P R E L I M I N A R Y

Flood Risk Assessment

(PFRA)

Dudley
Metropolitan Borough Council

JUNE 2011

Executive Summary

Like many other districts across the UK, Dudley experienced a number of flood events during the extreme rainfall periods of 2007 and 2008 resulting in substantial internal flood damage to more than 100 residential properties. Flooding resulted for many reasons from a range of simple to complex combinations of river, sewerage and surface water flood waters.

Across the West Midlands region, Government Office data suggests that around 8,450 residential properties flooded and 1,453 businesses were affected.

As a consequence of the 2007/2008 flooding, both Europe and the UK recognised the need for a more coordinated and risk based approach to mitigate against future flood events.

In compliance with the Flood Risk Regulations 2009 and in line with responsibilities for the preparation of a Surface Water Management Plan (SWMP) under the Flood and Water Management Act 2010, Lead Local Flood Authorities (LLFA's), of which Dudley MBC is one, are now responsible for undertaking a Preliminary Flood Risk Assessment (PFRA) for local sources of flood risk, primarily from surface runoff, groundwater and ordinary watercourses. The Environment Agency (EA) being responsible for Main River, the Sea and Reservoirs.

The PFRA is a high level screening exercise which involves collecting information on past (historic) and future (potential) floods, assembling it into a preliminary assessment report, and using it to identify Flood Risk Areas where the risk of flooding is significant.

This PFRA is based on existing and available information and brings together information from national and local sources including the Flood Map for Surface Water, Strategic Flood Risk/Consequence Assessments and local historical flood event records. Information from this PFRA will feed into other assessments including the Flood Risk Strategy, Regional Core and Local Development Strategies and in particular the development of Dudley's Surface Water Management Plan (SWMP).

The regulations require the PFRA to include information on past floods that had "Significant Harmful Consequences" and could occur again. Dudley, through consultation with its Strategic & Operational Flood Management Board, other LLFA's and following EA recommendations have determined "Local Significant Harmful Consequence" criteria. Analysis of past flood event data has identified 52 locations with incidents of multiple internal property flooding consisting of 226 residential properties and 2 non residential properties. 7 of these are of "Local Significant Harmful Consequence". In addition there are 20 multiple flood incidents on category "A" roads, 2 of which fall within the "Significant Harmful Consequence" criteria.

This PFRA has reviewed future flood risk to Dudley by analysing national datasets provided by the EA, it has considered the impacts of climate change and has decided to adopt the Flood Maps for Surface Water (1 in 200 annual probability 300mm deep) as "Locally Agreed Surface Water Information". This has identified that there are 11,500 properties at risk of flooding to a depth of 300mm during a rainfall event with 1 in 200 annual chance of occurring. This equates to 3% of the borough.

This report has also identified that Dudley are within the West Midlands Indicative Flood Risk Area of which there are only 10 identified areas across England.

The Director of the Urban Environment, Cabinet Member for Transportation and the Council's Select Committee on the Environment endorse this document and understand the roles and responsibilities of the council as Lead Local Flood Authority.

Contents

1.0 Introduction

The Flood Risk Regulations 2009 implement the requirements of the European Floods Directive. The aim of the Directive is to provide a consistent approach to managing flood risk across Europe. It establishes four stages of activity within a six year flood risk management cycle. Figure 1.0 shows the stages of the cycle, the products required and the timescale for Lead Local Flood Authority (LLFA) delivery.

LLFAs, of which Dudley is one, are required to produce and submit to the Environment Agency an initial Preliminary Flood Risk Assessment (PFRA) which consists of the first two stages of the flood risk management cycle. The timescale for publication of these PFRA's is set out in the Regulations and hence LLFA's will have to submit their PFRA's to the Environment Agency (EA) by 22nd June 2011. The PFRA will be reviewed by the EA for finalising before 22nd December 2011.

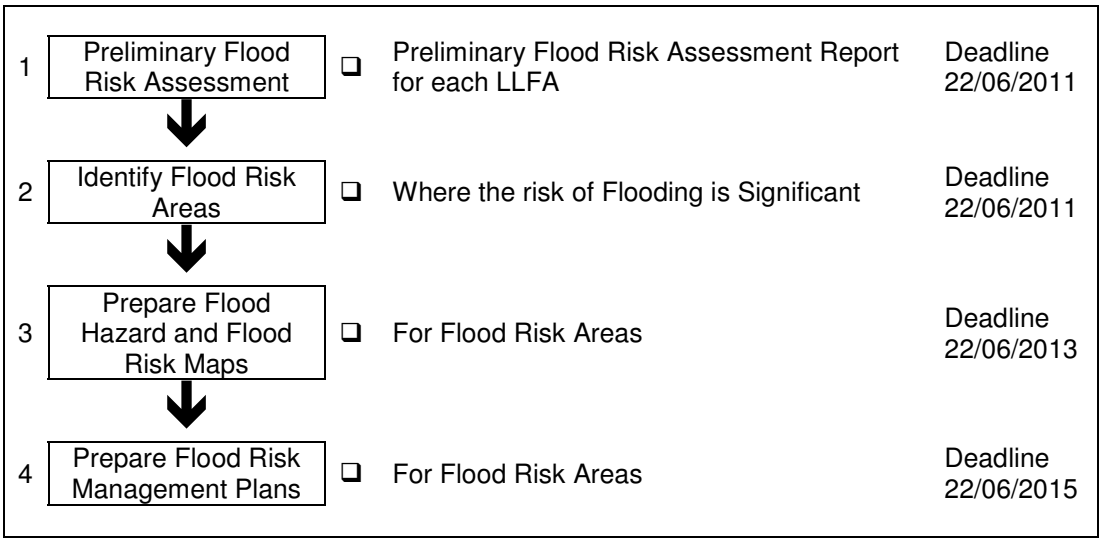

Figure 1.0

1.1 Scope

The scope of a Preliminary Flood Risk Assessment (PFRA) is detailed within the Environment Agency's PFRA Final Guidance Document dated December 2010.

The aim of this PFRA is to assess local flood risk and the consequences of flooding across Dudley borough. The objectives are:-

- To identify and engage with relevant partner organisations involved in flood risk
- Develop arrangements for the ongoing collection, assessment and storage of flood risk data and information

- Identify historic local flood events within Dudley borough and assess the consequences and impacts
- Assess the potential harmful consequences and impact of future flood events within Dudley borough
- Review the Indicative Flood Risk Areas provided by the Environment Agency and justification of any proposed changes

The PFRA is a high level screening exercise which involves collecting information on past (historic) and future (potential) floods, assembling it into a preliminary assessment report, and using it to identify Flood Risk Areas which are areas where the risk of flooding is significant.

This PFRA is based on existing and available information which brings together information from national and local sources including the Flood Map for Surface Water (FMfSW), Strategic Flood Risk/Consequence Assessments and local historical flood event records.

Information from this PFRA will feed into other assessments including the Flood Risk Strategy, Regional Core and Local Development Strategies and in particular the development of Dudley's Surface Water Management Plan (SWMP) which is currently being developed.

The PFRA requires LLFAs to assess risk from sources of flooding other than main river, the sea and reservoirs. In particular this includes surface water runoff, groundwater and ordinary watercourses and any interaction these have with drainage systems and other sources of flooding including sewers.

1.2 The Study Area

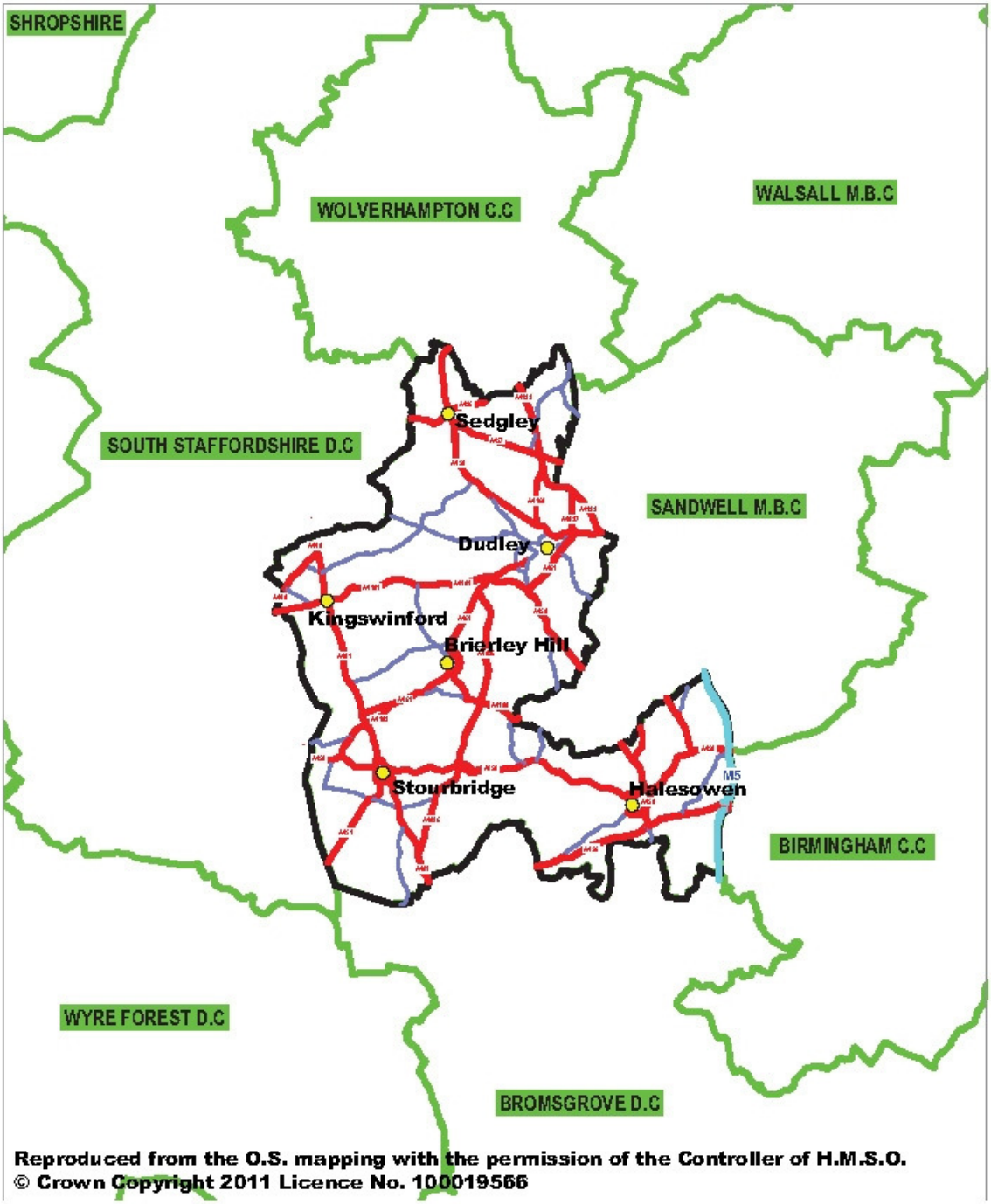

Figure 2.0

Figure 2.0 above shows Dudley as one of the four Metropolitan Boroughs along with Sandwell, Walsall and Wolverhampton which form the Black Country which in turn forms part of the wider West Midlands district. Dudley is adjoined by some very different neighbours, with Birmingham, the UK's largest urban Local Authority to the east, whilst to the south and west are the

rural districts of Staffordshire and Worcestershire. The borough covers an area of approximately 10,000 hectares and includes the population centres of Dudley, Stourbridge, Halesowen, Coseley, Sedgley and Kingswinford. Dudley is a predominantly urban area, however around 30% of the borough is made up of green spaces which includes approximately 1,700 hectares of green belt land.

The 2009 mid-year population estimate for Dudley borough was 306,600, a slight increase from the 2001 Census population which showed 305,155.

Dudley borough is one of the most geologically diverse areas in the UK, and the richness and variety of its mineral deposits has created a legacy which still shapes the borough today. Historic buildings and other structures made from locally produced bricks, tiles and stone make a significant contribution to the character of many of our town and district centres.

The landscape is characterised by a number of prominent high points (figure 3.0), still largely undeveloped, including the Sedgley Beacon, Wren's Nest and Castle Hill. There is a band or ridge of high ground all along the eastern boundary with a particularly high ridge along and beyond the southern boundary forming the Clent and Walton Hills.

Approximately three quarters of the borough is underlain by rocks of the Carboniferous period mainly productive coal measures containing inter bedded mudstones and sandstones. These measures contain numerous coal, fireclay and ironstone seams. The remaining quarter of the borough is underlain by rocks of the Triassic period namely sands and gravels. These rocks, locally known as the Sherwood sandstone group, are classified as high productive aquifers and have been used for storage and the abstraction of groundwater for many years. In fact there are several aquifer protection zones in the Stourbridge area. The Carboniferous and Triassic rocks are separated by a major geological fault, namely the Western Boundary Fault which runs approximately north to south.

It should be noted that the area occupied by the Carboniferous rocks is overlain by a varying thickness of man made fill material. The majority of the fill originated from activities associated with the industrial revolution including major mineral extractions and the iron and steel production industry. The fill materials can generally be classified as having a low permeability.

The borough lies within the Severn and Humber River Basin Catchments at a ratio of approximately 85:15 respectively and is served mainly by the River Stour and numerous brook courses.

Dudley Borough drainage generally includes mostly open channel watercourses. These watercourses mainly contain the headwaters of the River Stour and the River Trent.

The source of the River Stour is situated within the Clent and Walton Hills and runs from east to west through the southern half of the borough towards

Stourbridge and Kingswinford and its tributaries drain most of the borough (as well as parts of Sandwell and Wolverhampton), before joining the UK's largest river, the River Severn at Stourport.

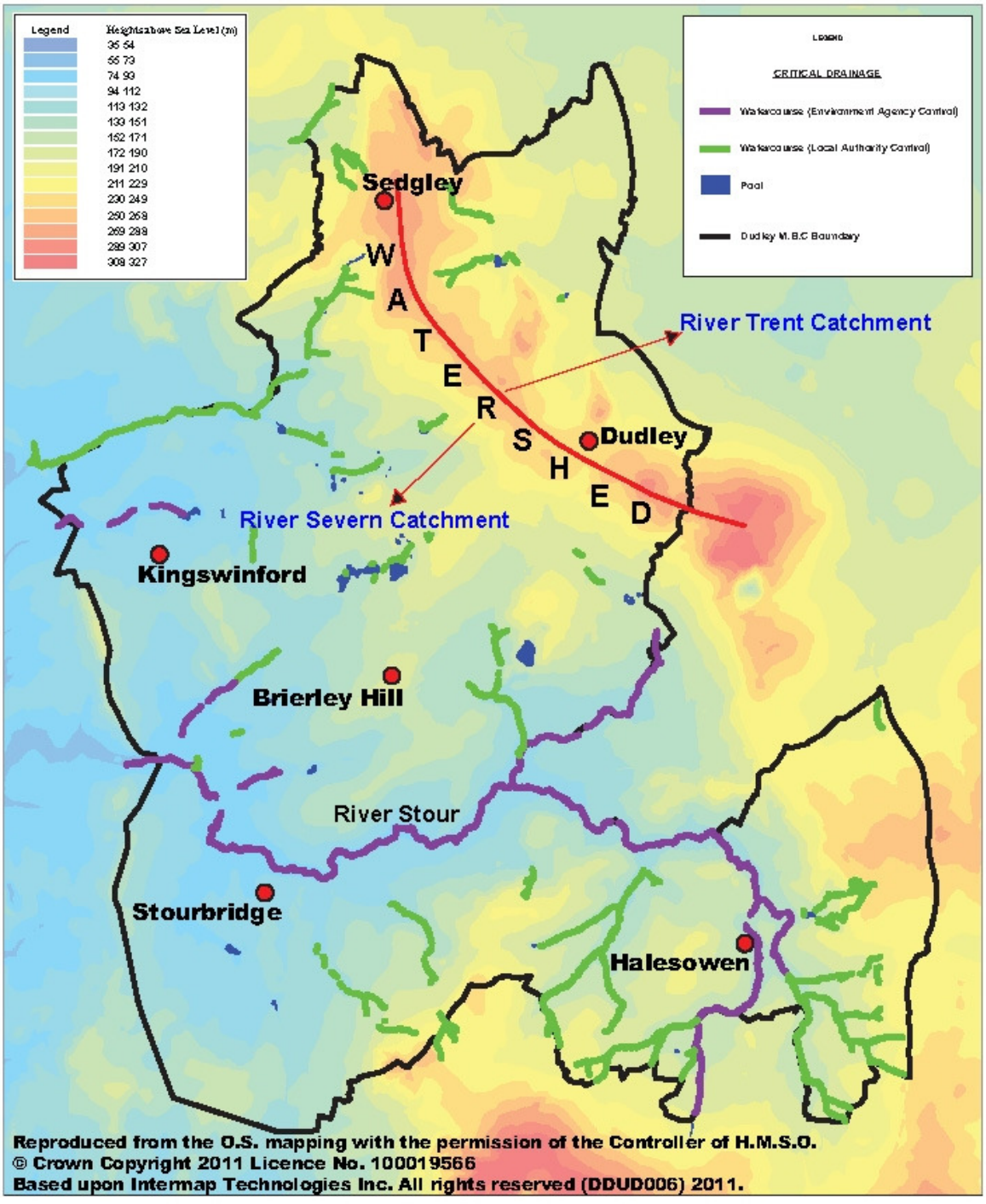

Figure 3.0

There is a small part of the borough situated to the north east that drains from the high ground in Dudley via Swan Brook and Tipton Brook through the neighbouring authorities to the River Trent, part of the Humber River Basin Catchment.

The majority of Dudley borough ultimately drains into the River Severn via the River Stour and therefore forms part of the River Severn Basin Catchment. The River Severn CMFP places Dudley in sub area 5 consisting of Telford, Black Country, Bromsgrove, Kidderminster and Coventry. The report puts Dudley in Policy Option 5 an area of moderate to high flood risk where we can generally take further action to reduce flood risk. This policy is about reducing the risk where the existing flood risk is high. Action is therefore required in the short term to reduce this level of risk.

There are a considerable number of minor and ordinary watercourses within Dudley including those at Audnam, Holbeche, Illey and Wordsley Brook.

There is a total approximate length of 56 km of ordinary watercourse, 16 km of which is in culvert and made up of 249 individual culverts. 65 Trash screens are situated on ordinary watercourses and at culverts entrances of which 13 are classified as critical from a flood risk potential. These details are shown in Map 1 Annex 5.

There is a total length of 27.3 km of canal network within the borough, the majority of which is under the ownership of British Waterways.

There are 7 Non/Impounding reservoirs within the borough that exceed 25,000 m^3.

Like many other similar urban authorities, Dudley's flood issues occur as a result of very simple to a complex combination of runoff, insufficient highway drainage, blocked gullies, river and ordinary watercourse out of bank flows, fly tipping, poor maintenance and under capacity of storm sewers systems. Flooding is further complicated by extreme changes in topography and hard urbanisation including buildings, walls and other structures on and along natural flow paths. This is further exacerbated by the popularity of hard impermeable surfacing of domestic gardens, erection of conservatories and lack of knowledge of riparian roles and responsibilities.

2.0 Lead Local Flood Authority Responsibilities

2.1 Governance and Partnership Arrangements

The Floods and Water Management Act 2010 (FWMA) aims to improve both flood risk management and the way we manage our water resources. It assigns specific responsibilities to 'risk management authorities' for different sources of flooding. This includes a new lead role for local authorities in managing local flood risk and a strategic overview/oversight role for all flood risk in England/Wales for the Environment Agency.

As Dudley is a Unitary Authority it now has the roles and responsibilities of a Lead Local Flood Authority under this new legislation.

The Flood Regulations 2009 are consistent with the responsibilities defined in the Act.

During early 2010 Dudley established a formal flood risk management structure consisting of all key Officers, Partners and Stakeholders (figure 4.0).

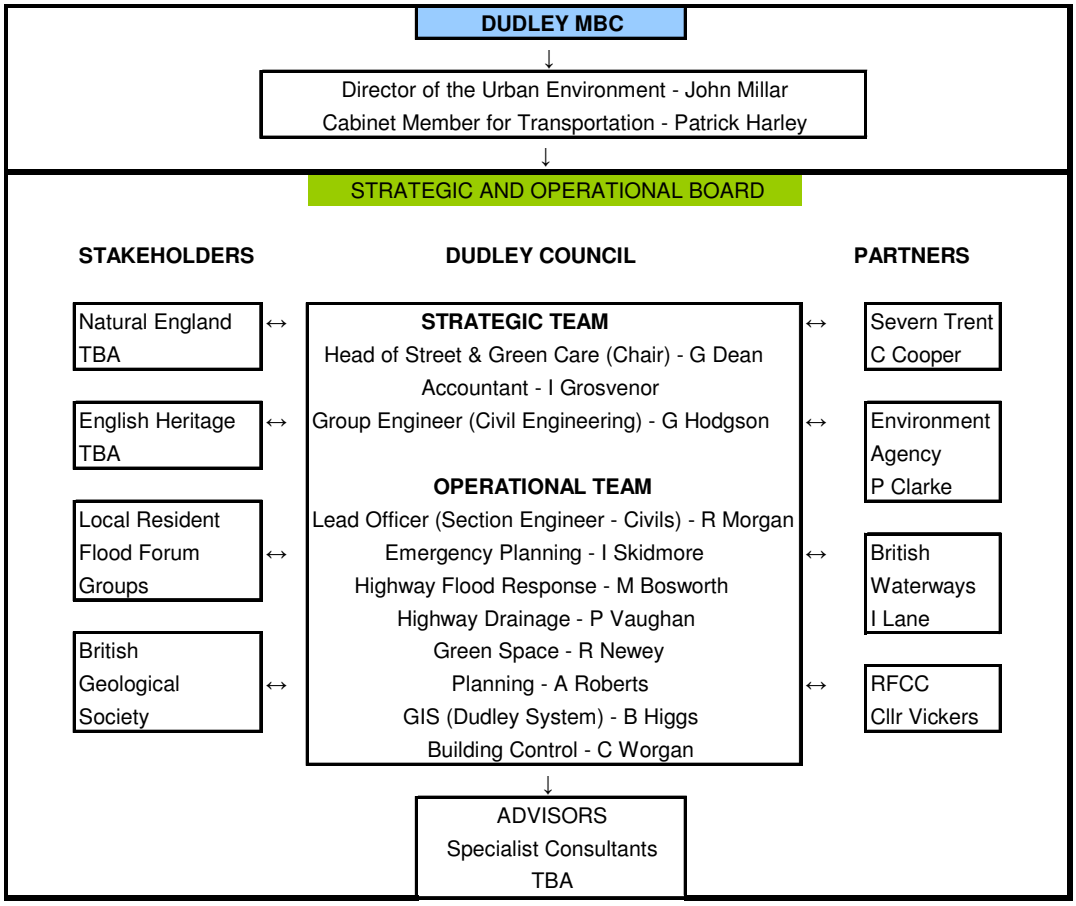

Figure 4.0

In order to develop a coordinated and consistent approach, Dudley decided to combine Strategic and Operational Management under one management board. Terms of Reference, Aims and Objectives have all been agreed.

Attendance at meetings has been extremely positive and includes officers within Dudley Council with responsibility for the preparation of the PFRA and SWMP; highway drainage maintenance & emergency response; contingency planning, planning strategy and policy; representatives from stakeholders and partners including the Environment Agency (EA), Severn Trent Water Ltd (STW) and British Waterways (BW) and also members of a Local Resident Flood Committee.

2.2 Communication with Partners and the Public

Since its establishment in July 2010 the Strategic and Operational Board has met on three separate occasions with formal minutes being prepared for each meeting. The latest meeting held in March 2011 was attended by members of a Local Resident Flood Committee and a report they prepared was presented to the Board.

In relation to ongoing operational issues, tremendous improvements have been made between the authority and its external partners in particular the Environment Agency. Dudley officers and EA representatives are working together on river and watercourse condition inspections and work programmes.

Currently two local community/resident committees have been established. Near quarterly meetings have been attended by officers of the Council and representatives of the EA and STW. Meetings are held with the community groups to discuss progress on flood mitigation, maintenance, flood warning, flood emergency response and voluntary warden responsibilities.

Dudley utilise the www.dudley.gov.uk website and at times the local press to inform the local community. One initiative was the request for past flood events from the public via the web and the local press.

3.0 Methodology and Data Review

3.1 Information Gathering

Historical data relating to flood events has been collected from a variety of internal and external sources. It is recognised that data from various sources can vary in detail, accuracy and can be recorded in various formats and mediums.

From the outset it was recognised that, where possible, flood incidents and data reliability and confidence can be greatly improved when there is more than one data source for any single incident. Dudley's approach has been to compare and analyze multiple data sets.

Identification of historical flood events has been problematical for a variety of reasons.

- Lack of communication between organisations
- Fragmentation of responsibilities
- De-centralisation of knowledge and data capture
- Lack of coordination in response to flood events
- Lack of coordination for maintenance works
- Blame culture associated with cause of flood events and responsibility
- No definitive drainage asset register

- Poor knowledge transfer between organisations
- Poor data capture

The list below details the main data sets identified and interrogated

- Dudley Council's highway incident reporting data base Symology
- Dudley Council's records of individual flood incidents
- Flood Recovery Grant Claims
- Dudley Council's Web and Local Press Flood Survey
- Severn Trent Water Limited DG5 Register
- British Waterways canal data
- Dudley Council's culvert and trash screen records
- Reservoir details
- Black Country Strategic Flood Risk Assessment (SFRA)
- Black Country Water Study and SWMP scoping report
- British Geological Society - Geological background for the Black Country
- EA Groundwater and Water Abstraction Data
- EA Geostore general historical river and surface water flood map
- West Midlands Fire Service Flood Incident Logs

3.2 Availability and Limitations

Data records of historical events have been collected in various formats including hand written notes, spreadsheets, plans, photographs, anecdotal knowledge and in electronic map format.

3.2.1 Dudley MBC Data

Dudley operates a Highways Asset Database recording system called Symology. This system contains logs of all reports received from the public on all forms of highway related issues ranging from pot holes to flood events. Although specifically developed for highway issues the database does include logs of non highway related matters including flooding to residential property. Several years of record data is available, but in many cases individual incidents, in particular those related to flooding, are of a limited quality.

Interrogation of Symology, using "key word" filters (i.e. flooding, internal, sandbag etc.) identified over 1,600 individual logs linked to flooding of properties or the highway over the last 10 years.

Within the 1,600 records there were a substantial number of known localised problems identified throughout Dudley, initially highlighted as an outcome of flooding experienced by local residents or businesses. Some of these have already been addressed through subsequent maintenance.

Due to the lack of confidence in the quality of records it was decided to apply a second filter to identify flood incidents that occurred twice or more at the same location. This filter provided the following results:

- 52 locations with incidents of multiple internal flooding consisting of 226 residential properties and 2 non residential properties
- 20 multiple flood incidents on category "A" highways.

Dudley has detailed records of actual flood incidents which provide a more comprehensive and confident set of data. These tend to relate to larger and more recent flood events including those in 2007 and 2008. These locations are identified as "Known Flood Extents" and have been recorded on their own layer in Dudley's Geographical Information System "GIS-MO" (Getting Information Simply – Mapping Online) and identified in Table 1 in Annex 5. For many of the known flood extents, video and photographic evidence is available.

3.2.2 Severn Trent Water Ltd. Data

Severn Trent Water provides water and sewerage services to over 3.7 million households and businesses in the Midlands and mid Wales.

All sewerage undertakers maintain a register of properties which have suffered flooding from public sewers and are at risk of flooding again. This is known as the DG5 Register. The register includes incidents of both internal property flooding together with flooding to curtilages, highway and other open areas (external flooding). The register also includes an indication of the likelihood of repeat flooding. Only flooding due to hydraulic deficiencies is recorded on the DG5 register. Sewer flooding due to blockages is not recorded on the DG5 register and properties that have been flooded in the past and a flood alleviation scheme provided are also not included.

Properties flooded in severe weather (rare events) are now recorded but OFWAT do not require these to go onto the DG5 register.

STW have provided a copy of the DG5 Register for the borough containing 210 records which identify 21 internal property, 40 highway and 1 public open space flooding events attributable to surface water. These locations are confirmed by Dudley's Symology records.

3.2.3 British Waterways Data

British Waterways are responsible for approximately 2,200 miles of the country's canals and rivers. They have provided some records of canal overtopping and breaches, however, they were many years old and are considered to be of limited use. It is therefore considered that the risk of flooding is relatively low from these sources.

3.2.4 Environment Agency Data

The Environment Agency's principal aims are to protect and improve the environment, and to promote sustainable development. They are the competent authority for managing risk from main rivers, the sea and large raised reservoirs.

Via access to the EA's Geo Store website, Dudley was able to import data into GIS-MO and inspect a variety of historical and National database records including:

- Main River maps
- EA River Flood Maps
- Areas Susceptible to Surface Water Flooding (AStSWF)
- Flood Maps for Surface Water (FMfSW) of 1 in 30 and 1 in 200 annual probability.
- National Receptor Database records
- Indicative Flood Risk Areas

LIDAR (Light Detection And Ranging) Topographical Survey information was also obtained from the EA Geomatic Group website.

The Environment Agency was unable to provide any additional historical flood incident information.

3.2.5 Groundwater Data

Groundwater flooding occurs as a result of water rising up from the underlying aquifer or from water flowing from surface springs. This tends to occur after long periods of sustained high rainfall, and the areas at most risk are often low-lying where the water table is more likely to be at shallow depth. Groundwater flooding is known to occur in areas underlain by major aquifers.

Groundwater rise is generally associated with the reduction in water abstraction resulting from change in industrial processes and in particular in areas where high grade aquifers occur. Within Dudley there is a limited area of quality aquifers to the western edge of the borough that have both historical and ongoing abstractions.

Having reviewed both the Black Country Strategic Flood Risk Assessment (SFRA) and the Black Country Water Cycle & Scoping Surface Water Management Plan it is clear that insufficient data is available to make a realistic assessment of any impact of groundwater or rising groundwater on surface water flooding in Dudley. Although there is some degree of evidence to support an increase in the groundwater level rise across the Black Country, there is currently no evidence to support a rise in the Dudley borough area.

Discussions with the EA suggest there is very little change in groundwater levels since the 1970's, however, evidence is limited to observation bore holes of the high grade aquifer zones near Stourbridge as no other evidence is available for other areas of the borough.

3.2.6 Rainfall Data

Periods of prolonged rainfall can lead to widespread flooding, especially in winter and early spring when soils are usually near saturation.

Thunderstorms are most likely to occur from May to September, reaching their peak in July and August. High intensity rainfall is often associated with summer showers and thunderstorms, rates of 100 mm/hr or more being possible for short periods.

Rainfall data records have been obtained from accessible sources, namely the Met Office and a local private operated weather observation station located in Halesowen.

Information from the local Halesowen weather station indicates an average annual rainfall of 762mm. Extreme measurements are recorded for 1960 (1033mm), 2000 (977mm), 2007 (938mm) and 2008 (997mm). Average monthly rainfall is around 65mm with very little variation between months, however, slightly higher monthly rainfalls occur in January and December.

During the now well documented storms of 2007, the most significant rainfall event was on 20th July over the south Midlands, with many stations recording their highest daily rainfall on record. In excess of 180 mm of rain fell over parts of the borough during the July period. This represents over twice the average July rainfall of 60 to 70mm. In fact on the 20th July, 68mm of rainfall was recorded, which is more than the average total for that month.

Comparing monthly (May, June and July) data from both the Met Office and the Halesowen local station, there appears to be some evidence to suggest that many of the main flood incidents occurred following a one or two day short high intense rainfall event proceeded by 2/3 months of particularly high rainfall. This suggests that much of the permeable ground was totally saturated prior to the storm event, watercourses were already high and storm sewer systems were running at higher capacities than normal.

The Met Office suggests that the storms that occurred in 2007 represent an above 1 in 200 year annual probability event which represents a 0.5% chance of occurrence.

3.2.7 Dundee University British Hydrological Events

A search of the Dundee University Chronology of British Hydrological events website on the River Severn basin, failed to provide any substantial historical

flood events relevant to Dudley borough. However, there are two specific records for 1472 and 1932. Unfortunately, an accurate location cannot be found for the 1472 event and the 1932 event only identifies general locations of considerable flooding in the low lying areas of Netherton, Blackheath and Halesowen.

3.2.8 Flood Recovery Grant Claims

Flood Recovery Grant is a scheme established by the Department for Communities and Local Government under section 31 of the Local Government Act 2003. A Flood Recovery Grant Scheme was first announced by the Prime Minister in July 2007 as part of a wider package of immediate financial support for the worst affected areas of exceptional flooding. Dudley invited "One Off Damage Claims" from members of the community who had been affected by internal residential property flooding. 73 justifiable flood damage claims were received, and each received a sum of £287.67. This data has also been accounted for.

3.2.9 Dudley Web and Local Press Survey

To ensure that Dudley had collected as much historical flood data as possible it was decided to invite members of the public to submit details of historic flooding. This was facilitated jointly via the www.dudley.gov.uk website and use of the local press. After a period of 4 months, 14 records were submitted generating 5 new locations where internal property flooding occurred more than twice.

3.3 Storage Systems

Dudley MBC has a strong, long-standing corporate outlook in terms of its Geographic Information System (GIS) which was conceived in the late 1970's in recognition of at least 80% of the Council's information holdings being geographic. There are currently over 350 individual 'creators' of data and over 4,500 staff (92% of all networked PC's) who have accessed the intranet version of the GIS (branded as "GIS-MO" – Getting Information Simply – Mapping Online).

The depth of information corporately available is substantial. Over 400 data sources including most of the Council's key business applications are currently accessible through GIS-MO, resulting in a holding of over 2 million spatial records. This data ranges from an archive of historic mapping and aerial imagery through planning, electoral, educational, environmental and demographic information.

GIS-MO has proven to change business processes at Dudley, resulting in it being seen as a business-critical application and as such features in the

Council's Business Continuity Plan. The GIS Manager is also a member of the Council's Strategic and Operational Board.

From the commencement of the flood risk management process Dudley took the decision that all data should be held by those with corporate responsibility for datasets, that being the GIS team.

As soon as any data is received it is passed to the GIS team for security checks, storage, capture and interrogation. Any necessary licensing arrangements are controlled by the GIS team and where required includes discussions with the data providers and users. The principle of "Capture Once Only" is adhered to where possible. All data is stored on one of the Council's central corporate server repositories with back up taking place daily. All data collected has been converted into electronic format so that data sets can be imaged within GIS-MO.

Dudley have determined that GIS-MO will be the complete asset register for Surface Water Management. The following data sets are currently available in GIS-MO:-

- Symology multiple flood datasets
- Flood Recovery Grant Claims
- Flood incident extents maps
- Main River and Ordinary watercourses
- Culverted Watercourses
- Storm Outfalls, Grills & Trash Screens
- EA Areas Susceptible to Surface Water Flooding
- EA Flood Maps for Surface Water (1 in 30 and 1 in 200 annual probability events)
- EA Blue Squares and West Midland Cluster Maps
- Reservoir Inundation Maps
- Severn Trent Water DG5 Register
- Flood Defence Structures

Separate layers have been created for each of the above unique sets of data. This has facilitated comparison of historical flood events with the predicted EA Flood Maps for Surface Water and Areas Susceptible to Surface Water Flooding and has provided confidence in predicted flood areas.

3.4 Information Sharing: Quality Assurance, Security and Licensing

The data received from partner and stakeholder organisations was shared subject to confidentiality agreements and was provided for the sole purpose of assessing flood risk. The data comes with no warranty of correctness or accuracy and in many cases is provided at street level only in order to protect individual properties.

Data security is a key consideration, especially for third party datasets. Limited officers within the Council are provided with secure access to the Surface Water Flood Management datasets and maps. Decisions on access requirements are made via the Strategic and Operational Board, however, access is likely to be made available, as a minimum, to Engineers, Planners and Contingency Officers with flood related responsibilities.

3.5 Future Developments

Dudley is committed to its corporate GIS and intends to continue to expand its capabilities by introducing additional data layers in order to support the Local Flood Risk Management Strategy. Future direct live linkages to external third party data will be preferable to regular frequent uploads.

4.0 Past Flood Risk

4.1 Information on Past Floods

The regulations and supporting guidance requires the PFRA to include information on past floods that had "Significant Harmful Consequences" and which could occur again. Only floods with "Significant Harmful Consequences" need to be reported to Europe via the Annex 1 spreadsheet.

Although no definition is provided in the legislation as to what "Locally Significant" means, advice from the EA indicates that the threshold for past floods with "Significant Harmful Consequences" should be of an order of magnitude below the Flood Risk Threshold for Future Floods (1km grid squares – informally referred to as "Blue Squares"). They also recommend that, as a minimum, it should involve flooding of a number of properties, on more than one occasion. The Flood Risk Thresholds for 1km grid squares are:-

Flood Risk Threshold	Description
• More than 200 people • More than 20 businesses • More than 1 Critical Service	Flooded to a depth of 300mm during a rainfall event with a 1 in 200 chance of occurring (or 0.5%)

However, the guidance does not preclude LLFA's from making reference to less significant flood events within the report.

4.2 Statement on Flood Harm and Consequences

Dudley identified a need to establish a methodology for risk categorisation and prioritisation based on flood harm and consequences. Currently Dudley are developing a scoring matrix to determine mitigation priority as part of the SWMP and Flood Risk Management Strategy. Consideration for

consequential harm to human health, economic activity, cultural heritage and the environment will all form part of the priority assessment.

4.2.1 Agreed Local "Significant Harmful Consequence Criteria"

There is no national definition for Local Significant Harmful Consequence, however, following the EA recommendations, consultations with other LLFA's and agreement via Dudley's Strategic and Operational Flood Management Board the following criteria has been adopted.

- Flooding more than 15 People or
- Flooding more than 1 Critical Service or
- Marooning more than 1 Critical Service
- Flooding more than 2 Non Residential Properties
- Flooding a Motorway or Strategic Road closing it for over 2 hours (See comments below)

In principle this set of thresholds appear to be robust and logical however further clarification on what is classified as "Critical" would help especially for Motorways and Category "A" roads. At this time Dudley has adopted highway threshold criteria of:

Closure of a Motorway or Strategic Route for more than 2 hours, specifically A456 Halesowen to Kidderminster, A4123 Birmingham New Road, A461 Dudley Southern Bypass, A449 at Wall Heath, A458 Stourbridge and the A491 Stourbridge to Kingswinford.

4.3 Summary of Past Floods

On analysing the data for past flood events it has been concluded that no flooding events fall within the National "Significant Harmful Consequence" Criteria and thus Annex 1 of this report will not be completed.

Dudley recognises that flood damage to property and loss of personal possessions is very distressing and hence has included notable historic flood events. These areas will be further reviewed as part of its Flood Risk Management Strategy.

Table 1 (Annex 5) identifies historic internal property flooding locations that have had multiple flood events. This table represents a confidence matrix of flood events and data source. For example, confidence of data is high for Hinsford Close as there are at least 6 separate data sets confirming a flood incident.

In summary there are 52 locations with incidents of multiple internal property flooding consisting of 226 residential properties and 2 non residential properties. 7 of these are of Local Significant Harmful Consequence.

Table 2 (Annex 5) identifies historic highway flooding locations that have had multiple flood events. Confidence in the data is identified by representation in multiple datasets. In summary, there are 20 multiple flood incidents on category "A" highways, 2 of which fall within the Local Significant Harmful Consequence Criteria.

Table 3 (Annex 5) indicates previous floods that have occurred in Dudley where there is supporting evidence to the extent of the flooding and some understanding of its cause. Photographic and video evidence is more readily available in order to determine depth, consequence, extent and cause of flooding.

Following recent flood events, many of the residents affected were prepared to provide information to Dudley on the level of consequences. For properties where internal flooding occurred, consequences can be summarised as follows:

- In many cases, properties were vacated for 3 to 6 months.
- Property repair costs ranged from £10,000 to over £100,000 with an average of £50,000.
- Many months of discussions and negotiations with insurance companies.

Due to the lack in confidence in past flood records and in order to fulfil one of Dudley's objectives and to supplement Symology, a new flood incident form has been produced for attending officers to capture accurate and consistent information. This record is then processed by the responsible office and if necessary further action taken.

A comparison of the locations of past flood events and the geological structure of the borough indicates that:

- All of the identified local significant property flood events occur in the Carboniferous strata area
- The majority of the remaining non classified flood events fall within Carboniferous strata areas.

From the above information it could be concluded that there may be some correlation or influence on surface water flood events from the underlying strata, however, additional research is required.

Map 2 contained in Annex 5 represents historic flooding identified in Tables 1 - 3 overlaying the Map of Locally Agreed Surface Water Information (See section 5.2).

5.0 Future Flood Risk

5.1 Relevant Information of Future Floods

Identification of future flood risk is a complex process involving consideration of historical information and predictions based on available flood maps, climate change and in some cases hydraulic modelling.

The Environment Agency has produced two national datasets showing predicted surface water flooding, namely:

- Areas Susceptible to Surface Water Flooding (AStSWF), and
- Flood Maps for Surface Water (FMfSW)

The Areas Susceptible to Surface Water Flooding map shows areas that are susceptible to flooding from surface water displayed in three bands, ranging from less susceptible to more susceptible to flooding.

The Flood Map for Surface Water shows areas where surface water would be expected to flow or pond, as a result of two different chances of rainfall event. The areas at risk of flooding are displayed in two bands showing a) surface water flooding and b) areas of deeper surface water flooding.

The Areas Susceptible to Surface Water Flooding map was produced using a simple method that assumes that underground sewerage and drainage systems, and smaller over ground drainage systems are full to capacity. Being full to capacity means that the water does not drain from the surface.

The impacts of buildings are not considered. As their position can affect how and where water moves, the map only provides a general indication of areas which may be more likely to suffer from surface water flooding. It uses a single rainfall event with a 1 in 200 chance of occurring in any year.

The Flood Map for Surface Water better represents the mechanisms that cause surface water flooding than the current 2009 Areas Susceptible to Surface Water Flooding map in the following ways:

- better ground and surface data in many areas - using ”local” data
- sewer flow now represented - using a single “national” figure
- infiltration now represented - using “national” figures for urban and rural areas
- storm duration more representative - using a single “national” figure
- buildings now included - using “local” data
- maps two storm likelihoods (1 in 30 and 1 in 200 chance of occurring in any year)
- different roughness figures for urban and rural now included - using “national” figures

The new Flood Map for Surface Water uses better data, and a more realistic representation of conditions affecting flooding. However, it does have some limitations. The main limitation is that the map has used a national average drainage capacity - as we do not currently know what the actual drainage capacity is in each part of England and Wales.

Therefore, in some places (particularly where drainage capacity is much less than the average) the old Areas Susceptible to Surface Water Flooding map may show a more realistic flood extent.

It's important that Lead Local Flood Authorities work with their partners to review, agree and record what surface water flood data best represents local conditions. This is known as Locally Agreed Surface Water Information.

5.2 Locally Agreed Surface Water Information

A briefing on the two predicted surface water flooding maps was given to Dudley's Strategic and Operational Flood Management Board and The Council Scrutiny Committee (namely the Select Committee on the Environment in March 2011).

Members of both meetings supported the use of Flood Maps for Surface Water as they represent local conditions and favourably reflect the topography of the borough, ground infiltration, sewer capacity and the substantial number of ordinary watercourses that drain the catchment.

Therefore, the "Locally Agreed Surface Water Information" is to be based on the adoption of the EA Flood Maps for Surface Water, 1 in 200 annual probability flood risk areas with flood water estimated to be greater than 300mm deep.

To support this decision it was noted that:

- 75% of the historical property flood events fall within the flood risk areas
- 85% of the historical highway flood events fall within the flood risk areas

A summary map indicating what constitutes Locally Agreed Surface Water Information is enclosed in Annex 5 (Map 2).

In summary, the Flood Maps for Surface Water indicate 3% of the borough has a 1 in 200 chance of flooding to a depth greater than 300mm. This equates to approximately 11,500 properties or 27,000 people at risk.

5.3 Reference to Detailed Records of Future Floods and Possible Consequences

After importing the 1km square flood risk threshold (informally known as “Blue Squares”) layer into GIS-MO the EA threshold criteria data was extracted for each square and compared against information already held by Dudley. In all cases of the 10% sampled squares, there was good correlation between EA and Dudley consequence threshold data.

5.4 Climate Change and Long Term Developments

The Climate Change Act (2008) requires a UK-wide climate change risk assessment every five years accompanied by a national adaptation programme that is also reviewed every five years. The Act has given the Government new powers to require public bodies and statutory organisations, such as water companies, to report on how they are adapting to climate change.

The impact of climate change on local flood risk is relatively poorly understood. Several national flood maps have informed the preliminary assessment report - specifically the Flood Map for Surface Water (surface runoff), Areas Susceptible to Surface Water Flooding (surface runoff), Areas Susceptible to Groundwater Flooding (groundwater) and Flood Map (ordinary watercourses). These do not show the impact of climate change on local flood risk.

There was consensus amongst climate model projections presented in the Intergovernmental Panel on Climate Change (IPCC) fourth assessment report for northern Europe suggesting that in winter high extremes of precipitation are very likely to increase in magnitude and frequency. These models project drier summers with increased chance of intense precipitation - intense heavy downpours interspersed with longer, relatively dry periods.

United Kingdom Climate Projections 2009 (UKCP09) provides the most up to date projections of future climate for the UK.

The projections are presented for three different future scenarios representing High, Medium and Low greenhouse gas emissions.

The types of climate information provided include:

- Observed climate data (20th and 21st century historical information about temperature, precipitation, storminess, sea surface temperatures and sea level)
- Climate change projections (for temperature, precipitation, air pressure, cloud and humidity)

UKCP09 provides a quick way to see projected changes in the UK climate at a national and regional level. All use the three UKCP09 emissions scenarios, three 30-year time periods (2020s, 2050s & 2080s) and a range of probability levels (10, 33, 50, 67 & 90%) to show the spread of possible outcomes.

Looking at the data for the West Midlands adopting medium emissions for rainfall the following can be determined.

Key findings for West Midlands, 2020's
• Under medium emissions, the central estimate of change in **annual mean precipitation** is 0%; it is very unlikely to be less than –5% and is very unlikely to be more than 6%. A wider range of uncertainty is from –5% to 6%.
• Under medium emissions, the central estimate of change in **winter mean precipitation** is 5%; it is very unlikely to be less than –3% and is very unlikely to be more than 14%. A wider range of uncertainty is from –3% to 15%.
• Under medium emissions, the central estimate of change in **summer mean precipitation** is –7%; it is very unlikely to be less than –23% and is very unlikely to be more than 12%. A wider range of uncertainty is from –23% to 15%.

Key findings for West Midlands, 2050's
• Under medium emissions, the central estimate of change in **annual mean precipitation** is 0%; it is very unlikely to be less than –5% and is very unlikely to be more than 6%. A wider range of uncertainty is from –6% to 6%.
• Under medium emissions, the central estimate of change in **winter mean precipitation** is 13%; it is very unlikely to be less than 2% and is very unlikely to be more than 27%. A wider range of uncertainty is from 1% to 30%.
• Under medium emissions, the central estimate of change in **summer mean precipitation** is –17%; it is very unlikely to be less than –37% and is very unlikely to be more than 6%. A wider range of uncertainty is from –39% to 14%.

Certain key processes such as localised convective rainfall is not represented within this modelling. As such there is still considerable uncertainty about rarer extreme rainfall events for the UK. We can however be more certain that heavy rainfall will intensify in winter compared to summer. The proportion of summertime rainfall falling as heavy downpours may also increase. The impact of these changes on local flood risk is not yet known.

Central estimates are for heavy rain days (rainfall greater than 25 mm) to increase by a factor of between 2 and 3.5 in winter, and 1 to 2 in summer.

5.4.1 Appraisal

Current Flood and Coastal Defence Appraisal Guidance FCDPAG3 Economic Appraisal (Defra, 2006) provides indicative sensitivity ranges for peak rainfall intensity, for use on small catchments and urban/local drainage sites. These are due to be updated following the UKCP09 projections above. They describe the following changes in peak rainfall intensity; +5% (1990-2025), +10% (2025-2055), +20% (2055-2085) and +30% (2085-2115).

This was reviewed by the Met Office in 2008 using UKCP09 models. They suggest that, on the basis of our current understanding, these levels represent a pragmatic but not a precautionary response to uncertainty in future climate impacts. In particular for a 1 in 5 year event, increases in precipitation intensity of 40% or more by the 2080s are plausible across the UK at the local scale.

Indicative Sensitivity Ranges				
Parameter	***1990- 2025***	***2025-2055***	***2055-2085***	***2085-2115***
Peak rainfall intensity (preferably for small catchments)	*+5%*	**+10%**	*+20%*	*+30%*
Peak river flow (preferably for larger catchments)	+10%	**+20%**		

5.4.2 Long Term Developments

It is possible that long term developments might affect the occurrence and significance of flooding. However, current planning policy aims to prevent new development from increasing flood risk.

In England, Planning Policy Statement 25 (PPS25) on development and flood risk aims to "ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at highest risk. Where new development is, exceptionally, necessary in such areas, policy aims to make it safe without increasing flood risk elsewhere and where possible, reducing flood risk overall."

Adherence to Government policy ensures that new development does not increase local flood risk. However, in exceptional circumstances the Local Planning Authority may accept that flood risk can be increased contrary to Government policy, usually because of the wider benefits of a new or proposed major development. Any exceptions would not be expected to increase risk to levels which are "significant" (in terms of the Government's criteria), but should be recorded here so that they can be reviewed in the future.

6.0 Review of Indicative Flood Risk Areas

To ensure a consistent approach in this high level screening exercise Defra have identified significance criteria and thresholds for defining Flood Risk Areas across Europe, these having significant harmful consequences on human health, economic activity and the environment.

In England the process to identify Indicative Flood Risk Areas has been to divide the country into 1km grid squares and overlay datasets of:

- Flood Maps for Surface Water (1 in 200 annual probability – Deep),
- Areas Susceptible to Surface Water Flooding (1 in 200 annual probability – Intermediate) and
- National Receptor Database

Once completed the EA then apply a Flood Risk Threshold to each of the grid squares.

Flood Risk Threshold	Description
• More than 200 people • More than 20 businesses • More than 1 Critical Service	Flooded to a depth of 300mm during a rainfall event with a 1 in 200 chance of occurring (or 0.5%)

If the Flood Risk Threshold is exceeded then this identifies 1km grid squares above flood risk threshold or more informally known as “Blue Squares”. There are 57 “Blue Squares” identified within Dudley shown in figure 5.0 below.

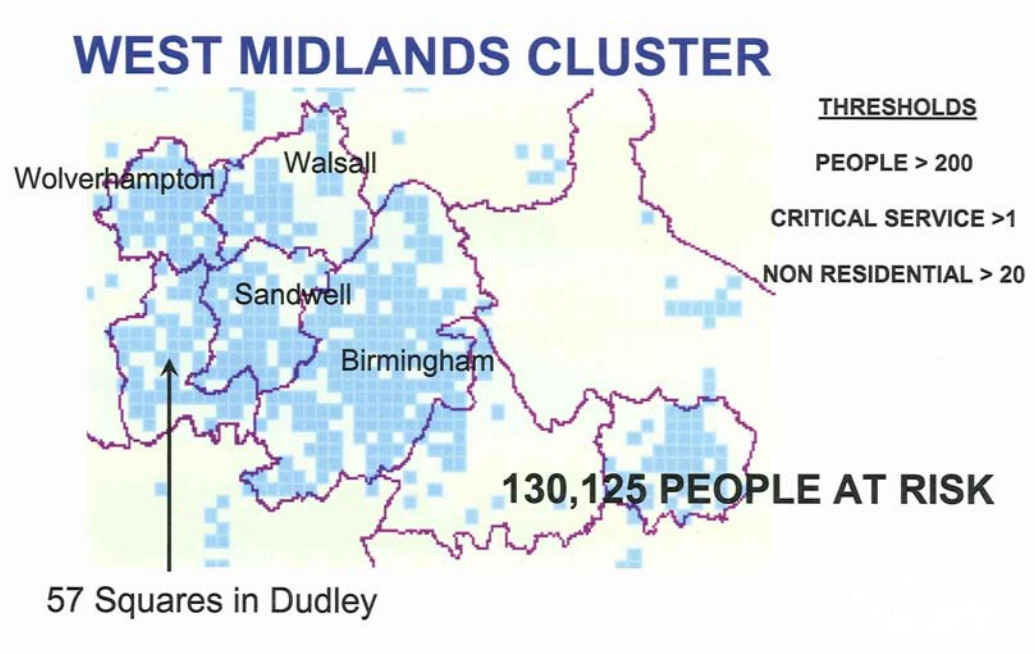

Figure 5.0

Clusters of “Blue Squares” were formed on the basis of 5 or more of them touching within a 3km by 3km grid square and then ranked on the basis of the total number of people at risk, the number of critical services and the number

of non residential properties. 219 cluster groups above the Flood Risk Threshold were identified in England as shown in Map 3 Annex 5. A final threshold of 30,000 people was then applied to these cluster groups to determine an "Indicative Flood Risk Area". There are 10 Indicative Flood Risk Areas identified in England as indicated in Map 4 Annex 5.

Dudley form part of the West Midlands (Cluster) Indicative Flood Risk Area as indicated in Map 5 Annex 5.

Over the last 12 months the EA has provided Dudley with surface water flood data in electronic data format. In all cases the data format has been compatible with GIS-MO.

This has facilitated a detailed comparison and interrogation between multi datasets relating to historical flood events with EA flood map data including Areas Susceptible to Surface Water Flooding and Flood Maps for Surface Water.

Table 1 contained in Annex 5 indicates the extent of correlation between previous flood event locations and the EA Flood Maps indicating predicted flooding.

Comparison of the location of previous flood events with EA's Flood Maps for Surface Water -1 in 200 annual probability greater than 300mm deep flood water indicate:

- 75% of property internal flood events lie within the 1 in 200 >300mm area
- 85% of highway related flood events lie within the 1 in 200 >300mm area

7.0 Identification of Flood Risk Areas

Following the review of the Indicative Flood Risk Area, (West Midlands Cluster Group) Dudley can confirm that they are not currently proposing to make any amendments to the area and hence will not be completing Annex 3 of the report.

8.0 Next Steps

In order to comply with its role as Local Lead Flood Authority, Dudley will continue to investigate future flood events and is committed to continued collection, assessment and storage of flood risk data and related information.

It will consider the commissioning of borough wide hydraulic modelling to verify EA Flood Maps which have been, at this stage, adopted as locally agreed surface water information. It is possible that any hydraulic modelling

could be incorporated into a study of the West Midlands National Indicative Flood Risk Area through collaborative working with the other West Midland Authorities.

Dudley's GIS system, GIS-MO, will continue to form the basis for all flood data, records, assessments and will be expanded to form Dudley's flood asset register, including information on condition and maintenance inspections for watercourses, culverts, trash screens and other features.

It is proposed to establish a central database controlled by Dudley.

Dudley has already developed an improved flood incident data collection process and data record sheet which is to be used by first Dudley Council attendees at flood incidents.

At present, a follow up process is being developed to collect additional, more specific data to supplement the incident sheet. This will be used to assist in future risk assessments and to support any necessary flood modelling.

To meet Dudley's responsibilities as SUD's approval board, GIS-MO will be further expanded to record all adopted SUD's systems with attribute tables identifying condition and maintenance works requirements.

Dudley will consider issues and responsibilities in relation to community and citizen access to data.

Further consultations will take place with external partners on the issue of external access levels to data.

Dudley believe that both the PFRA and SWMP are living documents and will be subject to regular review and modifications.

Consider supplementary planning guidance to supplement PPS25.

Improve internal communications and consultations between Planners and Flood Engineers during the planning and development process.

Consider the need for any supplementary guidance above the national guidance on SUD's for developers and others.

Continue to improve early warning and flood preparedness.

Improve prepared emergency response to help people at risk and protect as many properties as possible from flooding.

Continue to improve asset condition inspection and maintenance.

Better use and monitoring of local weather stations rainfall and storm data to support information from the Met Office.

Develop a Local Authority rainfall watch system linked to flood warning and early action processes.

Consider the establishment of local weather stations across the borough.

9.0 References

Black Country Water Cycle Study and Scoping Surface Water Management Plan 2009 prepared by Scott Wilson for Black Country Consortium

The Black Country Strategic Flood Risk Assessment (SFRA) prepared by Jacobs 2009

River Severn Catchment Flood Management Plan EA 2009

Black Country Core Strategy adopted February 2011 produced by the boroughs of Sandwell, Wolverhampton, Walsall and Dudley

Surface Water Management Plan Technical Guidance DEFRA 2010

Flood risk to people Phase 2 - DEFRA/EA 2006

Risk Performance and Uncertainty in Flood & Costal Defence – A Review - DEFRA/EA 2003

Managing Flood Risk – Condition Asset Manual EA 2006

Preliminary Flood Risk Assessment (PFRA) Final guidance EA 2010

What is the Flood Map for Surface Water EA 2010

Using Surface Water Flood Risk Information EA 2010

Indicative Flood Maps EA 2010

Areas Susceptible to Surface Water Flooding EA 209

The National Flood Emergency Framework For England DEFRA 2010

Flood and Coastal Erosion Risk Management Appraisal Guidance EA 2010

Planning Policy Statement 25 Development and Flood Risk 2006

Dudley Council's emerging draft Development Strategy Development Plan Document (DPD)

Dudley Council's adopted Parks and Green Space Strategy (adopted June 2009)

Dudley Council's adopted Nature Conservation Supplementary Planning Document (SPD) (adopted September 2006)

Dudley Council's Developing Brierley Hill, Halesowen and Stourbridge Area Action Plans.

National Receptor Dataset EA 2010

10.0 Glossary & Abbreviations

Term	Definition
AStSWF	Areas Susceptible to Surface Water Flooding – first generation surface water flood maps produced by the Environment Agency.
Blue Squares	A 1km² surface water flood risk area showing flooding where more than 200 people or more than 20 non-residential properties or more than 1 critical service is at risk.
BW	British Waterways
CFMP	Catchment Flood Management Plan
Climate Change	Long-term alteration in global weather patterns, especially increases in temperature and storm activity, both natural and as a result of human activity, regarded as a potential consequence of the greenhouse effect.
Culvert	A covered channel or pipe through which a watercourse flows below ground level.
DEFRA	Department for Environment, Food and Rural Affairs
DG5	Director General Performance Measure 5 – a register of properties kept by Severn Trent Water Limited, which have suffered flooding from public sewers and are at risk of flooding again.
DMBC	Dudley Metropolitan Borough Council
EA	Environment Agency
FMfSW	Flood Maps for Surface Water - second generation surface water flood maps produced by the Environment Agency.
FWMA	The Floods and Water Management Act 2010
GIS	Geographic Information System
GIS-MO	Dudley MBC's intranet version of Geographic Information System, branded GIS-MO (Getting Information Simply – Mapping Online)
Groundwater	Water which is below the surface of the ground and in direct contact with the ground or subsoil. It is most likely to occur in areas underlain by permeable rocks, called aquifers.
Indicative Flood Risk Areas	Areas based on clusters formed from all 3km squares that contain 5 or more places above the Flood Risk Thresholds (1km squares) that are touching, whereby more than 30,000 people are at risk of flooding.
IPCC	Intergovernmental Panel on Climate Change
LiDAR	Light Detection And Ranging – airborne laser mapping technique producing precise elevation data.

LLFA	Lead Local Flood Authority – responsible for managing local flood risk in particular from ordinary watercourses, surface runoff and groundwater.
Local Flood Risk	Flood risk from sources other than main rivers, the sea and reservoirs, principally meaning surface runoff, groundwater and ordinary watercourses.
Main River	Watercourses legally defined and marked as such on the main river map. Generally they are larger streams or rivers, but can be smaller watercourses. The Environment Agency has legal responsibility for them
National Receptor Database	A collection of risk receptors produced by the Environment Agency.
OFWAT	Office of Water Services
Ordinary Watercourse	Any river, stream, ditch, cut, sluice, dyke or non-public sewer which is not a main river.
PFRA	Preliminary Flood Risk Assessment
Reservoirs	The Environment Agency is responsible for regulating large raised reservoirs under the Reservoirs Act 1975. They currently regulate reservoirs over 25,000 m^3 in capacity. This will reduce to 10,000 m^3 by the commencement of provisions of the Floods and Water Management Act. Reservoirs below this size are unlikely to present significant flood risks in the context of the Regulations. On this basis there is no need to include information on reservoirs in the PFRA.
RFCC	Regional Flood and Coastal Committee
River Basin Catchment	An area that serves a river with water. Every part of land where the rainfall drains to a single watercourse is in the same catchment.
SFRA	Strategic Flood Risk Assessment
STW	Severn Trent Water Limited
SuDS	Sustainable Drainage Systems
Surface Runoff	Rainwater (including snow and other precipitations) which is on the surface of the ground (whether or not it is moving), and has not entered a watercourse, drainage system or public sewer. Flooding from surface water runoff is sometimes called pluvial flooding. Note that the term “surface water” is used generically to refer to water on the surface.
SWMP	Surface Water Management Plan
Trash Screen	A screen placed in a watercourse, usually at the entrance to a culvert, to prevent the passage of debris which may lead to blockages.

11.0 Annexes

Annex 1 - Records of past floods and their significant consequences (preliminary assessment report spreadsheet)

Annex 2 - Records of future floods and their consequences (preliminary assessment report spreadsheet)

Annex 3 - Records of Flood Risk Areas and their rationale (preliminary assessment report spreadsheet)

Annex 4 - Review checklist

Annex 5 - Supporting Documents