk scores of these grids due to FMfSW, no historical records of flooding; suggest further investigation of validity of FMfSW in this location and explore potential to update STW DAP model, linking in with the Birchfield risk area.	Assess validity of FMfSW in this location OR explore potential for update of STW DAP model	Yes
				Props:	692										
				People:	1571										
				Historical Score:	0										
				Score:	182										
18	9	c) Kingstanding	0.5	>10 major and minor roads at risk		£3,322,088	Surface Water (FMfSW)	22 / 12511	Small area of development opportunity. 2 small areas of private playing fields within the risk area.	Medium	Majority of area doesn't have recorded superficial type. Bedrock is interbedded sandstone and conglomerate.	Freely draining slightly acid sandy soils	Medium risk scores based on FMfSW, some opportunities for re-development may yield benefits; suggest further investigation of validity of FMfSW in this location.	Assess validity of FMfSW in this location.	No
				Props:	616										
				People:	1414										
				Historical Score:	0										
				Score:	133										

No.	Sub-Catchment	Name / Reference / Location	Approx. Area (km²)	Assets at risk (score, people, properties, transport)		Approx. Event Damages (£)	Flooding Source	Average Social Vulnerability: IMD Score / Rank	Other Comments (e.g. designated sites, Green Infrastructure, development opportunities, proposed schemes)	Rank (H/M)	Superficial / Drift Geology	Indicative Soilscapes Classification	Justification for taking forward / removing	Action	High Level Options Appraisal?
19	9	d) Perry Park	0.25	<5 minor roads at risk		£129,432	Historic fluvial record	30 / 8153	Small area of floodplain grazing marsh alongside watercourse. Majority of risk area is a public open space/playing fields.	High	River terrace deposits - sand and gravel.	Loamy soils with naturally high groundwater	High risk ranking due entirely to presence of fluvial flooding record of 5 properties, predicted flooding extremely limited.	Assess fluvial flooding record	No
				Props:	24										
				People:	44										
				Historical Score:	225										
				Score:	230										
20	10	a) Four Oaks Park	0.25	<5 minor roads and mainline railway at risk		£156,397	Historic fluvial record	13 / 20434	Park of Sutton Park NNR and public open space falls within risk area.	Medium	Glaciofluvial deposits - sand and gravel.	Freely draining slightly acid sandy soils	Medium risk ranking of one grid square due to presence of fluvial historic flooding record of one property. No adjoning medium/high risk grids. Recommend that fluvial historic record is investigated.	Assess fluvial flooding record	No
				Props:	29										
				People:	68										
				Historical Score:	45										
				Score:	52										
21	10	b) Maney	0.25	>5 minor roads and mainline railway at risk		£587,837	Historic fluvial record	16 / 17752	Park of Sutton Park NNR and public open space falls within risk area. Some development opportunities within the risk area.	Medium	Combinatio of: Head - sand and gravel, and Alluvium - clay, silt, sand and gravel	Freely draining slightly acid sandy soils	Medium risk ranking of one grid square due to presence of fluvial historic flooding record of one property. No adjoning medium/high risk grids. Recommend that fluvial historic record is investigated.	Assess fluvial flooding record	No
				Props:	109										
				People:	218										
				Historical Score:	45										
				Score:	66										

Notes:

Damage per property: £5,393 Based on weighted AAD for the average house with no flood protection, page 24, MCH 2010

Numbers of properties at risk based on T200 Shallow

Soilscapes data source: http://www.landis.org.uk/soilscapes/

Geology data source: http://www.bgs.ac.uk/opengeoscience/?Accordion1=1#maps

Index of Multiple Deprivation (IMD) Score derived from Lower Layer Super Output data supplied by BCC, higher score is more deprived but lower rank is more deprived.

A.8. High Level Options Appraisal

Summary

Local Flood Risk Areas Assessed

No.	Location Description
1	Lodge Hill, California, Selly Oak and Bourn Brook
3	Bourn Brook - River Rea Confluence
4	Woodgate Valley
6	Frankley
7	Central Sub-Catchment 6
8	Kings Norton
9	Rednal

No.	Location Description
11	Frankley West
15	East Handsworth
16	Birchfield
17	Handsworth Wood

Generic Response	Options	Potential response for specific local flood risk area																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Land management	Afforestation	X		X	X		X	X	X	X		X				X	X	X				
	Agricultural processes on the urban fringe						X	X	X	X		X										
	Use of Green Infrastructure	X		X	X		X	X	X	X		X				X	X	X				
2. Attenuation/retention	Floodplain storage	X		X	X		X	X	X	X		X					X	X				
	Wetland creation/river restoration	X		X	X		X	X	X			X						X				
	SUDS - new/retrospective	X		X			X	X									X	X				
3. Increased channel conveyance	Carry on existing maintenance regime																					
	Increase maintenance regime																					
	De-Culverting						X	X								X	X	X				
	River engineering i.e. channelisation	X		X	X		X	X	X			X				X						
	Diversion channels			X	X											X						
	Raised Defences	X		X	X		X	X	X			X				X						
4. Other Infrastructure Improvements	Pumping	X					X	X		X						X	X	X				
	Managing exceedance flows	X		X	X		X	X	X	X		X				X	X	X				
	Green Roofs	X		X	X		X	X	X	X		X				X	X	X				
	Improve capacity of piped networks	X		X	X		X	X		X		X				X	X	X				
	On-line storage (existing/new)	X		X	X		X	X		X		X				X	X	X				
	Off-line storage (existing/new)	X		X	X		X	X		X		X				X	X	X				
	Continue existing maintenance of networks / gullies	X			X		X	X		X		X				X	X	X				
	Increased maintenance regime for networks / gullies	X			X		X	X		X		X				X	X	X				
5. Planning Activities	Development control	X		X	X		X	X	X	X		X				X	X	X				
	SUDS Strategy	X		X	X		X	X	X	X		X				X	X	X				
	Blue Development Corridors	X					X	X								X	X	X				
	New Development Masterplanning	X					X	X								X	X	X				
6. Resilience	Flood awareness	X		X	X		X	X	X	X		X				X	X	X				
	Emergency & disaster planning/response	X		X	X		X	X	X	X		X				X	X	X				
	Property Level Protection / Building Resilience	X		X	X		X	X	X	X		X				X	X	X				
7. Monitoring/Advise/Survey	Asset inspection	X		X	X		X	X	X	X		X				X	X	X				
	Flood warning & forecasting			X																		
	Improve Hydrometric network			X																		
8. Further assessment	Investigation of past flooding	X		X	X		X	X	X			X				X	X					
	Survey of affected areas (e.g. condition surveys)	X		X	X		X	X	X	X		X				X	X	X				
	Detailed Modelling	X		X	X			X	X	X		X				X	X	X				

Local Flood Risk Area: 1 - Lodge Hill, California, Selly Oak and Bournbrook

Generic Response	Option	Is this a potential option for this Flood Risk Area? (Yes / No / Unsure)	Project Partners	Comments - Record decision making process for screening options based on high level assessment of technical viability, cost, etc Does it happen now? Why could it not be done in the future? Why has this response been screened out?
1. Rural land use change	Afforestation	Yes	BCC / Landowners	Large areas of public space within and adjacent to this risk area means this option is potentially viable.
	~~Agricultural processes on the urban fringe~~	~~No~~	N/A	Areas surrounding catchment and flood risk area already developed, limited to no agricultural land available for this option.
	Use of Green Infrastructure	Yes	BCC	Large areas of public open space within and adjacent to this risk area provides opportunities for this option.
2. Attenuation/retention	Floodplain storage	Yes	BCC / EA	Storage sites available in some of the open spaces, recreation grounds, or upstream of the risk area in Woodgate Valley. Greater understanding of flood risk mechanisms required before merit of such options can be determined.
	Wetland creation/river restoration	Yes	BCC / EA	Number of public open spaces and Woodgate Valley provide potential locations for this option.
	SUDS - new/retrospective	Yes	BCC / Developer	With a number of re-development sites within and adjacent the risk area that is potential for both new and retrospective SUDS, although funding for the latter may be problematic.
3. Increased channel conveyance	Carry on existing maintenance regime	Unsure	BCC / EA	Unsure of existing maintenance regime so difficult to comment on the adequacy or otherwise of this.
	Increase maintenance regime	Unsure	BCC / EA	Again, without information about the existing maintenance regime and the mechanisms of flooding it is difficult to comment on whether this would be an effective measure.
	De-Culverting	Unsure	BCC / EA	Relatively short lengths of culverted watercourse in this area (in comparison to other parts of the catchment), so benefits maybe limited; although conversely the costs would be lower.
	River engineering i.e. channelisation	Yes	BCC / EA	
	Diversion channels	Unsure	BCC / EA	Some potential for diversion channels but proximity and density of urban network does limit the extent of this
	Raised Defences	Yes	BCC / EA	Yes but given dispersed nature of flood risk this may not be a cost beneficial option.
4. Other Infrastructure improvements	Pumping	Yes	BCC / STW	
	Managing exceedance flows	Yes	BCC / STW	
	Green Roofs	Yes	BCC / Developer	
	Improve capacity of piped networks	Yes	STW	
	On-line storage (existing/new)	Yes	BCC / STW	
	Off-line storage (existing/new)	Yes	BCC / STW	
	Continue existing maintenance of networks / gullies	Yes	BCC	
	Increased maintenance regime for networks / gullies	Yes	BCC	
5. Planning Activities	Development Control	Yes	BCC	Catchment wide policy.
	SUDS Strategy	Yes	BCC	Potential catchment wide policy rather than specific to risk area.
	Blue Development Corridors	Yes	BCC / Developer	Proposed development areas in the risk area should adopt this policy
	New Development Masterplanning	Yes	Developer	Proposed development areas in the risk area should Masterplan appropriately
6. Resilience	Flood awareness	Yes	BCC / EA	Potential catchment wide policy rather than specific to risk area
	Emergency & disaster planning/response	Yes	BCC / EA	Potential catchment wide policy rather than specific to risk area
	Property level protection / Building Resilience	Yes	BCC / DEFRA	
7. Monitoring/Advise/Survey	Asset inspection	Yes	BCC	This is likely to be beneficial and would link in to a more detailed assessment and modelling of flooding in this area.
	Flood warning and forecasting	Unsure	EA	Given the small catchment area of the watercourses in this area, and thus the quickness of response to rainfall events it is unlikely to be technically viable or cost-beneficial to invest in and provide flood warning.
	Improve Hydrometric network	Unsure	EA	As comment above.
8. Further assessment	Investigation of past flooding	Yes	BCC	Further assessment of past events in this risk area would be beneficial.
	Survey of affected areas (e.g. condition surveys)	Yes	BCC	
	Detailed modelling	Yes	BCC	Network of watercourses and their interaction with surface water and sewer networks requires a better understanding. Potential for use of Bartley Reservoir as flood storage to limit flows on the Stonehouse Brook

.ocal Flood Risk Area: 3 - Bourn Brook - River Rea Confluence

Generic Response	Option	Is this a potential option for this Flood Risk Area? (Yes / No / Unsure)	Project Partners	Comments - Record decision making process for screening options based on high level assessment of technical viability, cost, etc Does it happen now? Why could it not be done in the future? Why has this response been screened out?
1. Rural land use change	Afforestation	Yes	BCC / Landowners	Large areas of public space upstream and adjacent this risk area means this option is potentially viable.
	~~Agricultural processes on the urban fringe~~	~~No~~	N/A	Areas surrounding catchment and flood risk area already developed, limited to no agricultural land available for this option; plus any agricultural land is sited >10km from this area hence any benefits from changes to agricultural practices are unlikely to be propagated this far
	Use of Green Infrastructure	Yes	BCC	Large areas of public open space within and adjacent to this risk area provides opportunities for this option.
2. Attenuation/retention	Floodplain storage	Yes	BCC / EA	Storage sites available in some of the open spaces, recreation grounds, or upstream of the risk area in Woodgate Valley. Greater understanding of flood risk mechanisms required before merit of such options can be determined.
	Wetland creation/river restoration	Yes	BCC / EA	Number of public open spaces, such as Cannon Hill Park and Woodgate Valley provide potential locations for this option.
	SUDS - new/retrospective	Yes	BCC / Developer	Limited potential for new SUDS in this risk area due to lack of development opportunities; may benefit from new developments upstream however. Potential for retrofitting.
3. Increased channel conveyance	Carry on existing maintenance regime	Unsure	BCC / EA	Unsure of existing maintenance regime so difficult to comment on the adequacy or otherwise of this.
	Increase maintenance regime	Unsure	BCC / EA	Again, without information about the existing maintenance regime and the mechanisms of flooding it is difficult to comment on whether this would be an effective measure.
	De-Culverting	Unsure	BCC / EA	Relatively short lengths of culverted watercourse in this area (in comparison to other parts of the catchment), so benefits maybe limited; although conversely the costs would be lower.
	River engineering i.e. channelisation	Yes	BCC / EA	2 records of fluvial flooding in this location so fluvial based options may be required.
	Diversion channels	Yes	BCC / EA	Some potential for diversion channels but proximity and density of urban network does limit the extent of this
	Raised Defences	Yes	BCC / EA	2 records of fluvial flooding in this location so fluvial based options may be required.
4. Other Infrastructure improvements	~~Pumping~~	~~No~~	N/A	Not considered to be technically viable or beneficial in this area.
	Managing exceedance flows	Yes	BCC / STW	
	Green Roofs	Yes	BCC / Developer	
	Improve capacity of piped networks	Yes	STW	
	On-line storage (existing/new)	Yes	BCC / STW	
	Off-line storage (existing/new)	Yes	BCC / STW	
	Continue existing maintenance of networks / gullies	Unsure	BCC	Given dominance of fluvial flooding in this location this option may not derive notable benefits
	Increased maintenance regime for networks / gullies	Unsure	BCC	Given dominance of fluvial flooding in this location this option may not derive notable benefits
5. Planning Activities	Development Control	Yes	BCC	Catchment wide policy.
	SUDS Strategy	Yes	BCC	Potential catchment wide policy rather than specific to risk area.
	~~Blue Development Corridors~~	~~No~~	N/A	No proposed developments within flood risk area.
	~~New Development Masterplanning~~	~~No~~	N/A	No proposed developments within flood risk area.
6. Resilience	Flood awareness	Yes	BCC / EA	Potential catchment wide policy rather than specific to risk area
	Emergency & disaster planning/response	Yes	BCC / EA	Potential catchment wide policy rather than specific to risk area
	Property level protection / Building Resilience	Yes	BCC / DEFRA	
7. Monitoring/Advise/Survey	Asset inspection	Yes	BCC	This is likely to be beneficial and would link in to a more detailed assessment and modelling of flooding in this area.
	Flood warning and forecasting	Yes	EA	This risk area may already been within a Flood Warning Area - but with modelling of the upstream system improvements to the flood warnings are possible.
	Improve Hydrometric network	Yes	EA	
8. Further assessment	Investigation of past flooding	Yes	BCC	Further assessment of past events in this risk area would be beneficial.
	Survey of affected areas (e.g. condition surveys)	Yes	BCC	
	Detailed modelling	Yes	BCC	Network of watercourses and their interaction with surface water and sewer networks requires a better understanding.

Local Flood Risk Area: 4 - Woodgate Valley

Generic Response	Option	Is this a potential option for this Flood Risk Area? (Yes / No / Unsure)	Project Partners	Comments - Record decision making process for screening options based on high level assessment of technical viability, cost, etc Does it happen now? Why could it not be done in the future? Why has this response been screened out?
1. Rural land use change	Afforestation	Yes	BCC / Landowners	Large areas of public space within and adjacent to this risk area means this option is potentially viable.
	~~Agricultural processes on the urban fringe~~	~~No~~	N/A	Areas surrounding catchment and flood risk area already developed, limited to no agricultural land available for this option.
	Use of Green Infrastructure	Yes	BCC	Large areas of public open space within and adjacent to this risk area provides opportunities for this option.
2. Attenuation/retention	Floodplain storage	Yes	BCC / EA	Storage sites available in Woodgate Valley. Greater understanding of flood risk mechanisms required before merit of such options can be determined.
	Wetland creation/river restoration	Yes	BCC / EA	Woodgate Valley provide potential location for this option.
	SUDS - new/retrospective	Unsure	BCC / Developer	Limited potential for new SUDS in this risk area due to lack of development opportunities; retrospective SUDS possible although funding may be problematic.
3. Increased channel conveyance	Carry on existing maintenance regime	Unsure	BCC / EA	Unsure of existing maintenance regime so difficult to comment on the adequacy or otherwise of this.
	Increase maintenance regime	Unsure	BCC / EA	Again, without information about the existing maintenance regime and the mechanisms of flooding it is difficult to comment on whether this would be an effective measure.
	~~De-Culverting~~	~~No~~	N/A	There do not appear to be any culverted watercourses in this area.
	River engineering i.e. channelisation	Yes	BCC / EA	
	Diversion channels	Yes	BCC / EA	
	Raised Defences	Yes	BCC / EA	
4. Other Infrastructure improvements	~~Pumping~~	~~No~~	N/A	Not considered to be technically viable or beneficial in this area.
	Managing exceedance flows	Yes	BCC / STW	
	Green Roofs	Yes	BCC / Developer	
	Improve capacity of piped networks	Yes	STW	
	On-line storage (existing/new)	Yes	BCC / STW	
	Off-line storage (existing/new)	Yes	BCC / STW	
	Continue existing maintenance of networks / gullies	Yes	BCC	
	Increased maintenance regime for networks / gullies	Yes	BCC	
5. Planning Activities	Development Control	Yes	BCC	Catchment wide policy.
	SUDS Strategy	Yes	BCC	Potential catchment wide policy rather than specific to risk area.
	~~Blue Development Corridors~~	~~No~~	N/A	No proposed developments within flood risk area.
	~~New Development Masterplanning~~	~~No~~	N/A	No proposed developments within flood risk area.
6. Resilience	Flood awareness	Yes	BCC / EA	Potential catchment wide policy rather than specific to risk area.
	Emergency & disaster planning/response	Yes	BCC / EA	Potential catchment wide policy rather than specific to risk area.
	Property level protection / Building Resilience	Yes	BCC / DEFRA	
7. Monitoring/Advise/Survey	Asset inspection	Yes	BCC	This is likely to be beneficial and would link in to a more detailed assessment and modelling of flooding in this area.
	~~Flood warning and forecasting~~	~~No~~	N/A	Given the small catchment area of the watercourses in this area, and thus the quickness of response to rainfall events it is unlikely to be technically viable or cost-beneficial to invest in and provide flood warning.
	~~Improve Hydrometric network~~	~~No~~	N/A	As comment above.
8. Further assessment	Investigation of past flooding	Yes	BCC	Further assessment of past events in this risk area would be beneficial.
	Survey of affected areas (e.g. condition surveys)	Yes	BCC	
	Detailed modelling	Yes	BCC	Network of watercourses and their interaction with surface water and sewer networks requires a better understanding.

Local Flood Risk Area: 6 - Frankley

Generic Response	Option	Is this a potential option for this Flood Risk Area? (Yes / No / Unsure)	Project Partners	Comments - Record decision making process for screening options based on high level assessment of technical viability, cost, etc Does it happen now? Why could it not be done in the future? Why has this response been screened out?
1. Rural land use change	Afforestation	Yes	BCC / Landowners	Potential for this but only outside of the BCC Boundary.
	Agricultural processes on the urban fringe	Yes	BCC / Landowners	Opportunity for this but since it is outside of the BCC Boundary it may be difficult to influence landowners.
	Use of Green Infrastructure	Yes	BCC	
2. Attenuation/retention	Floodplain storage	Yes	BCC / EA	Potential for this option upstream of Frankley (although this is outside of the BCC Boundary), but limited opportunity elsewhere in the risk area due to presence of properties adjacent the watercourses and dense woodland of Balaams Wood.
	Wetland creation/river restoration	Yes	BCC / EA	Potential for this on the River Rea and tributaries.
	SUDS - new/retrospective	Yes	BCC / Developer	Proposed development sites offer opportunity for new SUDS.
3. Increased channel conveyance	Carry on existing maintenance regime	Unsure	BCC / EA	Unsure of existing maintenance regime so difficult to comment on the adequacy or otherwise of this.
	Increase maintenance regime	Unsure	BCC / EA	Again, without information about the existing maintenance regime and the mechanisms of flooding it is difficult to comment on whether this would be an effective measure.
	De-Culverting	Yes	BCC / EA	
	River engineering i.e. channelisation	Yes	BCC / EA	
	Diversion channels	Unsure	BCC / EA	
	Raised Defences	Yes	BCC / EA	
4. Other Infrastructure improvements	Pumping	Yes	BCC / STW	
	Managing exceedance flows	Yes	BCC / STW	
	Green Roofs	Yes	BCC / Developer	
	Improve capacity of piped networks	Yes	STW	
	On-line storage (existing/new)	Yes	BCC / STW	
	Off-line storage (existing/new)	Yes	BCC / STW	
	Continue existing maintenance of networks / gullies	Yes	BCC	
	Increased maintenance regime for networks / gullies	Yes	BCC	
5. Planning Activities	Development Control	Yes	BCC	Catchment wide policy
	SUDS Strategy	Yes	BCC	Potential catchment wide policy rather than specific to risk area.
	Blue Development Corridors	Yes	BCC / Developer	Proposed development areas in the risk area should adopt this policy
	New Development Masterplanning	Yes	Developer	Proposed development areas in the risk area should Masterplan appropriately
6. Resilience	Flood awareness	Yes	BCC / EA	Potential catchment wide policy rather than specific to risk area
	Emergency & disaster planning/response	Yes	BCC / EA	Potential catchment wide policy rather than specific to risk area
	Property level protection / Building Resilience	Yes	BCC / DEFRA	
7. Monitoring/Advise/Survey	Asset inspection	Yes	BCC	This is likely to be beneficial and would link in to a more detailed assessment and modelling of flooding in this area.
	~~Flood warning and forecasting~~	~~No~~	N/A	Given the small catchment area, and proximity to the source of the watercourse this option is unlikely to be technically viable or cost beneficial
	~~Improve Hydrometric network~~	~~No~~	N/A	Linked to the point above, hydrometric investment in this area would not be cost beneficial
8. Further assessment	Investigation of past flooding	Yes	BCC	This would be beneficial to understand the flooding mechanisms related to the historical records of flooding in this risk area.
	Survey of affected areas (e.g. condition surveys)	Yes	BCC	
	Detailed modelling	Unsure	BCC	Given the fairly limited size of this risk area it may not be cost effective to undertake detailed modelling; it could potentially be included within the downstream risk areas modelling however.

Local Flood Risk Area: **7 - Central Sub-Catchment 6**

Generic Response	Option	Is this a potential option for this Flood Risk Area? (Yes / No / Unsure)	Project Partners	Comments - Record decision making process for screening options based on high level assessment of technical viability, cost, etc Does it happen now? Why could it not be done in the future? Why has this response been screened out?
1. Rural land use change	Afforestation	Yes	BCC / Landowners	Large areas of public space within and adjacent to this risk area means this option is potentially viable.
	Agricultural processes on the urban fringe	Yes	BCC / Landowners	Areas surrounding catchment and flood risk area already developed, limited agricultural land available for this option except to the south where there may be some potential (although it should be noted that the bulk of these areas are outside of the BCC Boundary).
	Use of Green Infrastructure	Yes	BCC	Large areas of public open space within and adjacent to this risk area provides opportunities for this option.
2. Attenuation/retention	Floodplain storage	Yes	BCC / EA	Storage sites available in some of the open spaces, recreation grounds. Greater understanding of flood risk mechanisms required before merit of such options can be determined.
	Wetland creation/river restoration	Yes	BCC / EA	Number of public open spaces provide potential locations for this option.
	SUDS - new/retrospective	Yes	BCC / Developer	With a number of re-development sites (especially Longbridge) within and adjacent the risk area there is potential for both new and retrospective SUDS, although funding for the latter may be problematic.
3. Increased channel conveyance	Carry on existing maintenance regime	Unsure	BCC / EA	Unsure of existing maintenance regime so difficult to comment on the adequacy or otherwise of this.
	Increase maintenance regime	Unsure	BCC / EA	Again, without information about the existing maintenance regime and the mechanisms of flooding it is difficult to comment on whether this would be an effective measure.
	De-Culverting	Yes	BCC / EA	
	River engineering i.e. channelisation	Yes	BCC / EA	
	Diversion channels	Unsure	BCC / EA	Some potential for diversion channels but proximity and density of urban network does limit the extent of this
	Raised Defences	Yes	BCC / EA	Yes but given dispersed nature of flood risk this may not be a cost beneficial option.
4. Other Infrastructure improvements	Pumping	Yes	BCC / STW	
	Managing exceedance flows	Yes	BCC / STW	
	Green Roofs	Yes	BCC / Developer	
	Improve capacity of piped networks	Yes	STW	
	On-line storage (existing/new)	Yes	BCC / STW	
	Off-line storage (existing/new)	Yes	BCC / STW	
	Continue existing maintenance of networks / gullies	Yes	BCC	
	Increased maintenance regime for networks / gullies	Yes	BCC	
5. Planning Activities	Development Control	Yes	BCC	Catchment wide policy.
	SUDS Strategy	Yes	BCC	Potential catchment wide policy rather than specific to risk area.
	Blue Development Corridors	Yes	BCC / Developer	Proposed development areas in the risk area should adopt this policy.
	New Development Masterplanning	Yes	Developer	Proposed development areas in the risk area should Masterplan appropriately.
6. Resilience	Flood awareness	Yes	BCC / EA	Potential catchment wide policy rather than specific to risk area.
	Emergency & disaster planning/response	Yes	BCC / EA	Potential catchment wide policy rather than specific to risk area.
	Property level protection / Building Resilience	Yes	BCC / DEFRA	
7. Monitoring/Advise/Survey	Asset inspection	Yes	BCC	This is likely to be beneficial and would link in to a more detailed assessment and modelling of flooding in this area.
	Flood warning and forecasting	Unsure	EA	Given the small catchment area of the watercourses in this area, and thus the quickness of response to rainfall events it is unlikely to be technically viable or cost-beneficial to invest in and provide flood warning.
	Improve Hydrometric network	Unsure	EA	As comment above.
8. Further assessment	Investigation of past flooding	Yes	BCC	Further assessment of past events in this risk area would be beneficial.
	Survey of affected areas (e.g. condition surveys)	Yes	BCC	
	Detailed modelling	Yes	BCC	Network of watercourses and their interaction with surface water and sewer networks requires a better understanding, and investigate potential improvements achievable through the Longbridge re-development.

Local Flood Risk Area: 8 - Kings Norton

Generic Response	Option	Is this a potential option for this Flood Risk Area? (Yes / No / Unsure)	Project Partners	Comments - Record decision making process for screening options based on high level assessment of technical viability, cost, etc Does it happen now? Why could it not be done in the future? Why has this response been screened out?
1. Rural land use change	Afforestation	Yes	BCC / Landowners	Areas of public space within and adjacent to this risk area means this option is potentially viable.
	Agricultural processes on the urban fringe	Yes	BCC / Landowners	Areas surrounding catchment and flood risk area already developed, limited agricultural land available for this option except to the south where there may be some potential (although it should be noted that the bulk of these areas are outside of the BCC Boundary).
	Use of Green Infrastructure	Yes	BCC	Areas of public open space within and upstream of this risk area provides opportunities for this option.
2. Attenuation/retention	Floodplain storage	Yes	BCC / EA	Storage sites available in some of the open spaces, and may benefit from storage upstream. Greater understanding of flood risk mechanisms required before merit of such options can be determined.
	Wetland creation/river restoration	Yes	BCC / EA	Public open spaces provide potential locations for this option.
	SUDS - new/retrospective	Unsure	BCC / Developer	Limited potential for new SUDS in this risk area due to lack of development opportunities; retrospective SUDS possible although funding may be problematic.
3. Increased channel conveyance	Carry on existing maintenance regime	Unsure	BCC / EA	Unsure of existing maintenance regime so difficult to comment on the adequacy or otherwise of this.
	Increase maintenance regime	Unsure	BCC / EA	Again, without information about the existing maintenance regime and the mechanisms of flooding it is difficult to comment on whether this would be an effective measure.
	~~De-Culverting~~	~~No~~	N/A	There do not appear to be any culverted watercourses in this area.
	River engineering i.e. channelisation	Yes	BCC / EA	
	~~Diversion channels~~	~~No~~	N/A	Potential for diversion channels but these are unlikely to solve flooding problems in this area.
	Raised Defences	Yes	BCC / EA	
4. Other Infrastructure improvements	~~Pumping~~	~~No~~	N/A	Not considered to be technically viable or beneficial in this area.
	Managing exceedance flows	Yes	BCC / STW	
	Green Roofs	Yes	BCC / Developer	
	Improve capacity of piped networks	Unsure	STW	Given dominance of fluvial flooding in this location this option may not derive notable benefits
	On-line storage (existing/new)	Unsure	BCC / STW	Given dominance of fluvial flooding in this location this option may not derive notable benefits
	Off-line storage (existing/new)	Unsure	BCC / STW	Given dominance of fluvial flooding in this location this option may not derive notable benefits
	Continue existing maintenance of networks / gullies	Unsure	BCC	Given dominance of fluvial flooding in this location this option may not derive notable benefits
	Increased maintenance regime for networks / gullies	Unsure	BCC	Given dominance of fluvial flooding in this location this option may not derive notable benefits
5. Planning Activities	Development Control	Yes	BCC	Catchment wide policy.
	SUDS Strategy	Yes	BCC	Potential catchment wide policy rather than specific to risk area.
	~~Blue Development Corridors~~	~~No~~	N/A	No proposed developments within flood risk area.
	~~New Development Masterplanning~~	~~No~~	N/A	No proposed developments within flood risk area.
6. Resilience	Flood awareness	Yes	BCC / EA	Potential catchment wide policy rather than specific to risk area.
	Emergency & disaster planning/response	Yes	BCC / EA	Potential catchment wide policy rather than specific to risk area.
	Property level protection / Building Resilience	Yes	BCC / DEFRA	
7. Monitoring/Advise/Survey	Asset inspection	Yes	BCC	This is likely to be beneficial and would link in to a more detailed assessment and modelling of flooding in this area.
	Flood warning and forecasting	Unsure	EA	Given the small catchment area of the watercourses in this area, and thus the quickness of response to rainfall events it is unlikely to be technically viable or cost-beneficial to invest in and provide flood warning. Would need to form part of wider works on the River Rea.
	Improve Hydrometric network	Unsure	EA	As comment above.
8. Further assessment	Investigation of past flooding	Yes	BCC	Further assessment of past events in this risk area would be beneficial.
	Survey of affected areas (e.g. condition surveys)	Yes	BCC	
	Detailed modelling	Yes	BCC	Network of watercourses and their interaction with surface water and sewer networks requires a better understanding, and investigate potential improvements achievable upstream through the Longbridge re-development.

Local Flood Risk Area: 9 - Rednal

Generic Response	Option	Is this a potential option for this Flood Risk Area? (Yes / No / Unsure)	Project Partners	Comments - Record decision making process for screening options based on high level assessment of technical viability, cost, etc Does it happen now? Why could it not be done in the future? Why has this response been screened out?
1. Rural land use change	Afforestation	Yes	BCC / Landowners	Areas of public space adjacent to this risk area means this option is potentially viable.
	Agricultural processes on the urban fringe	Yes	BCC / Landowners	Areas surrounding flood risk area already developed, limited agricultural land available for this option except to the south where there may be some potential (although it should be noted that the bulk of these areas are outside of the BCC Boundary).
	Use of Green Infrastructure	Yes	BCC	Areas of public open space adjacent to this risk area provide opportunities for this option.
2. Attenuation/retention	Floodplain storage	Yes	BCC / EA	Storage sites available in some of the open spaces, recreation grounds. Greater understanding of flood risk mechanisms required before merit of such options can be determined.
	~~Wetland creation/river restoration~~	~~No~~	N/A	No watercourses present in this flood risk area.
	SUDS - new/retrospective	Unsure	BCC / Developer	Limited potential for new SUDS in this risk area due to lack of development opportunities; retrospective SUDS possible although funding may be problematic.
3. Increased channel conveyance	~~Carry on existing maintenance regime~~	~~No~~	N/A	No watercourses present in this flood risk area.
	~~Increase maintenance regime~~	~~No~~	N/A	No watercourses present in this flood risk area.
	~~De-Culverting~~	~~No~~	N/A	There do not appear to be any culverted watercourses in this area.
	~~River engineering i.e. channelisation~~	~~No~~	N/A	Flood risk from surface water rather than fluvial sources hence this option is unlikely to be beneficial
	~~Diversion channels~~	~~No~~	N/A	Flood risk from surface water rather than fluvial sources hence this option is unlikely to be beneficial
	~~Raised Defences~~	~~No~~	N/A	Flood risk from surface water rather than fluvial sources hence this option is unlikely to be beneficial
4. Other Infrastructure improvements	Pumping	Yes	BCC / STW	
	Managing exceedance flows	Yes	BCC / STW	
	Green Roofs	Yes	BCC / Developer	
	Improve capacity of piped networks	Yes	STW	
	On-line storage (existing/new)	Yes	BCC / STW	
	Off-line storage (existing/new)	Yes	BCC / STW	
	Continue existing maintenance of networks / gullies	Yes	BCC	
	Increased maintenance regime for networks / gullies	Yes	BCC	
5. Planning Activities	Development Control	Yes	BCC	Catchment wide policy.
	SUDS Strategy	Yes	BCC	Potential catchment wide policy rather than specific to risk area.
	~~Blue Development Corridors~~	~~No~~	N/A	No proposed developments within flood risk area.
	~~New Development Masterplanning~~	~~No~~	N/A	No proposed developments within flood risk area.
6. Resilience	Flood awareness	Yes	BCC / EA	Potential catchment wide policy rather than specific to risk area.
	Emergency & disaster planning/response	Yes	BCC / EA	Potential catchment wide policy rather than specific to risk area.
	Property level protection / Building Resilience	Yes	BCC / DEFRA	
7. Monitoring/Advise/Survey	Asset inspection	Yes	BCC	This is likely to be beneficial and would link in to a more detailed assessment and modelling of flooding in this area.
	~~Flood warning and forecasting~~	~~No~~	N/A	Area is not at fluvial flood risk
	~~Improve Hydrometric network~~	~~No~~	N/A	As comment above.
8. Further assessment	~~Investigation of past flooding~~	~~No~~	N/A	No historical flooding records.
	Survey of affected areas (e.g. condition surveys)	Yes	BCC	
	Detailed modelling	Yes	BCC	Network of watercourses and their interaction with surface water and sewer networks requires a better understanding, and investigate potential improvements achievable through the Longbridge re-development.

Local Flood Risk Area: 11 - Frankley West

Generic Response	Option	Is this a potential option for this Flood Risk Area? (Yes / No / Unsure)	Project Partners	Comments - Record decision making process for screening options based on high level assessment of technical viability, cost, etc Does it happen now? Why could it not be done in the future? Why has this response been screened out?
1. Rural land use change	Afforestation	Yes	BCC / Landowners	Areas of public space adjacent to this risk area means this option is potentially viable, or upstream of the risk area (although this is outside of the BCC boundary).
	Agricultural processes on the urban fringe	Yes	BCC / Landowners	Agricultural land immediately upstream/north of the risk area may provide some potential (although it should be noted that this area is outside of the BCC Boundary).
	Use of Green Infrastructure	Yes	BCC	
2. Attenuation/retention	Floodplain storage	Yes	BCC / EA	Limited areas available for storage sites adjacent the watercourse or upstream of the risk area. Greater understanding of flood risk mechanisms required before merit of such options can be determined.
	Wetland creation/river restoration	Yes	BCC / EA	Limited space available adjacent to the watercourse for this option.
	SUDS - new/retrospective	Unsure	BCC / Developer	Limited potential for new SUDS in this risk area due to lack of development opportunities; retrospective SUDS possible although funding may be problematic.
3. Increased channel conveyance	Carry on existing maintenance regime	Unsure	BCC / EA	Unsure of existing maintenance regime so difficult to comment on the adequacy or otherwise of this.
	Increase maintenance regime	Unsure	BCC / EA	Again, without information about the existing maintenance regime and the mechanisms of flooding it is difficult to comment on whether this would be an effective measure.
	~~De-Culverting~~	~~No~~	N/A	Culverted lengths in this flood risk area are limited to road crossings, hence de-culverting is not considered to be a viable or worthwhile option.
	River engineering i.e. channelisation	Yes	BCC / EA	
	~~Diversion channels~~	~~No~~	N/A	Proximity and density of urban network alongside the watercourses in this area means this option is not viable.
	Raised Defences	Yes	BCC / EA	
4. Other Infrastructure improvements	~~Pumping~~	~~No~~	N/A	Not considered to be technically viable or beneficial in this area.
	Managing exceedance flows	Yes	BCC / STW	
	Green Roofs	Yes	BCC / Developer	
	Improve capacity of piped networks	Yes	STW	
	On-line storage (existing/new)	Yes	BCC / STW	
	Off-line storage (existing/new)	Yes	BCC / STW	
	Continue existing maintenance of networks / gullies	Yes	BCC	
	Increased maintenance regime for networks / gullies	Yes	BCC	
5. Planning Activities	Development Control	Yes	BCC	Catchment wide policy.
	SUDS Strategy	Yes	BCC	Potential catchment wide policy rather than specific to risk area.
	~~Blue Development Corridors~~	~~No~~	N/A	No proposed developments within flood risk area.
	~~New Development Masterplanning~~	~~No~~	N/A	No proposed developments within flood risk area.
6. Resilience	Flood awareness	Yes	BCC / EA	Potential catchment wide policy rather than specific to risk area.
	Emergency & disaster planning/response	Yes	BCC / EA	Potential catchment wide policy rather than specific to risk area.
	Property level protection / Building Resilience	Yes	BCC / DEFRA	
7. Monitoring/Advise/Survey	Asset inspection	Yes	BCC	This is likely to be beneficial and would link in to a more detailed assessment and modelling of flooding in this area.
	~~Flood warning and forecasting~~	~~No~~	N/A	Area is at fluvial risk but is located at the upper end of the catchment and a flood forecasting and warning system here would not be technically or financially viable.
	~~Improve Hydrometric network~~	~~No~~	N/A	As comment above.
8. Further assessment	Investigation of past flooding	Yes	BCC	Further assessment of past events in this risk area would be beneficial.
	Survey of affected areas (e.g. condition surveys)	Yes	BCC	
	Detailed modelling	Yes	BCC	Network of watercourses and their interaction with surface water and sewer networks requires a better understanding.

Local Flood Risk Area: 15 - East Handsworth

Generic Response	Option	Is this a potential option for this Flood Risk Area? (Yes / No / Unsure)	Project Partners	Comments - Record decision making process for screening options based on high level assessment of technical viability, cost, etc Does it happen now? Why could it not be done in the future? Why has this response been screened out?
1. Rural land use change	Afforestation	Yes	BCC / Landowners	Areas of public space within the risk area means this option is potentially viable.
	~~Agricultural processes on the urban fringe~~	~~No~~	N/A	Areas surrounding flood risk area already developed, agricultural land / heath available is remote from the risk area hence any changes to agricultural practices are unlikely to yield benefits in the risk area.
	Use of Green Infrastructure	Yes	BCC	Areas of public open space adjacent to this risk area provide opportunities for this option.
2. Attenuation/retention	Floodplain storage	Unsure	BCC / EA	Limited availability of open land suitable for storage due to dense urban network in this risk area.
	~~Wetland creation/river restoration~~	~~No~~	N/A	Given dense urban nature of this area, and culverted watercourses this is not thought possible.
	SUDS - new/retrospective	Unsure	BCC / Developer	Limited potential for new SUDS in this risk area due to lack of development opportunities; retrospective SUDS possible although funding may be problematic.
3. Increased channel conveyance	Carry on existing maintenance regime	Unsure	BCC / EA	Unsure of existing maintenance regime so difficult to comment on the adequacy or otherwise of this.
	Increase maintenance regime	Unsure	BCC / EA	Again, without information about the existing maintenance regime and the mechanisms of flooding it is difficult to comment on whether this would be an effective measure.
	De-Culverting	Yes	N/A	
	River engineering i.e. channelisation	Yes	N/A	
	Diversion channels	Yes	N/A	
	Raised Defences	Yes	N/A	
4. Other Infrastructure improvements	Pumping	Yes	BCC / STW	
	Managing exceedance flows	Yes	BCC / STW	
	Green Roofs	Yes	BCC / Developer	
	Improve capacity of piped networks	Yes	STW	
	On-line storage (existing/new)	Yes	BCC / STW	
	Off-line storage (existing/new)	Yes	BCC / STW	
	Continue existing maintenance of networks / gullies	Yes	BCC	
	Increased maintenance regime for networks / gullies	Yes	BCC	
5. Planning Activities	Development Control	Yes	BCC	Catchment wide policy.
	SUDS Strategy	Yes	BCC	Potential catchment wide policy rather than specific to risk area.
	Blue Development Corridors	Yes	BCC / Developer	Proposed development areas in the risk area should adopt this policy, although limited development opportunities so impact on flood risk may be limited.
	New Development Masterplanning	Yes	Developer	Proposed development areas in the risk area should Masterplan appropriately.
6. Resilience	Flood awareness	Yes	BCC / EA	Potential catchment wide policy rather than specific to risk area.
	Emergency & disaster planning/response	Yes	BCC / EA	Potential catchment wide policy rather than specific to risk area.
	Property level protection / Building Resilience	Yes	BCC / DEFRA	
7. Monitoring/Advise/Survey	Asset inspection	Yes	BCC	This is likely to be beneficial and would link in to a more detailed assessment and modelling of flooding in this area.
	~~Flood warning and forecasting~~	~~No~~	N/A	Given the small catchment area of the watercourses in this area, and thus the quickness of response to rainfall events it is unlikely to be technically viable or cost-beneficial to invest in and provide flood warning.
	~~Improve Hydrometric network~~	~~No~~	N/A	As comment above.
8. Further assessment	Investigation of past flooding	Yes	BCC	Further assessment of past events in this risk area would be beneficial.
	Survey of affected areas (e.g. condition surveys)	Yes	BCC	
	Detailed modelling	Yes	BCC	Network of watercourses and their interaction with surface water and sewer networks requires a better understanding, as part of the Hockley Brook and Handsworth / Birchfield studies - detailed modelling of this area in isolation is not justified.

Local Flood Risk Area: 16 - Birchfield

Generic Response	Option	Is this a potential option for this Flood Risk Area? (Yes / No / Unsure)	Project Partners	Comments - Record decision making process for screening options based on high level assessment of technical viability, cost, etc Does it happen now? Why could it not be done in the future? Why has this response been screened out?
1. Rural land use change	Afforestation	Yes	BCC / Landowners	Areas of public space within and upstream of the risk area means this option is potentially viable.
	~~Agricultural processes on the urban fringe~~	~~No~~	N/A	Areas surrounding flood risk area already developed, agricultural land / heath is remote from the risk area hence any changes to agricultural practices are unlikely to yield benefits in the risk area.
	Use of Green Infrastructure	Yes	BCC	Areas of public open space within and adjacent to this risk area provide opportunities for this option.
2. Attenuation/retention	Floodplain storage	Yes	BCC / EA	Some availability of open land suitable for storage within and upstream of this risk area.
	~~Wetland creation/river restoration~~	~~No~~	N/A	Given dense urban nature of this area, and culverted watercourses this is not thought possible.
	SUDS - new/retrospective	Yes	BCC / Developer	With a number of re-development sites within and adjacent the risk area there is potential for both new and retrospective SUDS, although funding for the latter may be problematic.
3. Increased channel conveyance	Carry on existing maintenance regime	Unsure	BCC / EA	Unsure of existing maintenance regime so difficult to comment on the adequacy or otherwise of this.
	Increase maintenance regime	Unsure	BCC / EA	Again, without information about the existing maintenance regime and the mechanisms of flooding it is difficult to comment on whether this would be an effective measure.
	De-Culverting	Yes	N/A	
	River engineering i.e. channelisation	Unsure	BCC / EA	Due to dominance of surface water related flood risk, and lack of open watercourses the benefit of this option is thought to be limited
	Diversion channels	Unsure	BCC / EA	Due to dominance of surface water related flood risk, and lack of open watercourses the benefit of providing diversion channels is thought to be limited
	Raised Defences	Unsure	BCC / EA	Due to dominance of surface water related flood risk, and lack of open watercourses the benefit of providing raised defences is thought to be limited
4. Other Infrastructure improvements	Pumping	Yes	BCC / STW	
	Managing exceedance flows	Yes	BCC / STW	
	Green Roofs	Yes	BCC / Developer	
	Improve capacity of piped networks	Yes	STW	
	On-line storage (existing/new)	Yes	BCC / STW	
	Off-line storage (existing/new)	Yes	BCC / STW	
	Continue existing maintenance of networks / gullies	Yes	BCC	
	Increased maintenance regime for networks / gullies	Yes	BCC	
5. Planning Activities	Development Control	Yes	BCC	Catchment wide policy.
	SUDS Strategy	Yes	BCC	Potential catchment wide policy rather than specific to risk area.
	Blue Development Corridors	Yes	BCC / Developer	Proposed development areas in the risk area should adopt this policy.
	New Development Masterplanning	Yes	Developer	Proposed development areas in the risk area should Masterplan appropriately.
6. Resilience	Flood awareness	Yes	BCC / EA	Potential catchment wide policy rather than specific to risk area.
	Emergency & disaster planning/response	Yes	BCC / EA	Potential catchment wide policy rather than specific to risk area.
	Property level protection / Building Resilience	Yes	BCC / DEFRA	
7. Monitoring/Advise/Survey	Asset inspection	Yes	BCC	This is likely to be beneficial and would link in to a more detailed assessment and modelling of flooding in this area.
	~~Flood warning and forecasting~~	~~No~~	N/A	Given the small catchment area of the watercourses, and thus the quickness of response to rainfall events it is unlikely to be technically viable or cost-beneficial to invest in and provide flood warning.
	~~Improve Hydrometric network~~	~~No~~	N/A	As comment above.
8. Further assessment	Investigation of past flooding	Yes	BCC	Further assessment of past events in this risk area would be beneficial.
	Survey of affected areas (e.g. condition surveys)	Yes	BCC	
	Detailed modelling	Yes	BCC	Network of watercourses and their interaction with surface water and sewer networks requires a better understanding, detailed modelling of this area in isolation may not be justified however. Intention would be to make use of existing STW DAP model for this area and improve on this.

Local Flood Risk Area: 17 - Handsworth Wood

Generic Response	Option	Is this a potential option for this Flood Risk Area? (Yes / No / Unsure)	Project Partners	Comments - Record decision making process for screening options based on high level assessment of technical viability, cost, etc Does it happen now? Why could it not be done in the future? Why has this response been screened out?
1. Rural land use change	Afforestation	Yes	BCC / Landowners	Areas of public space within and upstream of the risk area means this option is potentially viable.
	~~Agricultural processes on the urban fringe~~	~~No~~	N/A	Areas surrounding flood risk area already developed, agricultural land / heath is remote from the risk area hence any changes to agricultural practices are unlikely to yield benefits in the risk area.
	Use of Green Infrastructure	Yes	BCC	Areas of public open space within and adjacent to this risk area provide opportunities for this option.
2. Attenuation/retention	Floodplain storage	Yes	BCC / EA	Some availability of open land suitable for storage within and upstream of this risk area.
	Wetland creation/river restoration	Yes	N/A	Given dense urban nature of this area opportunities are limited, but potential in Handsworth Park.
	SUDS - new/retrospective	Yes	BCC / Developer	With a number of re-development sites within and adjacent the risk area there is potential for both new and retrospective SUDS, although funding for the latter may be problematic.
3. Increased channel conveyance	Carry on existing maintenance regime	Unsure	BCC / EA	Unsure of existing maintenance regime so difficult to comment on the adequacy or otherwise of this.
	Increase maintenance regime	Unsure	BCC / EA	Again, without information about the existing maintenance regime and the mechanisms of flooding it is difficult to comment on whether this would be an effective measure.
	De-Culverting	Yes	N/A	
	River engineering i.e. channelisation	Unsure	BCC / EA	Due to dominance of surface water related flood risk, and lack of open watercourses the benefit of this option is thought to be limited
	Diversion channels	Unsure	BCC / EA	Due to dominance of surface water related flood risk, and lack of open watercourses the benefit of providing diversion channels is thought to be limited
	Raised Defences	Unsure	BCC / EA	Due to dominance of surface water related flood risk, and lack of open watercourses the benefit of providing raised defences is thought to be limited
4. Other Infrastructure improvements	Pumping	Yes	BCC / STW	
	Managing exceedance flows	Yes	BCC / STW	
	Green Roofs	Yes	BCC / Developer	
	Improve capacity of piped networks	Yes	STW	
	On-line storage (existing/new)	Yes	BCC / STW	
	Off-line storage (existing/new)	Yes	BCC / STW	
	Continue existing maintenance of networks / gullies	Yes	BCC	
	Increased maintenance regime for networks / gullies	Yes	BCC	
5. Planning Activities	Development Control	Yes	BCC	Catchment wide policy.
	SUDS Strategy	Yes	BCC	Potential catchment wide policy rather than specific to risk area.
	Blue Development Corridors	Yes	BCC / Developer	Proposed development areas in the risk area should adopt this policy.
	New Development Masterplanning	Yes	Developer	Proposed development areas in the risk area should Masterplan appropriately.
6. Resilience	Flood awareness	Yes	BCC / EA	Potential catchment wide policy rather than specific to risk area.
	Emergency & disaster planning/response	Yes	BCC / EA	Potential catchment wide policy rather than specific to risk area.
	Property level protection / Building Resilience	Yes	BCC / DEFRA	
7. Monitoring/Advise/Survey	Asset inspection	Yes	BCC	This is likely to be beneficial and would link in to a more detailed assessment and modelling of flooding in this area.
	~~Flood warning and forecasting~~	~~No~~	N/A	Given the small catchment area of the watercourses, and thus the quickness of response to rainfall events it is unlikely to be technically viable or cost-beneficial to invest in and provide flood warning.
	~~Improve Hydrometric network~~	~~No~~	N/A	As comment above.
8. Further assessment	~~Investigation of past flooding~~	~~No~~	N/A	No historical flooding records.
	Survey of affected areas (e.g. condition surveys)	Yes	BCC	
	Detailed modelling	Yes	BCC	Network of watercourses and their interaction with surface water and sewer networks requires a better understanding, detailed modelling of this area in isolation would not be justified however. Intention would be to make use of existing STW DAP model for this area and improve on this.

A.9. SWMP Briefing – Consultation

Briefing Note: Surface Water Management Plan Consultation

Introduction

On Thursday 28th February 2013 a workshop was held with stakeholders to outline the work undertaken on the Birmingham Surface Water Management Plan (SWMP). This workshop covered the approach taken to identifying the areas of highest flood risk, outlined the actions proposed to manage this risk into the future and was used gauge opinion on how best to share the plan and communicate this risk with the wider community.

The workshop was well attended by over 20 delegates. The event was well received by the stakeholders that attended and many commented on how good it was to see such a wide variety of stakeholders involved. Good feedback was received during the event and a number of further comments were also sent following the workshop.

Further stakeholder engagement took place with emergency responders at a meeting of the Birmingham Resilience Forum on Thursday 4th April 2013.

Stakeholders

The following stakeholders were identified as having an interest in the development of the plan but also as having experience of working with and/or experiencing flood risk issues first hand and as a result being able to bring an informed view point to any consultation or engagement.

- Members of Parliament and Local Elected Members
- Highways Agency
- Network Rail
- Canal and River Trust
- Land owners and developers
- Flood Action Groups
- Emergency responders

Consultation Aims

The aim of the stakeholder consultation was to:

- Seek stakeholders views on the approach taken to determining the highest areas of flood risk
- Seek views on the options being taken forward to the action plan
- Identify further options that could be included in the action plan
- Determine if the risk could be communicated in a way that would assist emergency responders in their role of planning for and responding to surface water flooding.
- Seek views on how to communicate the risk to the wider community.

Consultation Feedback and Response

Feedback was collected at the workshop in break-out groups. The stakeholders were split into three groups representing the community, business and infrastructure. Some of the questions asked in the breakout groups were tailored specifically to the theme of the group and others were asked to all groups.

The feedback has been used to refine the long-term action plan and develop an approach to communicating the risk and plan to the Birmingham community.

The key responses from the consultation are outlined below together with the actions taken or proposed to take account of the feedback:

Approach to Determining the Highest Areas of Flood Risk

Question: Do you feel we have taken an appropriate approach to determining the locations of highest surface water flood risk in Birmingham?

Generally it was felt that a robust approach had been taken to determining the highest flood risk areas; however the following comments were also received.

- There are some areas of known flood risk that aren't included in the plan including the River Cole.
    - A screening mechanism was used to determine the areas of highest surface water flood risk. In doing so there will remain areas of the City outside of the Local Flood Risk Areas that are at risk of flooding but have not been considered as part of this study. Within the budget and timescales for this project it was not possible to consider the entire City in detail. Work will continue to look at other flood risk areas through the existing flood risk management governance arrangements and ultimately through the Local Flood Risk Management Strategy.
    - Considerable work has been undertaken in the River Cole catchment developing an integrated model and testing a number of flood alleviation options. At the present time Birmingham City Council and the Environment Agency have been unable to develop a fundable scheme and will continue to look for a viable option to reduce flood risk in the area. At such a time as a solution/proposal is developed the surface water flood risk to the remainder of the catchment will be assessed and appropriate options developed for the SWMP Action Plan.
- There is a need to consider receptors more widely than just property, including derelict land and critical infrastructure
    - When the scoring matrix was developed it was identified that redevelopment and the planning process was one of the key opportunities for influencing long term flood risk within communities, therefore the Strategic Housing Land Availability Assessment (SHLAA) sites were included in the screening process. Some current planning strategy opportunities have been included in the Action Plan, notably the opportunities within the Southern Gateway which will provide an opportunity to consider opportunities for derelict land in Digbeth. Further opportunities will be considered as strategic plans are developed for other areas of the City.
    - Critical Infrastructure was considered at the early stages of the project and was included in the scoring matrix to determine the highest areas of surface water flood risk. At the consultation with emergency responders it was agreed that there would be benefits in screening the latest emergency responder properties to determine if any were at risk of surface water flooding. This same opportunity can be offered to other asset owners through the Local Resilience Forum.
- The outputs are based on current risk with no allowance for climate change
    - The flood outlines were produced using 1 in 200 year simulations, this approximately equated to a 1 in 100year + 15% simulation, which goes some way towards allowing for climate change. When options are taken forward to the feasibility and design stage an allowance for climate change will be included in the design.
- How has effect of the urban fringe been included
    - The highest areas of surface water flood risk were determined by assessing predicted and historic flood risk. The Environment Agency Flood Map for Surface Water was used to assess predicted risk, this is a national dataset and therefore is not influenced by political boundaries meaning that runoff from the urban fringe and adjacent administrative areas would have been allowed for. In terms of historical risk there are a number of locations where we know the flooding is from the urban fringe and these were included in the dataset along with any other flooding incidents. In terms of assessing the Local Flood Risk Areas the integrated model boundaries were developed around river and sewer catchments not administrative boundaries to ensure that all contributing areas were fully covered.

Views on the Options in the Draft Action Plan

Question: Are you confident that allocating actions to lead organisations will deliver a more comprehensive response to mitigating surface water flood risk?

Generally there was agreement that this was the best approach and that having a clear lead agency is essential. However the following comments were also received:

- The council should be the first point of contact
    - Birmingham City Council is the lead organisation for the Surface Water Management and will continue to monitor all of the actions on the plan and update the plan when actions are progressed. However some of the actions outlined in the plan are on non local authority assets, i.e. Main Rivers or sewers, therefore the appropriate asset management authority will need to take the lead on any actions as they will have the powers to undertake the work/actions.

Question: The Draft Action Plan identifies policies to reduce run-off to Greenfield rates. Is a blanket requirement across the city a fair approach or should this be applied to sites within Local Flood Risk Areas?

The stakeholders felt that a blanket approach was not fair and that it would be fairer to apply to sites only within the Local Flood Risk Areas. However the following additional comments were received:

- There is no point hampering developments that meets the councils other strategic development objectives if they then become undevelopable due to the runoff constraints.
    - It is inevitable that there will at times be conflict between strategic development objectives and flood risk. Where policies are introduced they are to protect new development from surface water flooding and to minimise the impact of development on existing communities that are at flood risk. It would be wrong to allow unrestricted runoff from a development site knowing that this would create flood risk within the catchment, however we will work with developers to provide solutions that allow development to proceed without adversely affecting flood risk.
- Need to consider the effects of Community Infrastructure Levy (CIL) as many Local Flood Risk Areas coincide with the areas of higher CIL charging.
    - A review of Local Flood Risk Areas and CIL higher charging zones will be undertaken to assess the degree to which there is an overlap and if there is a need for a change to this policy.

Further Options that could be included in the Draft Action Plan

Question: Is there an opportunity/need to develop any community led measures for inclusion in the Draft Action Plan?

The following comments were received

- A communication strategy should be developed to ensure that the risk is communicated in a way that can be understood
    - A communication and engagement strategy is being developed taking on board the stakeholder views gathered at the consultation.
- Generally there needs to be clearer information on sandbags, responsibilities for sewers, gullies, blockages, responsibilities of property owners etc.
    - Under the Flood and Water Management Act 2010, there is a requirement for Local Authorities to produce a Local Flood Risk Management Strategy which will outline the roles and responsibilities of flood risk management authorities, the level of flood risk in Birmingham and the measures which will be taken to manage flood risk. The draft strategy will be developed this year and will be the repository for the more general information on flood risk management.

Question: Can you identify any ways that the business community can contribute to reducing surface water flood risk that could be included in the Action Plan?

The following suggestions were received

- Use Community Infrastructure Levy funding to mitigate flood risk issues
    - Flood Risk Management schemes have been identified for inclusion in the CIL Implementation Plan. The Flood Risk Management team will continue to work with the CIL team to reinforce the need to include flood risk management schemes in the plan.
- Consider how the existing 420,000 homes in Birmingham can play their part.
    - The Local Flood Risk Management Strategy will outline the role householders can play in flood risk management. However new housing often provides the best opportunity for change, for example the Birmingham Municipal Housing Trust already offers affordable homes to rent and buy built to Level 4 of the code for sustainable with rainwater recycling and water butts.

Question: Can you identify any actions your organisation could take to mitigate against surface water flooding particularly in Local Flood risk Areas?

The following suggestions were received:

- Severn Trent Water have a flood action kit for temporary alleviation
- Environment Agency have to address all sources of flooding for capital funding, there may also be opportunities through Water Framework Directive projects
- Canal and Rivers Trust have an active planning team for canalside developments
- Amey work to an output specification, however there may be an opportunity to give more visibility to the improvements they are making to highway drainage.
    - Whilst all of the actions outlined above are contributing to reducing flood risk, none of them are specific actions that can be included in the Action Plan.

Question: Can you identify opportunities for partnership working to include in the Draft Action Plan?

The following suggestions were received:

- High Speed 2
    - Birmingham City Council and the Environment Agency are already involved in discussions with the High Speed 2 project team and will use this partnership to seek opportunities for reduction in flood risk. Any appropriate actions will be included in the Action Plan as they emerge, however the proposed route of High Speed 2 does not directly affect any Local Flood Risk Areas.
- Involve Railtrack and Canal and River Trust in project moving forward.
    - Moving forward these organisations will be invited to future meeting of the SWMP stakeholder group and also to the Birmingham Water Group.

Views of Emergency Responders

Question: Would there be any benefit in producing hazard and depth maps for emergency responders?

Emergency responders generally felt that the response to an event would be on a reactive basis and there would be minimal benefit in these plans.

Views on the Approach to Communicating the Risk to the Wider Community

Question: Should we communicate the risk identified through this study with the wider community?

Stakeholders all agreed that the risk needed to be communicated to the public.

- ♦ The risk will be communicated to the public. An engagement strategy is being developed to support this process.

Question: What is an appropriate level of risk to communicate?

The following suggestions were received:

- Mapped outputs may as well be at property level as people will ask anyway
- There will be different levels of interest in different areas dependent on the level of risk, therefore communication needs to be tailored to the audience with appropriate warnings.
- Also communicate the potential mitigations, responsibilities and what people can do themselves
- Need to consider the consequences for insurance and property values
- Ensure local members are briefed first.

- ♦ These suggestions will be incorporated into the community engagement strategy which is being developed.

Question: What method of communication should we use?

The following suggestions were received:

- Publish on Birmingham City Council website
- More proactive approach in the risk areas using leaflets/letters
- Arrange 'Flood Fairs'
- Encourage landowners to communicate the risks to their tenants

- ♦ An engagement strategy is being developed taking on board the stakeholder views gathered at the consultation.

A.10. SWMP Action Plan

ID	Action	Type	How	Location	SWMP Ref	SWMP Site Ref	SWMP Area Name	No. of Properties at risk 1 in 30 year	No. of Properties at risk 1 in 75 year	No. of Properties at risk 1 in 200 year	Lead Organisation	Stakeholders	Costs	Benefits	Potential Funding Source	Timing
SWMP 01	Inspection and Maintenance	Maintenance	Inspection and maintenance of property protection and highway drainage works. Include on Asset Register	Cotswold Close to Miranda Close	B	4	Frankley	0	0	0	BCC Housing BCC Highways		Low	To maintain current standard of protection	Existing maintenance budgets	Ongoing
SWMP 02	Model Update	Investigation	Refine model to take account of works being undertaken at the Longbridge site.	Former MG Rover Site	C	6	Longbridge	2	3	6	BCC Drainage BCC Planning	St Modwen	Low	To improve representation of this area in the model and better understand the effect of the development on upstream and downstream flood risk.	Developer funding (S106/CIL) FDGIA Local Levy BCC Funding Application	2013-2023
SWMP 03	Inspection and Maintenance	Maintenance	Inspection and maintenance of highway drainage works in Exe Croft and Rednal Road. Include on Asset Register	31-37 Exe Croft	D	8	West Heath	0	0	0	BCC Drainage BCC Highways	STW	Low	To maintain current standard of protection	Existing maintenance budgets	Ongoing
SWMP 04	Inspection and Maintenance	Maintenance	Inspection and maintenance of highway drainage works in Pitclose and Houdley Road. Include on Asset Register	7-21 Pitclose	D	9	West Heath	0	0	0	BCC Drainage BCC Highways		Low	To maintain current standard of protection	Existing maintenance budgets	Ongoing
SWMP 05	Inspection and Maintenance	Maintenance	Inspection and maintainence of exceedence flow pathway	Bushwood Road	E	11	Bournville	2	4	6	BCC Drainage	BCC Parks	Low	To maintain current standard of protection	BCC Rivers and Brooks	Ongoing
SWMP 06	Feasibility	Investigation	Investigate storage options on The Bourn, Wood Brook and Griffins Brook	The Bourn (Woodbrooke Road to Cadburys)	E	13	Bournville	2	3	8	EA	BCC Drainage Cadburys Bournville Village Trust	Low	To determine if a viable scheme can be developed to mitigate flooding	FDGIA Local Levy Third Party Contributions	2015-2022
SWMP 07	Inspection and Maintenance	Maintenance	Inspection and maintenance of flood defence wall to rear of Oxford Street properties	Oxford Street, Bond Street	F	14	Selly Park	38	38	40	EA		Low	To maintain current standard of protection	Existing maintenance budgets	Ongoing
SWMP 08	Inspection and Maintenance	Maintenance	Inspection and maintenance of storage and upsized sewers.	Ripple Road, Pershore Road	F	16	Selly Park	45 (38)	60 (50)	60 (50)	STW	EA BCC Drainage	Low	To maintain current standard of protection	Severn Trent Water	Ongoing
SWMP 09	Model update	Investigation	Flood alleviation scheme. Scheme to be modelled in SWMP model to assess residual risk.	Ripple Road, Pershore Road	F	16	Selly Park	n/a	n/a	n/a	BCC Drainage	STW EA	Low	To understand residual risk from scheme and determine whether further works are necessary.	Partnership through Strategic Board	2015
SWMP 10	Feasibility	Investigation	Investigate feasibility of storage upstream of Dogpool Lane and on Pebble Mill Playing Fields	Selly Park South	F	17	Selly Park	38	60	107	EA		Low	To determine if a viable scheme can be developed to mitigate flooding	FDGIA Local Levy	2015-2022
SWMP 11	Feasibility	Investigation	Investigate capacity of Mill Lane culvert and feasibility of storage at Senneleys Park	Stonehouse Brook (Mill Lane)	G	18	Selly Park	6	7	9	EA	BCC Housing BCC Highways	Low	To determine if a viable scheme can be developed to mitigate flooding	FDGIA Local Levy	2015-2022
SWMP 12	Feasibility	Investigation	Assess feasibility of storage on Harbourne Golf Course	Harts Green Brook Corridor	G	20	Selly Oak	0	5	7	BCC Drainage	BCC Leisure	Low	To determine whether there is a cost beneficial scheme.	FDGIA Local Levy	2015-2022
SWMP 13	Inspection and Maintenance	Maintenance	Inspection and Maintenance of Arosa Drive culvert and Harts Green Brook Channel	Harts Green Brook Corridor	G	21	Selly Oak	incl. in above	incl. in above	incl. in above	BCC Drainage		Low	To maintain current standard of protection	Revenue Budget	Ongoing
SWMP 14	Community Level Flood Mitigation	Mitigation	Flood mitigation scheme to re-route flows, provide surface water storage and implement property level protection	Alwold Road/Corrisande Road/Weoley Avenue	G	23	Selly Oak	15	18	35	BCC Drainage	STW	Medium	To reduce flood risk to properties in Alwold Road, Corrisande Road and Weoley Avenue	FDGIA Local Levy Severn Trent Water	2016-2017
SWMP 15	Inspection and Maintenance	Maintenance	Establish regime for regular inspection and maintenance of drainage in Lodge Hill Cemetery	Lodge Hill Cemetery	G	24	Selly Oak	incl. in above	incl. in above	incl. in above	BCC Bereavement Services		Low	Contributes to mitigating surface water flows	Cemetery Maintenance budget	Ongoing
SWMP 16	Feasibility	Investigation	Investigate the need for management of exceedence flows	Gibbins Road/Harborne Lane	G	26	Selly Oak	7	11	16	BCC Drainage	BCC Highways	Low	To determine whether properties are at risk and hence whether a scheme needs to be promoted	Revenue budget	2015 - 2025
SWMP 17	Investigation	Investigation	Investigate if parts of surface water system are not mapped or modelled.	Tiverton Road	G	27	Selly Oak	34 (10)	79 (13)	102 (15)	STW		Low	To determine if the surface water issue identified can be atributed to surface water sewer capacity and to determine best way forward to mitigate against risk to properties.	Severn Trent Water	2014-2016
SWMP 18	Feasibility	Investigation	Assess both upstream and downstream effects of reprofiling Eastern Road Bridge and increasing its capacity as this structure has been identified as being susceptible to blockage	77 - 85 Eastern Road	G	28	Selly Oak	15	24	32	EA	BCC Highways	Low	To determine if a viable scheme can be developed to mitigate flooding	FDGIA Local Levy	2015-2022
SWMP 19	Feasibility	Investigation	Assess action needed to prevent flooding to Selly Park from overland flow routes derived from spills on the Bourn Brook.	Selly Park North	G	29	Selly Oak	32	43	50	EA	BCC Highways BCC Parks Calthorpe Estates	Low	To determine if a viable scheme can be developed to mitigate flooding	FDGIA Local Levy Third Party Contributions	2015-2022
SWMP 20	Inspection and Maintenance	Maintenance	Inspection and maintenance of highway scheme in Cheddar Road. Include on Asset Register	Cheddar Road	H	30	Edgbaston	14 (0)	24 (0)	53 (14)	BCC	BCC Drainage BCC Highways	Low	To maintain current standard of protection	Existing maintenance budgets	Ongoing

ID	Action	Type	How	Location	SWMP Ref	SWMP Site Ref	SWMP Area Name	No. of Properties at risk 1 in 30 year	No. of Properties at risk 1 in 75 year	No. of Properties at risk 1 in 200 year	Lead Organisation	Stakeholders	Costs	Benefits	Potential Funding Source	Timing
SWMP 21	Data improvement	Investigation	Improve coverage of surface water sewer system in model	Belgrave Road area	H	31	Edgbaston	6	7	8	STW	BCC Drainage	Low	To allow coverage of surface water network to be improved in integrated model and hence gain a better understanding of flood risk in this area.	Severn Trent Water	2014-2016
SWMP 22	Feasibility	Investigation	Investigate opportunities to open up access to river and possibility of widening channel as part of Southern Gateway redevelopment	Southern Gateway Area	I	32	Digbeth	8	10	20	BCC Planning	EA BCC Drainage STW	Low	To determine if a viable scheme can be developed to mitigate flooding	Developer funding S106/CIL FDGIA Local Levy	2014-2017
SWMP 23	Southern Gateway Area Action Plan	Policy	Southern Gateway planning policies on River Rea and surface water management/SUDS	Southern Gateway Area	I	32	Digbeth	incl. in above	incl. in above	incl. in above	BCC Planning	EA BCC Drainage STW	Low	To reduce flood risk to new development and existing catchment by appropraite management of flows	Planning budget	2014-2017
SWMP 24	Data improvement	Investigation	Improve data on surface water network with information from STW model when available	Glover Street	I	33	Digbeth	0	0	3	BCC Drainage	STW	Low	To allow coverage of surface water network to be improved in integrated model and hence gain a better understanding of flood risk in this area.	Revenue Budget	2014-2016
SWMP 25	Data improvement	Investigation	Improve data on surface water network with information from STW model when available	Lawley Middleway, Landor Street	I	34	Digbeth	0	1	7	BCC Drainage	STW	Low	To allow coverage of surface water network to be improved in integrated model and hence gain a better understanding of flood risk in this area.	Revenue Budget	2014-2016
SWMP 26	Investigation	Investigation	Assess likely overland flow routes	Network Park, Crawford Street	J	35	Saltley	2	2	2	BCC Draiange		Low	To improve confidence in model results and determine whether a scheme needs to be promoted.	Revenue Budget	2014-2016
SWMP 27	Data improvement	Investigation	Improve data on surface water network and CSO schemes	Upstream of Ninevah Road	K	36	Hockley	0	50+ (0)	80+ (0)	STW	BCC Drainage	Low	To allow coverage of surface water network to be improved in integrated model and hence gain a better understanding of flood risk in this area.	Severn Trent Water	2014-2016
SWMP 28	Data improvement	Investigation	Improve representation of Thimblemill Brook in integrated model by working with Sandwell Metropolitan Borough Council to share data	Upstream of Ninevah Road (Sandwell)	K	37	Hockley	0 (0)	5 (0)	11 (0)	BCC Drainage	Sandwell MBC	Low	To improved integrated model and hence gain a better understanding of flood risk in this area.	FDGIA Local Levy BCC Funding Application	2014-2016
SWMP 29	Model refinement	Investigation	Refine model to reflect conditions on site	Ninevah Road & Grassmere Road	K	38	Hockley	0	20+ (6)	50+ (12)	BCC Drainage		Low	To achieve better understanding of the the flood risk to properties in this area.	Revenue Budget	2014-2016
SWMP 30	Investigation	Investigation	Assess surface water risk following model refinement	Factory Road	K	39	Hockley	0 (0)	20 (6)	50 (20)	BCC Drainage		Low	To assess risk to proprties following upstream modifications to the model with a view to identiftying whether a scheme needs to be promoted.	Revenue Budget	2014-2016
SWMP 31	Data improvement	Investigation	Improve coverage of surface water sewer system in model	Burbery Park / Farm Croft	K	40	Hockley	1 (0)	8 (8)	33 (12)	STW	BCC Drainage	Low	To allow coverage of surface water network to be improved in integrated model and hence gain a better understanding of flood risk in this area.	Severn Trent Water	2014-2016
SWMP 32	Inspection and Maintenance	Maintenance	5 yearly inspection and maintenance of channel	Hockley Brook	K	41	Hockley	n/a	n/a	n/a	BCC Drainage		Low	Based on level of risk from detailed survey	Revenue Budget	Ongoing
SWMP 33	Investigation	Investigation	Improve representation of Handsworth Pool in model	Church Hill Road	L	43	Handsworth	10 (0)	12 (0)	13 (1)	STW	BCC Drainage	Low	To improve understanding of how level in pond affects flow in downstream surface water sewers.	Severn Trent Water	2014-2016
SWMP 34	Tame Flood Scheme	Mitigation	Consider effect of the Perry Barr and Witton Flood Scheme on surface water flooding and develop appropriate mitigation	Witton Road (Railway) Tame Road areas	M	47	Birchfield	80 (60)	82 (62)	90 (70)	EA	BCC Draiange STW	High	To ensure that when the Perry Barr & Witton Flood Scheme is implement any residual surface water flood risk is appropriately managed.	FDGIA	2014-2016
SWMP 35	Inspection and Maintenance	Maintenance	Inspect and maintain culverts at Knowles Drive, Balckroot Road and Anderson Close	Knowles Drive, Balckroot Road and Anderson Close	N	48	Four Oaks	incl. in above	incl. in above	incl. in above	BCC Drainage	Railtrack	Low	To maintain current standard of protection	Revenue Budget	Ongoing
SWMP 36	Inspection and Maintenance	Maintenance	Inspection and desilting of Clifton Road bridge	Clifton Road area	O	49	Sutton Coldfield	n/a	n/a	n/a	BCC Drainage		Low	To maintain current standard of protection	Revenue Budget	Ongoing
SWMP 37	Inspection and Maintenance	Maintenance	Inspection and riparian maintenance	Clifton Road area	O	49	Sutton Coldfield	n/a	n/a	n/a	BCC Drainage	Riparian owners	Low	To maintain current standard of protection	Revenue Budget	Ongoing
SWMP 38	Highway Maintenance	Maintenance	Maintenance of Highway Drainage	Citywide				n/a	n/a	n/a	Amey	BCC	Low	To ensure gullies and connections are fully functioning and hence mitigate against surface water flooding	BCC Highways PFI	Ongoing

ID	Action	Type	How	Location	SWMP Ref	SWMP Site Ref	SWMP Area Name	No. of Properties at risk 1 in 30 year	No. of Properties at risk 1 in 75 year	No. of Properties at risk 1 in 200 year	Lead Organisation	Stakeholders	Costs	Benefits	Potential Funding Source	Timing
SWMP 39	Highway Maintenance	Maintenance	Look at potential to increase highway gully cleansing frequencies in high risk areas	SWMP Local Flood Risk Areas	A-O		All	n/a	n/a	n/a	Amey	BCC	Low	To ensure gullies and connections are fully functioning and hence mitigate against surface water flooding	BCC Highways PFI	2015-2016
SWMP 40	Grill Maintenance	Maintenance	Maintenance of all grills on watercourses	Citywide				n/a	n/a	n/a	BCC	EA	Low	To mitigate against blockage and therefore flood risk	BCC & EA Maintenance budgets	Ongoing
SWMP 41	Investigation	Investigation	Assess locations where leaf fall coincides with surface water flood risk	SWMP Local Flood Risk Areas	A-O		All	n/a	n/a	n/a	BCC Drainage	BCC Fleet & Waste	Low	To mitigate against bloackage of gullies and therefore reduce surface water flood risk	Revenue Budget	2014-2015
SWMP 42	Investigation	Investigation	Residual and resultant risk from Sparkhill proposals	Upper Cole catchment				To be determined	To be determined	To be determined	BCC Drainage	EA	Low	To understand properties at risk in Upper Cole catchment and develop proposals for appropraite mitigation	Revenue Budget	To be determined dependent on Sparkhill timescales
SWMP 43	Awareness	Communication	To raise awareness of the issues of discharging fats, oils and greases nito the sewer network	Citywide	To be determined		To be determined	n/a	n/a	n/a	STW	BCC	Low	To minimise blockage in the foul and combined sewer systems which can in some locations lead to surface water flooding	Severn Trent Water	Ongoing
SWMP 44	Consultation	Communication	To communicate outputs of SWMP with the community	Citywide				n/a	n/a	n/a	BCC Drainage		Low	To ensure community ios aware of flood risk and actions that can be taken to address the risk	Revenue Budget	2015-2016

Notes:

X (Y) means X properties modelled as at risk, Y re-assessed after site visit.

Estimated costs are based on the following bands

	Per Property
Low	< £7000
Medium	£7000 > £15000
High	> £15000

Revenue budget assumes Rivers and Brooks budget plus funding for new duties

Cells to be completed

	BCC
	EA
	STW

Appendix B. Drawings and Figures

B.1. Subcatchments Defined for the Strategic SWMP Assessment

Key

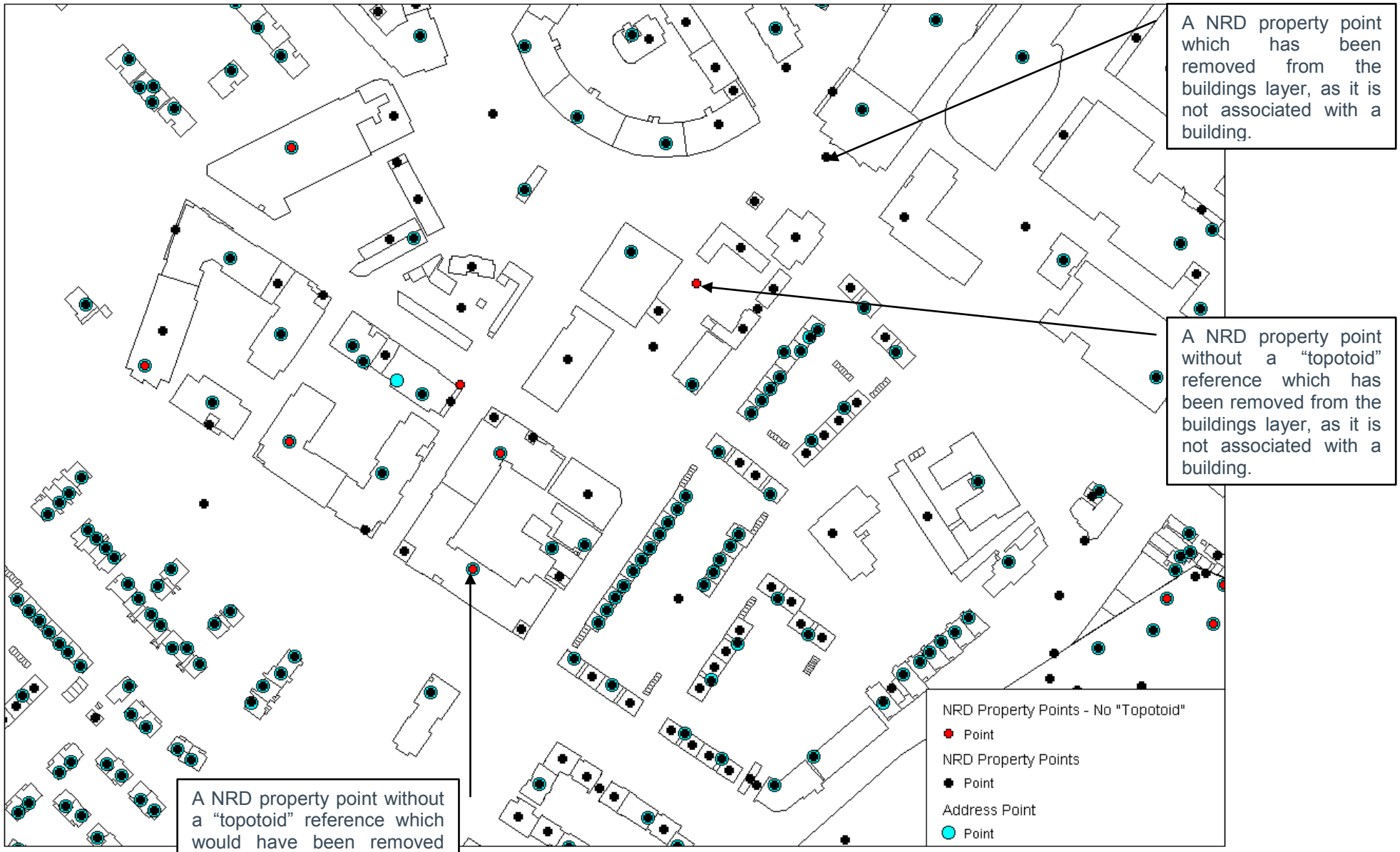
- Watercourse
- Canal
- Water body
- Catchment Boundary
- Sub-catchment Boundary
- Birmingham City Council Administrative Area

N

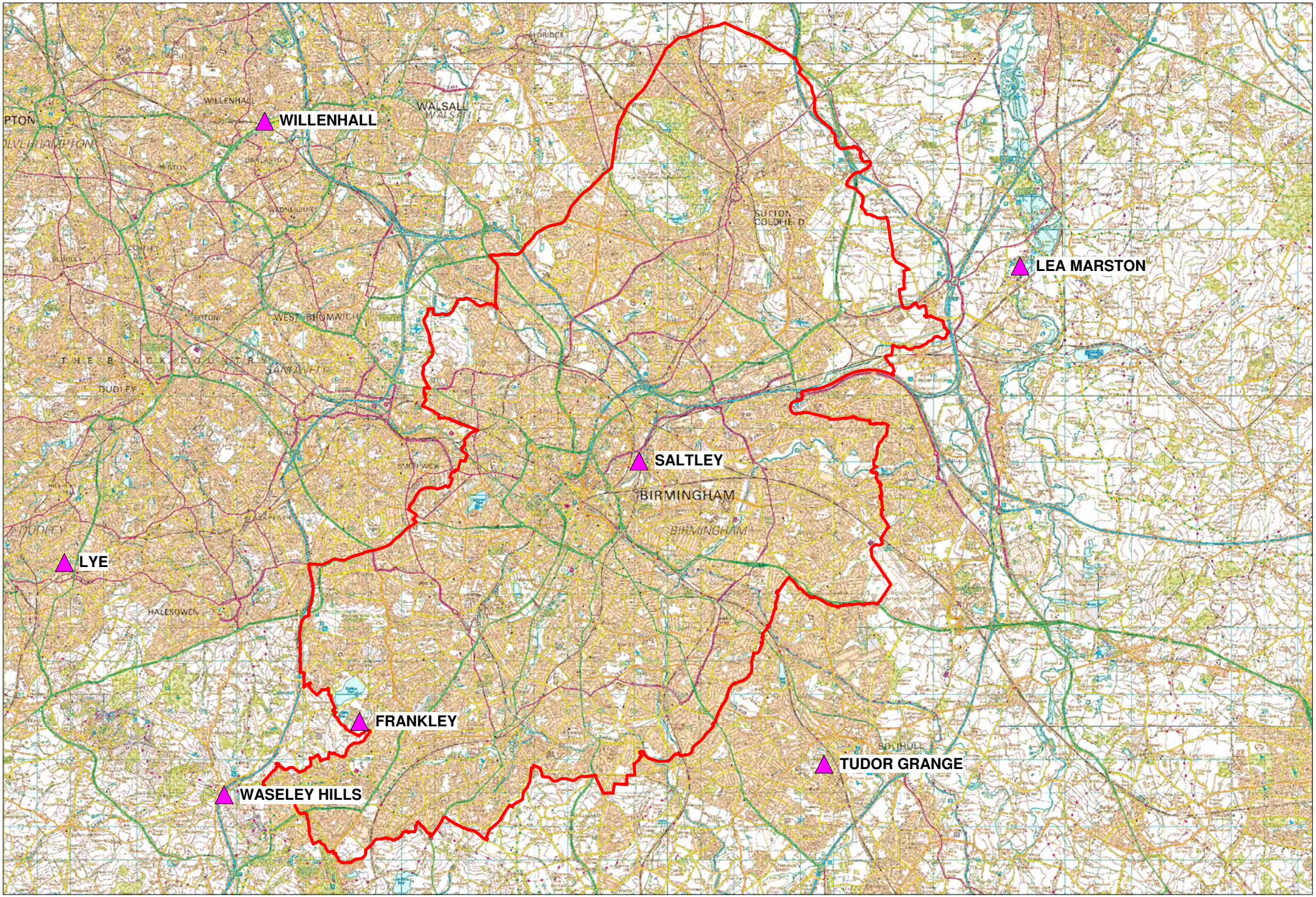
1
2
3
4
5
6
7
8
9
10
11
12
13
14

Km
0 0.5 1 1.5 2 2.5

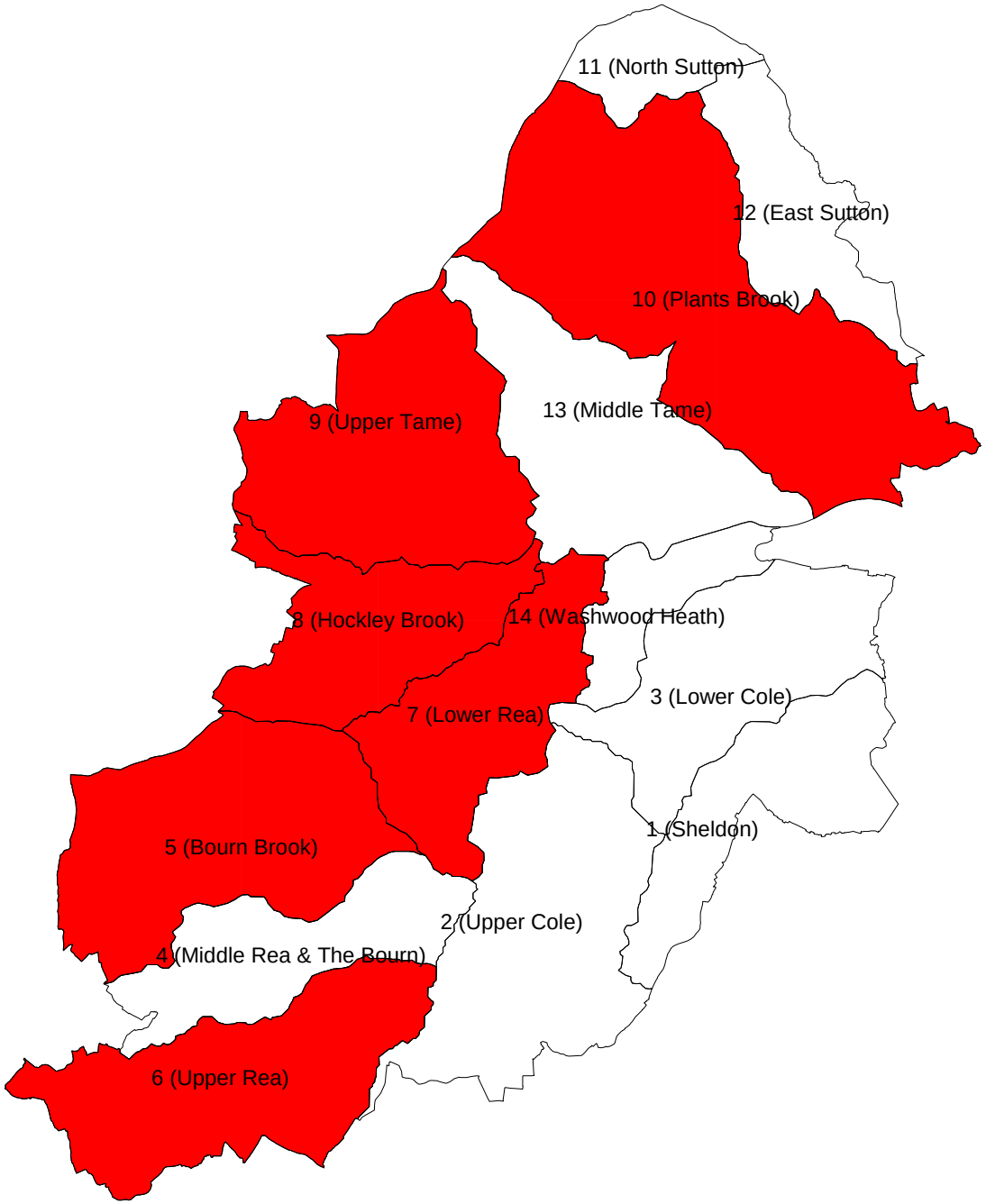
B.2. Comparison of Address and NRD Property Points


A NRD property point which has been removed from the buildings layer, as it is not associated with a building.
A NRD property point without a “topotoid” reference which has been removed from the buildings layer, as it is not associated with a building.
A NRD property point without a “topotoid” reference which would have been removed from the buildings layer, as it is not associated with a building, when it should have been retained as it is an OS address point.
NRD Property Points - No "Topotoid"
Point
NRD Property Points
Point
Address Point
Point

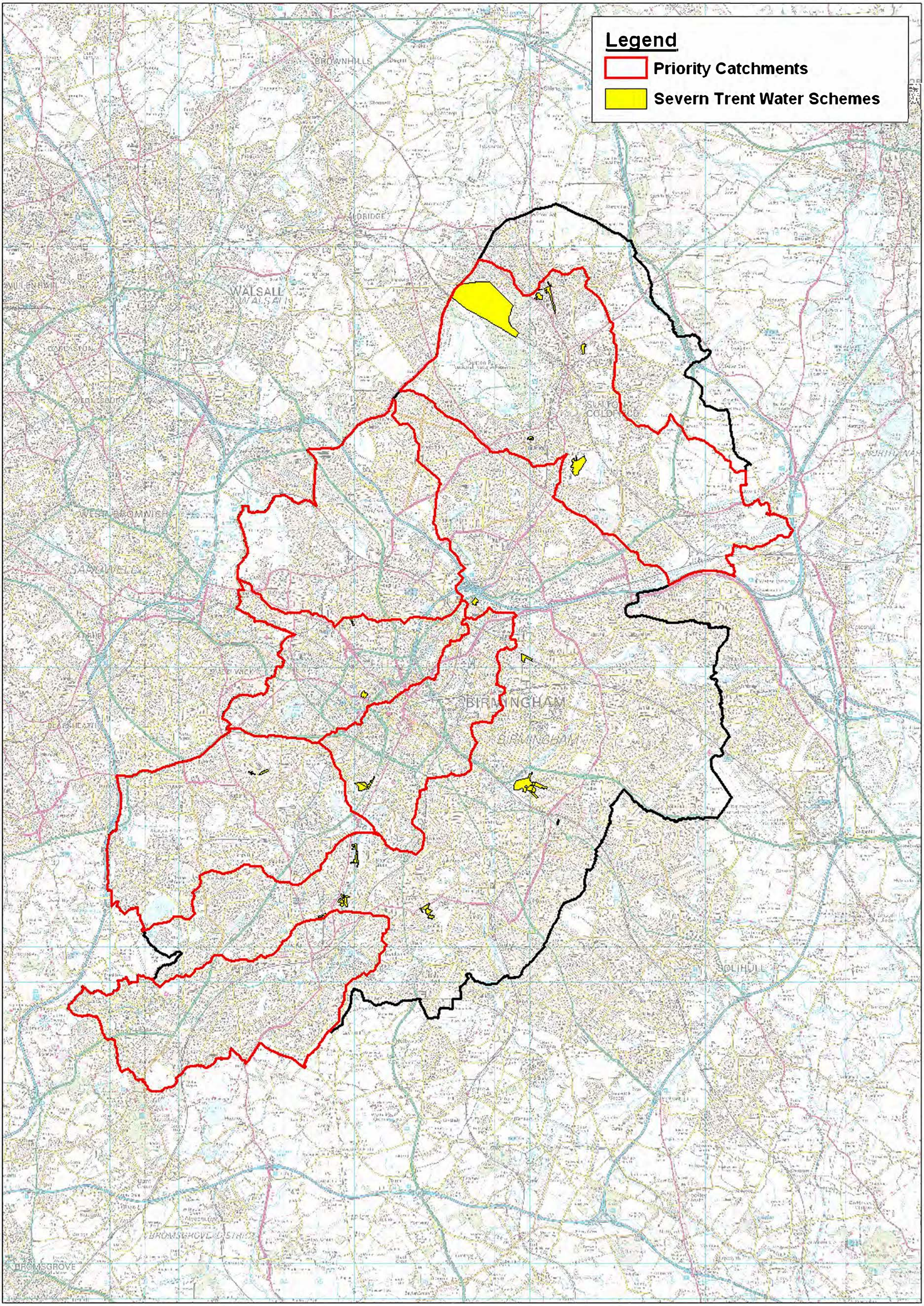
B.3. Rainfall Gauge Locations


WILLENHALL
LEA MARSTON
SALTLEY
LYE
FRANKLEY
TUDOR GRANGE
WASELEY HILLS
WALSALL
WEST BROMWICH
BIRMINGHAM
DUDLEY
HALESOWEN
SOLIHULL

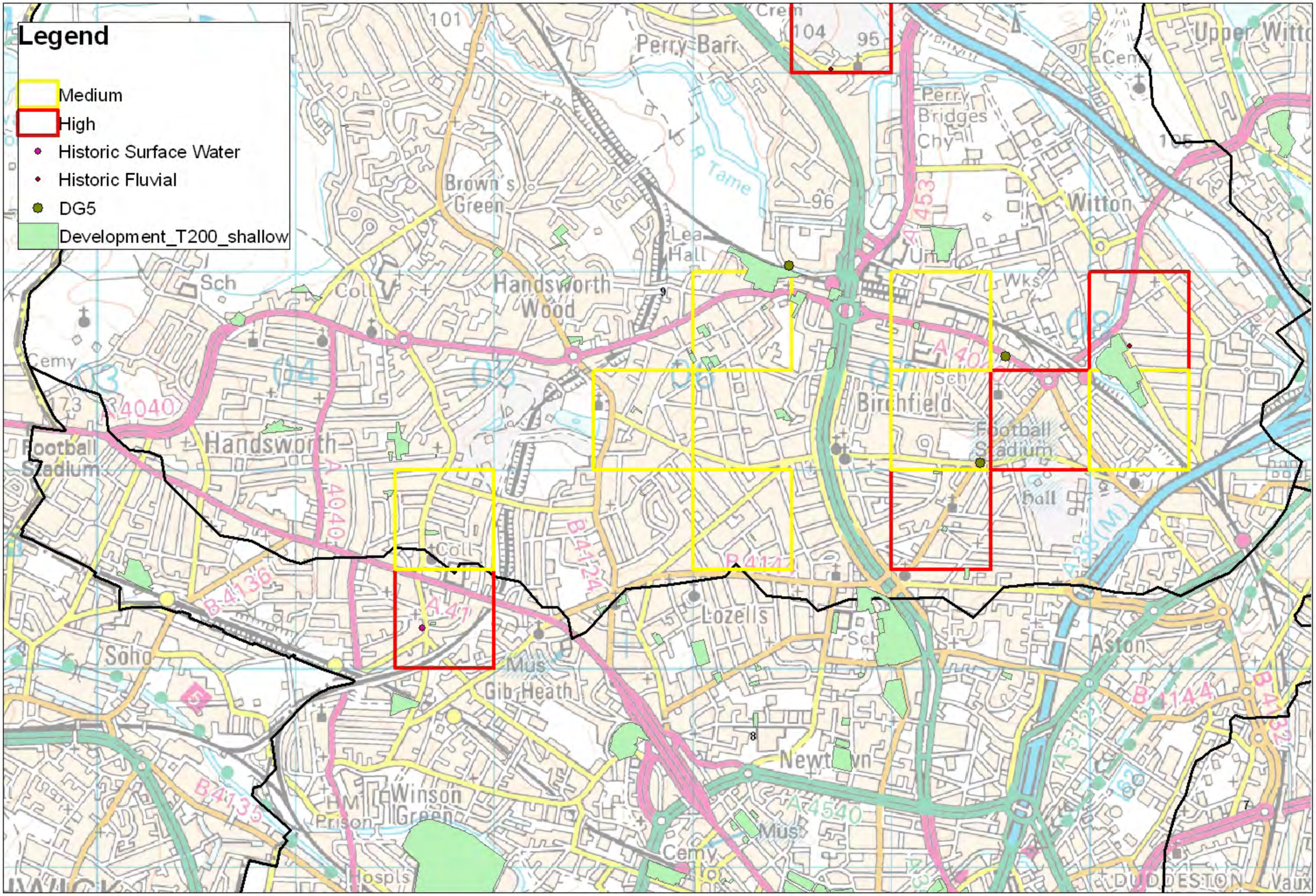
B.4. Priority Subcatchments

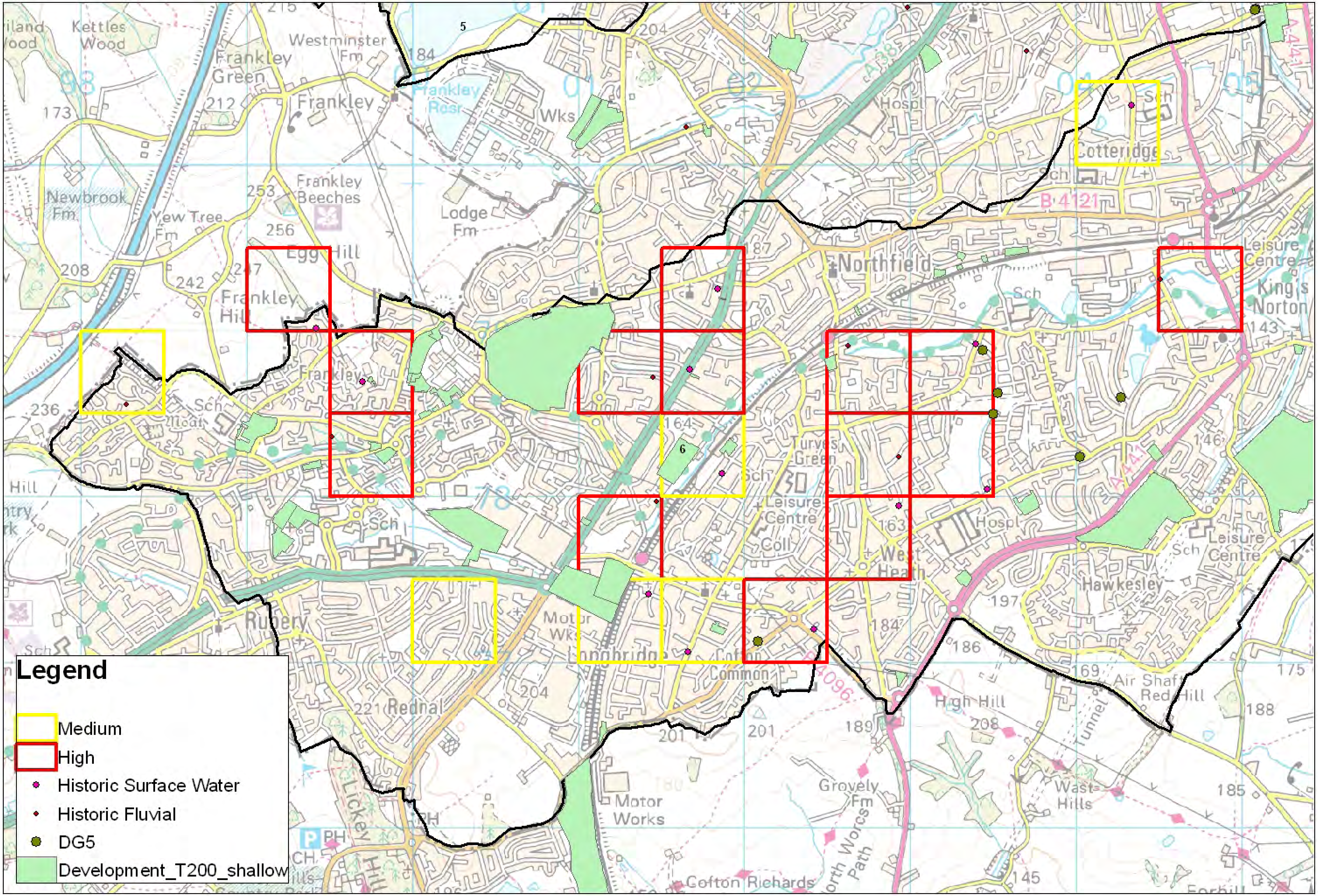

11 (North Sutton)
12 (East Sutton)
10 (Plants Brook)
9 (Upper Tame)
13 (Middle Tame)
8 (Hockley Brook)
14 (Washwood Heath)
3 (Lower Cole)
7 (Lower Rea)
1 (Sheldon)
5 (Bourn Brook)
2 (Upper Cole)
4 (Middle Rea & The Bourn)
6 (Upper Rea)

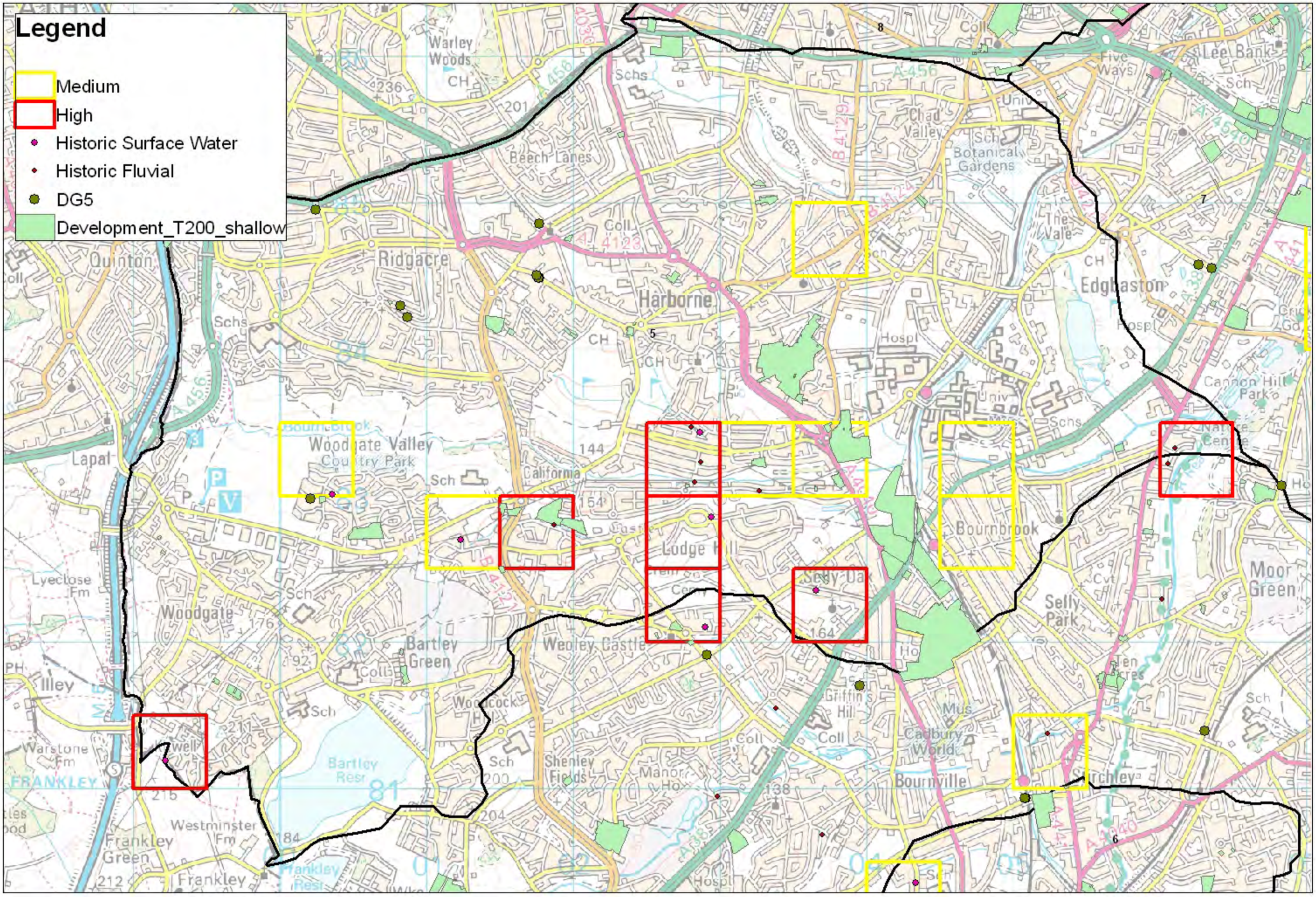
B.5. Severn Trent Water Schemes


Legend
Priority Catchments
Severn Trent Water Schemes
BROWNHILLS
ALDRIDGE
WALSALL
WALSALL
COLESHILL
SUTTON COLDFIELD
WEST BROMWICH
SANDWELL
BIRMINGHAM
SOLIHULL
BROMSGROVE DISTRICT
BROMSGROVE

B.6. Preliminary Local Flood Risk Areas


Legend
Medium
High
Historic Surface Water
Historic Fluvial
DG5
Development_T200_shallow
Perry Barr
Brown's Green
Handsworth Wood
Lea Hall
Perry Bridges
Witton
Upper Witto
Birchfield
Football Stadium
Handsworth
Soho
Gib Heath
Winson Green
HM Prison
Lozells
Aston
Newtown
Cemy
Hospls
DUDDESTON
A4040
A41
B4124
B4136
B4135
A4540
A38(M)
B4144
A453
A40
Tame


Legend
Medium
High
Historic Surface Water
Historic Fluvial
DG5
Development_T200_shallow
Kettles Wood
Westminster Fm
Frankley Green
Frankley
Frankley Resr
Frankley Beeches
Lodge Fm
Newbrook Fm
Yew Tree Fm
Egg Hill
Frankley Hill
Cotteridge
B 4121
Northfield
Leisure Centre
Kings Norton
Turves Green
West Heath
Hawkesley
Rubery
Rednal
Longbridge
Cofton Common
Motor Works
High Hill
Wast Hills
Grovely Fm
Cofton Richards
Air Shaft
Red Hill
Lickey Hill


Legend
Medium
High
Historic Surface Water
Historic Fluvial
DG5
Development_T200_shallow
Warley Woods
Beech Lanes
Ridgacre
Quinton
Harborne
Edgbaston
Chad Valley
Botanical Gardens
The Vale
Five Ways
Lee Bank
Cannon Hill Park
Woodgate Valley Country Park
Lapal
Woodgate
Bartley Green
Weoley Castle
Lodge Hill
Selly Oak
Bournbrook
Selly Park
Moor Green
Bournville
Cadbury World
Griffin's Hill
Shenley Fields
Manor Ho
Bartley Resr
Frankley
Frankley Green
Westminster Fm
Lyeclose Fm
Warstone Fm
Illey
California
Hospl
Univ
Coll
Sch
CH