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# Buckingham Surface Water Management Plan

## Preliminary Risk Assessment

## Final

September 2013

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# Document control sheet

BPP 04 F8
version 15; Mar 2013

| | | | |
|---|---|---|---|
| **Project:** | Buckingham and Marlow SWMP | | |
| **Client:** | Buckinghamshire County Council | **Project No:** | B1279843 |
| **Document title:** | Preliminary Risk Assessment | | |
| **Ref. No:** | Buckingham SWMP v5.doc | | |

| | Originated by | Checked by | Reviewed by |
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# 1 Introduction

## 1.1 Introduction to a Surface Water Management Plan

Under the Flood & Water Management Act 2010[1], Buckinghamshire County Council (BCC) is the Lead Local Flood Authority (LLFA) with responsibility for management of local flood risk in Buckingham. BCC works in partnership with Aylesbury Vale District Council, the Environment Agency, Anglian Water, Buckingham & River Ouzel IDB and others. Local flooding can be caused by:

- intense rainfall before it enters a watercourse or sewer (pluvial flooding although often referred to as surface water flooding);
- overland flow resulting from high groundwater levels (groundwater flooding);
- exceedance of the capacity of the sewer network (sewer flooding); and
- out of bank flow from (typically) small watercourses which are not designated by the Environment Agency as 'Main River' (fluvial flooding from ordinary watercourses).

Therefore, whilst widely known as *Surface Water* Management Plans (SWMPs), they are increasingly seen as tools for the LLFA to manage all forms of "local flooding" in an area, and are considered as such in this case. However, the commonly used term SWMP will be retained. Flooding from Main Rivers (and the Sea) continues to be managed by the Environment Agency and is not within the scope of this SWMP study. However, interactions with Main Rivers have been considered. It is emphasised that the term "local flood risk" means flooding from sources other than Main Rivers. The term is best understood in the context of, for example, fluvial flooding from the River Great Ouse (Main River) - whilst flooding from this source may be experienced locally, it is not a "local" flood source.

The purpose of a Surface Water Management Plan (SWMP) study is to identify sustainable responses to manage surface water flooding and to prepare an Action Plan. The Action Plan and supporting material provide an evidence base for future decisions and funding applications for putting the recommendations into practice.

BCC commissioned Jacobs to undertake Stage 1 of a SWMP for Buckingham. The work in this report therefore represents only the first *Preparation* stage of a SWMP as defined by the Defra guidance[2].

In Buckinghamshire, SWMPs have previously been prepared for Chesham and High Wycombe. Through gathering a range of evidence, these have provided benefits including the following:

- Greater understanding of the flooding mechanisms in the key risk locations, detailed modelling and mapping and a list of site specific and policy options to improve surface water management
- Stronger partnership working, including the EA funding a subsequent study to investigate blockage scenarios for the Vale Brook culvert

[1] http://www.legislation.gov.uk/ukpga/2010/29/contents
[2] Defra (2010) Surface Water Management Plan Technical Guidance. March 2010. Available at: https://www.gov.uk/government/publications/surface-water-management-plan-technical-guidance

- Evidence to support successful funding applications to implement site specific options in Chesham and West Wycombe

Chesham and High Wycombe were identified by Defra as the likely highest risk locations in Buckinghamshire and therefore SWMPs for these areas were prioritised. However, due to evidence of past flooding and uncertainty in the information about future risk, preparation of a SWMP for Buckingham will support ongoing improvements in management of local flooding across the county.

This report constitutes Phase 1 (Inception) of the SWMP, with any proposals for Phase 2 (Detailed Assessment) to follow at the end of Phase 1 once sufficient information has been gathered and the proposed Partnerships have reviewed the Preliminary Risk Assessment reports.

## 1.2 The Study Area and Links to Main River Flooding

The primary urban area of Buckingham covers 3.5km$^2$, although this SWMP has included the area of Maids Moreton to the north and development areas to the south (Figure 1.1)[3]. This SWMP has considered local flooding within this area, in addition to hydrological contributions flowing into these areas from the wider catchment.

Buckingham has approximately 4km of River Great Ouse in the study area, with the 1% (1 in 100) AEP flood extent from the River Great Ouse (Environment Agency Flood Zone 3a[4]) well confined in many areas. The area is at risk of flooding from the River Great Ouse. Figure 1.1 shows the areas of Buckingham which could be at risk of fluvial (1% AEP flood from the River Great Ouse) and surface water (0.5% AEP) flooding. Main River flooding from the River Great Ouse has occurred in March 1947, December 1979, the 1980s/90s, April 1998, 1999 and January 2003. There was also a major flooding incident in 2007, which was likely to have been a combination of fluvial flooding from the Main River Great Ouse as well as some surface water and groundwater flooding. In December 2010, 87 properties, largely at risk of fluvial flooding, were fitted with household level flood protection measures. Flooding from Main Rivers continues to be managed by the Environment Agency and, in general, is not considered further in this SWMP study. However, interaction between local flood sources and the River Great Ouse is important to ensure a holistic and integrated approach to flood risk management and is therefore considered.

Flooding from non-Main River (termed 'ordinary') watercourses is within the scope of this SWMP. In Buckingham, the EA Detailed River Network data shows the following ordinary watercourses:

- The watercourse from Chackmore joins with that from Castle Fields and enters the River Great Ouse upstream of the Tingewick Road Industrial Estate
- A largely culverted watercourse follows Tingewick Road to enter the River Great Ouse at Castle Bridge
- The Badgers Brook originating near Buckingham Industrial Estate and flowing north east past Verney Park to enter the River Great Ouse on the north side of Bourton Road. The watercourse downstream of London Road is managed by the Buckingham & River Ouzel Internal Drainage Board (IDB).

[3] A number of villages around Buckingham have been considered in this SWMP due to their history of flooding, but these are not within the study area.
[4] Land assessed as having a 1 in 100 (1%) or greater annual probability of river flooding or 1 in 200 (0.5%) or greater annual probability of sea flooding in any one year

- A watercourse originating near Lime Avenue and flowing north to the River Great Ouse opposite Bourton Meadow School

## 1.3 Local Flood Risk Management Partnership

BCC, as the LLFA for Buckinghamshire, is the lead partner for this Buckingham SWMP. However, in order to coordinate delivery of flood risk management responsibilities across Buckingham, the following Partners are being invited to input to the SWMP:

- Aylesbury Vale District Council
- Buckingham Town Council
- Environment Agency
- Anglian Water
- Buckingham & River Ouzel IDB
- Elected Members
- Local volunteer groups, including Flood Action 4 Buckingham
- Buckingham Canal Society

An initial meeting to discuss local flood risk in the area was held on 24 July in Buckingham and this report has subsequently been updated. The notes of the meeting are provided in Appendix C.

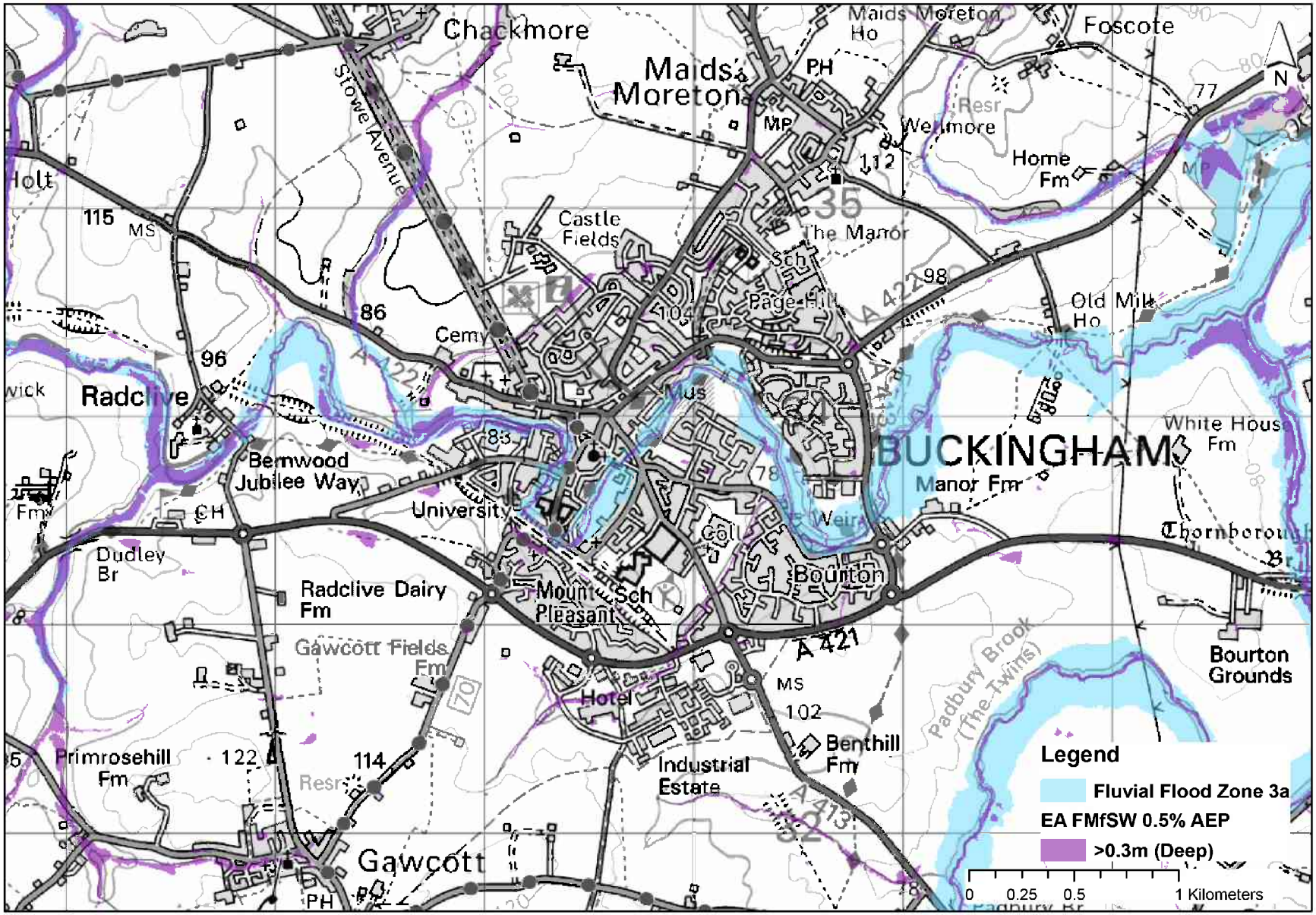



*Figure 1.1 Areas at risk from a 1% AEP fluvial (blue) and 0.5% AEP surface water (purple) flood*

# 2 Data for Local Flood Risk Management

## 2.1 Collation of Available Data

Data were collated from the SWMP Partners and the data are catalogued in this section in Tables 2.1 to 2.4.

***Table 2.1 Data provided by Buckinghamshire County Council***

| Data received | Details | Notes |
|---|---|---|
| Aylesbury Vale Strategic Flood Risk Assessment | Final Report August 2012[5] | Housing commitment sites were listed in the SFRA |
| Buckinghamshire Preliminary Flood Risk Assessment (PFRA) | Final Report June 2011[6] | Contains records of past flooding from various sources |
| Geological Information | 1:625 000 scale solid and drift layers | |

***Table 2.2 Data provided by the Environment Agency***

| Data received | Details | Notes |
|---|---|---|
| Great Ouse Catchment Flood Management Plan | January 2011[7] | |
| Detailed River Network | Guidance 2010 | |
| Fluvial Flood Zones | National Flood Zones 2 and 3a February 2013 | |
| Flood Map for Surface Water (FMfSW) | November 2010[8] | The PFRA identified the FMfSW as the best available information to represent surface water flooding in Buckingham (Locally Agreed Surface Water Information) |
| Topographic data | 1m LiDAR data | Complete coverage of the Buckingham SWMP study area is available |

***Table 2.3 Data provided by Anglian Water***

| Data received | Details |
|---|---|
| Sewer Network Plan | GIS data supplied March 2013 |
| DG5 sewer flooding locations | GIS data supplied August 2013 |

***Table 2.4 Data provided by the Buckingham & River Ouzel IDB***

| Data received | Details |
|---|---|
| IDB Area and managed watercourses | GIS data (supplied for the PFRA February 2011) |

[5] Aylesbury Vale District Council (2012) Strategic Flood Risk Assessment: Level 1. August 2012.
[6] Jacobs (2011) Buckinghamshire Preliminary Flood Risk Assessment. May 2011
[7] Environment Agency (2010) Great Ouse Catchment Flood Management Plan. Summary Report. January 2011
[8] 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

In addition to the above, the following data have been used:

- Jacobs Groundwater Emergence Maps (taken from Jacobs (2004) Groundwater Flooding Scoping Study (LDS23). Final Report to Defra. May 2004.)
- Local news website report of flooding on the A421 in Buckingham on 24 February 2013 available at: *http://www.buckinghamtoday.co.uk/news/local/doubts-about-drainage-on-a413-development-after-torrent-floods-road-1-4816628*
- EA report on 2007 floods in Buckingham available at: http://www.environment-agency.gov.uk/research/library/publications/40601.aspx
- http://www.buckingham-tc.gov.uk/environment/20120111111608_ea_flood_letter.pdf

## 2.2 Note on Topographic Data

As illustrated in Figure 2.1, the EA has 1m LiDAR data covering the entire SWMP study area of Buckingham. This data was used to produce the natural flow paths in this SWMP. There is no higher resolution data for the area available from the EA.

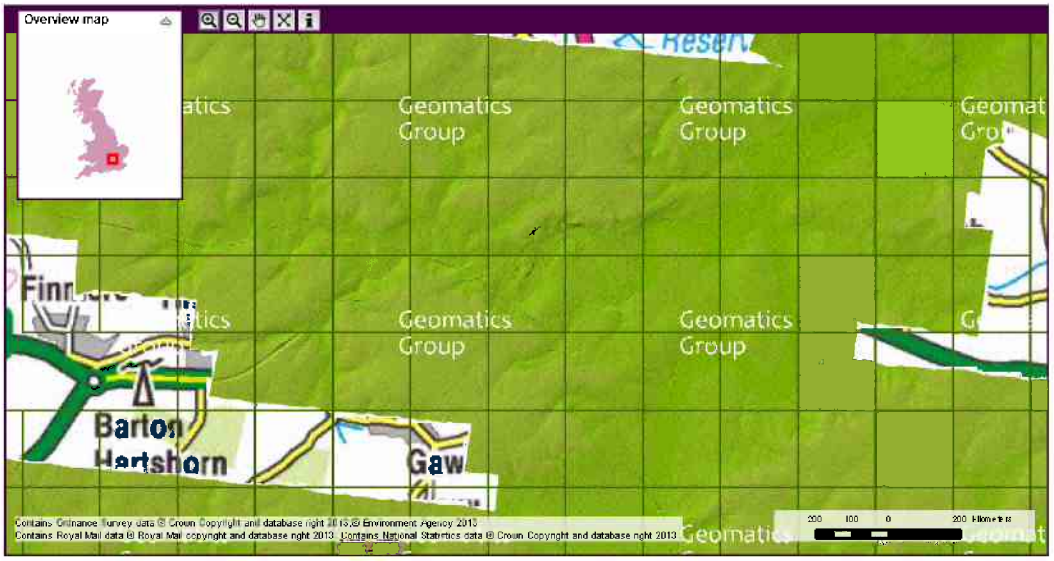



***Figure 2.1 EA 1m LiDAR data coverage in the Buckingham area***

Note: Entire Buckingham study area is covered by EA LIDAR in this figure.

## 2.3 Note on the Updated Flood Map for Surface Water

The EA is currently finalising the Updated Flood Map for Surface Water, which is anticipated to be available in summer 2013. This updated mapping will provide depth, velocity and hazard information for the 3.33% (1 in 30) AEP, 1% (1 in 100) AEP and 0.1% (1 in 1000) AEP rainfall events. A visual inspection of the draft mapping for Buckingham suggests that the 3.33% updated mapping will be largely unchanged from the 2010 FMfSW. Similarly, the updated 1% mapping is similar to the existing 0.5% FMfSW. The updated 0.1% mapping shows strong flowpaths and deep ponding at features already identified in the 2010 FMfSW. In addition to combined flooding from surface water and the River Great Ouse, particularly strong features are evident in the Moreton Road and Buckingham Industrial Estate/Badgers Brook ordinary watercourse areas.

# 3 Buckingham Catchment Characteristics

## 3.1 Introduction

Buckingham is in Aylesbury Vale District which lies in north Buckinghamshire. Buckingham, and the northern part of the Vale, is in the River Great Ouse catchment. Although compared with the topography in the other Districts, Aylesbury Vale is relatively flat, there is some steep land around Buckingham. The majority of the Buckingham area is underlain by the sandstone and limestones of the Great Oolite Group, with the southern portion underlain by sandstone, mudstone and siltstones. A superficial deposit of glacial till lies near the surface. A large underground reserve of water makes the water table higher than average in the Vale of Aylesbury. Whilst the Grand Union Canal still flows through the eastern side of the District (and includes the Aylesbury and Wendover Arms), the Buckingham Arm is now disused. Typically across the District, flooding from the Main Rivers and ordinary watercourses is thought to pose a greater risk of flooding than from surface water or groundwater, although these have been recorded. A number of the ordinary watercourses in the District are managed by the Buckingham & River Ouzel IDB, although in Buckingham this is limited to a 1km reach of the Badgers Brook.

The Great Ouse CFMP main report[9] states the preferred policy for Buckingham is to take further action to keep pace with climate change. The following is a summary of this policy unit which is focussed on fluvial flooding:

- Approximately 300 properties in Buckingham are at risk of a 1% AEP flood from the River Great Ouse, rising to over 400 with climate change.
- There is an acknowledged risk of surface water flooding in Buckingham and a recommendation to undertake a SWMP to understand the risk of local flooding better.
- Urban environments could be made more resilient to flooding, including improvements in flood warning and developing emergency response plans

## 3.2 Local Flooding in and Around Buckingham

Buckingham was not identified as a priority risk area in Buckinghamshire based on the numbers of properties at risk according to the 2010 national Flood Map for Surface Water. However, it has been found in other areas, where sewers, geology and groundwater may play important roles in local drainage, that the FMfSW does not always give a complete picture of the local flood risk. Indeed, Buckingham is underlain by limestone which can lead to high groundwater levels and runoff caused by intense rainfall on saturated ground. Buckingham has suffered a number of flood incidents, including:

- Around 96 homes were flooded in July 2007 from a combination of local sources and flooding from the River Great Ouse.
- Around 75 properties were flooded in April 1998, most likely from a combination of small watercourses and from the River Great Ouse.
- The highest number of sewer flooding incidents reported by Anglian Water in Aylesbury Vale District (as recorded in the PFRA).

[9] Environment Agency (2011) Great Ouse Catchment Flood Management Plan (CFMP) Summary Report. January 2011

A previous successful Defra grant has led to property-level protection for around 87 properties in 2010, most of which were at risk of fluvial flooding.

Table 3.1 summarises the available information on local and fluvial flooding in Buckingham, in chronological order of the flood events since 1947. Further detail is provided in the relevant sections of Chapter 4, alongside observations from site inspections.

The following villages were highlighted in the SWMP Meeting held on 24 July 2013 as having experienced flooding in recent years:

- **Preston Bissett:** No records of past flooding were reported in the PFRA or were readily available from a web search. The flood risk appears to be primarily from ordinary watercourses crossing Main Street to the north and south of the village centre (see Figure 3.1).

- **Gawcott:** Two records of past flooding were reported in the PFRA, relating to flooding in January 2002 from surface water and the ordinary watercourse which begins at the western end of Main Street. The FMfSW highlights the risk along Main Street (see Figure 3.1). The Buckinghamshire Fire & Rescue Service was called to rising floodwaters in Preston Road and Main Street in January 2008[10].

- **Tingewick:** Two records of past flooding were reported in the PFRA, both relating to flooding in Main Street. Surface water flooding in July 2007 reportedly flooded 11 properties internally. The FMfSW (see Figure 3.1) shows some risk through the village and follows the line of the ordinary watercourse which runs along Main Street and is almost entirely within culvert.

- **Thornborough:** Three records of past flooding were reported in the PFRA, relating to flooding in July 2000 and July 2007, from surface water and ordinary watercourses. Ten properties and a college are reported to have been flooded, as well as some roads. The FMfSW shows risk areas following the course of two ordinary watercourses which converge near the High Street. It is also noted that these risk areas appear to lie within the Flood Zone 3 outline from the River Great Ouse.

[10] http://www.bucksfire.gov.uk/BucksFire/News/2008/Flooding15January2008.htm

*Table 3.1 History of local flooding in Buckingham*

| Date | Location | Notes | Type of flooding | Information source |
|---|---|---|---|---|
| March 1947 | Buckingham Town Centre, River Great Ouse | | Fluvial | http://www.buckingham-tc.gov.uk/environment/20120111111608_ea_flood_letter.pdf |
| December 1979 | Town Centre | | Unknown | • http://www.buckingham-tc.gov.uk/environment/20120111111608_ea_flood_letter.pdf<br>• SFRA |
| 1980s/90s | Town Centre | | Unknown | SFRA |
| April 1998 | Suspected multiple locations including area around Bridge Street mentioned in FRA. | 75 properties flooded<br><br>"followed a month of approximately three times the average rainfall. 25 residential and 5 commercial properties were affected in Buckingham" | Fluvial and surface water | • http://www.buckingham-tc.gov.uk/environment/20120111111608_ea_flood_letter.pdf<br>• Buckinghamshire County Council Local Flood Risk Management Strategy (Draft for Consultation 2012)<br>• http://www.transportforbucks.net/Uploads/121002_Final_Part_2.pdf |
| 1999 | Chandos Park, Buck Tennis Club, Football Club | | Likely fluvial | SFRA |
| Jan 2003 | Town Centre | | Likely fluvial | SFRA |
| July 2007 | Chandos Road, Cecils Yard, Fishers Field, Nelson Street, March Edge, Norton's Place, Pateman Close, Stratford Road, Victoria Row, Well Street, Wharfside Place, University of Buckingham, Tingewick Road Industrial Estate | 96 properties flooded<br>River level at 1.99m (normal range 0.06-0.46) | Likely to be fluvial and surface water | • http://www.buckingham-tc.gov.uk/environment/20120111111608_ea_flood_letter.pdf<br>• http://www.environment-agency.gov.uk/research/library/publications/40601.aspx<br>• http://www.environment-agency.gov.uk/homeandleisure/floods/riverlevels/120732.aspx?stationId=6183<br>• SFRA |

| Date | Location | Notes | Type of flooding | Information source |
|---|---|---|---|---|
| November 2012 | Chandos Park, Cornwalls Meadow car park | River level at 1.75m on 25 November 2012 (normal range 0.13-0.53) | Likely fluvial | • http://www.aylesburyvaledc.gov.uk/news/2012/nov/flooding-update-buckingham/ |
| February 2013 | A421 town bypass road, close to the junction with the A413 | Linked by the media to a new development on a site (Lace Hill) on London Road (A413), to the south of Buckingham | Surface water | • http://www.buckinghamtoday.co.uk/news/local/doubts-about-drainage-on-a413-development-after-torrent-floods-road-1-4816628<br>• http://www.bovishomes.co.uk/new-homes-at-buckingham/london-road/<br>• http://www.dwh.co.uk/new-homes/buckinghamshire/H520601-Windsor-Park/#<br>• http://www.barratthomes.co.uk/new-homes/buckinghamshire/H521201-Windsor-Park/<br>• http://www.bellway.co.uk/new-homes/northern-home-counties/windsor-park |

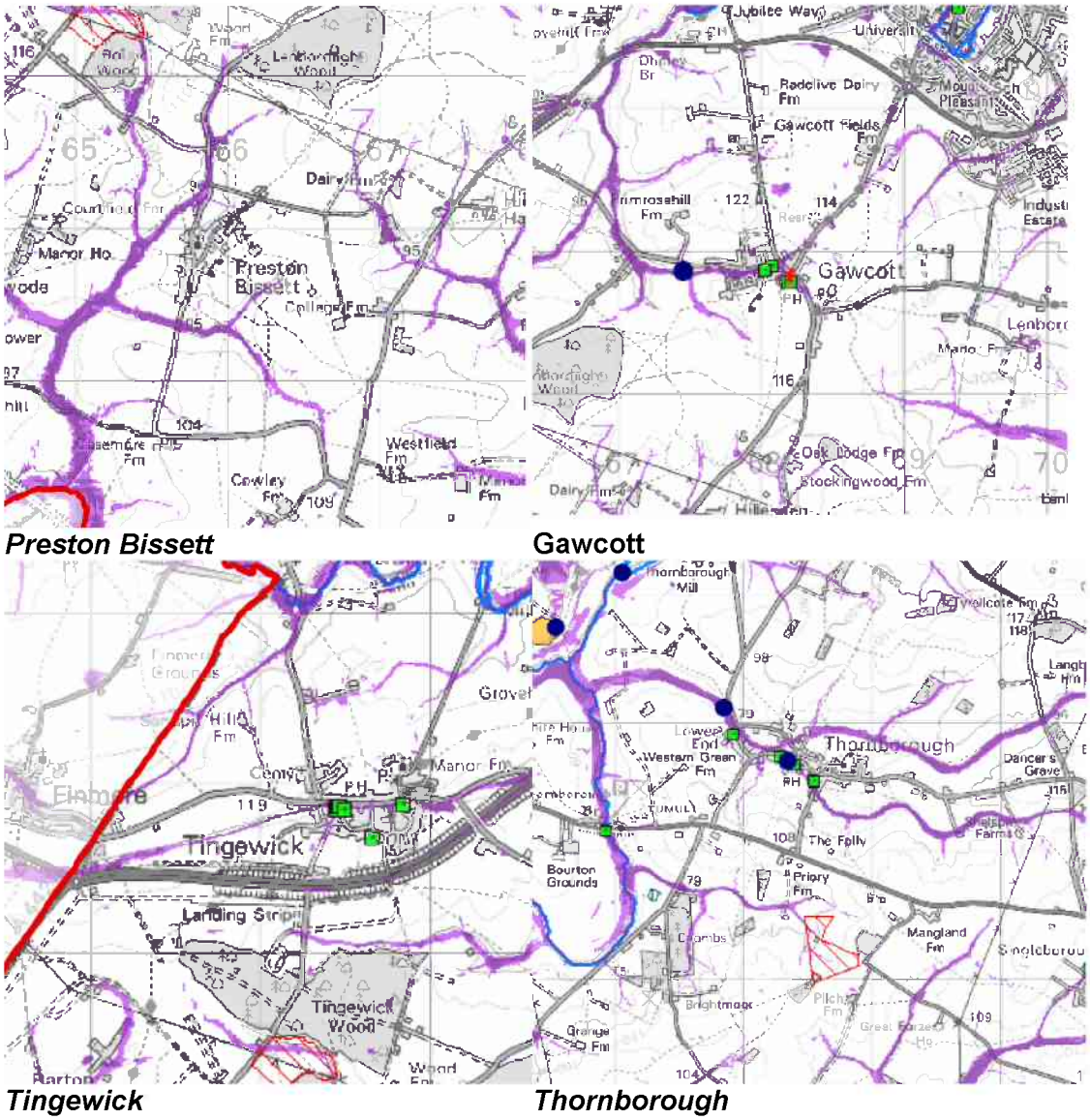



*Figure 3.1 Extracts from the Buckinghamshire Preliminary Flood Risk Assessment maps showing the Flood Map for Surface Water in villages around Buckingham*

## 3.3 Climate Change

Already, we are experiencing trends in our weather patterns which are consistent with changes predicted by global climate models. These broadly state that, for the UK, we will experience warmer and wetter winters, hotter and drier summers, sea level rise and more severe weather. For example, the temperature in central England has risen by about 1°C since the 1970s, all regions of the UK have experienced an increase in the amount of winter rain that falls in heavy downpours and sea levels around the UK have risen by about 1mm a year over the 20th century[11]. Seasonal rainfall is variable and some of the changes might reflect natural variation. However, past emissions of greenhouse gasses mean some climate change is inevitable in the next 20-30 years, although action now could reduce the amount of change we experience. If emissions follow a medium

[11] Defra (2009) Adapting to climate change. UK Climate Projections. June 2009

future scenario, UKCP09 projected changes for the broad area around Buckingham by the 2050s relative to the recent past are:

- Winter precipitation increases of around 14%
- Precipitation on the wettest day in winter up by around 14%
- Peak river flows in a typical catchment likely to increase between 8 and 16%

Wetter winters and more of this rain falling in wet spells may increase river flooding. More intense rainfall causes more surface runoff, increasing localised flooding and erosion. In turn, this may increase pressure on drains, sewers and water quality. Storm intensity in summer could increase even in drier summers. Rising river levels may also increase local flood risk away from the River Great Ouse because of interactions with drains, sewers and smaller watercourses.

## 3.4 Housing Commitments in Buckingham

The SFRA highlights the following housing commitments agreed by the council in March 2012 (shown on the extracted plan in Figure 3.2):

- **Bridge Street:** 103 properties along with underground parking area designed to accommodate high flows from the River Great Ouse. Development appeared to be complete at the time of the site inspection (5 March 2013) although there are unresolved issues connected with flooding of the parking area.
- **London Road (Lace Hill):** 700 dwellings along with community infrastructure in a green field site to the south of the A421 and east of the A413. Development was underway at the time of the site inspection. Although temporary drainage arrangements were in place during a heavy rainfall event in February 2013, they appear not to have been sufficient to prevent flooding of the A421 to the north. However, it is understood from AVDC that the proposed detention basin to manage surface runoff from the site is now in place.
- **Market Hill:** Plans for 61 residential and commercial properties. This development is outside mapped areas of fluvial and surface water flood risk and was therefore not considered in this SWMP.
- **Moreton Road:** Largely residential development of approximately 200 homes, the majority of which had been completed at the time of the site inspection.
- **Tingewick Road Industrial Estate:** This area has planning permission for mixed use development (housing and employment). No development had commenced at the time of the site inspection.

## 3.5 Anglian Water Sewer Network

Anglian Water is responsible for the management of the sewer network within Buckingham. A visual inspection of the Anglian Water sewer network plans suggests that the older town centre is largely served by combined sewers, whereas the outer newer areas are largely separately sewered. A number of surface water sewers are shown to discharge into the River Great Ouse. The foul sewers discharge into the combined sewers at various locations. The combined sewer serving the Buckingham area discharges via a 400mm pipe passing near Bourton Meadow School and across the River Great Ouse to the waste water treatment works.

Anglian Water supplied the DG5 register of properties which have experienced sewer flooding due to hydraulic overload. As of August 2013, sewer flooding had

been recorded by Anglian Water in Nelson Street (2 incidents), Market Hill, near Stratford Road and in the new development adjacent to Moreton Road.

The Buckingham Canal Society (BCS) is currently investigating the feasibility of a scheme to intercept surface water from the sewer networks serving the Page Hill and Linden Village areas and route some into new ponds built on meadow land adjacent to the A422/ Page Hill roundabout. This impounded water would be made available for release into the newly restored Buckingham Canal, to maintain its depth to the level required. If feasible, the BCS suggest that the scheme could provide a sustainable water supply for the Buckingham Canal. This would enable the restoration to advance to a watered canal state more quickly and lead to a reduction in runoff volume entering the River Ouse during prolonged rainfall or storm events and hence reduce the potential for occurrence of urban flooding during these times.

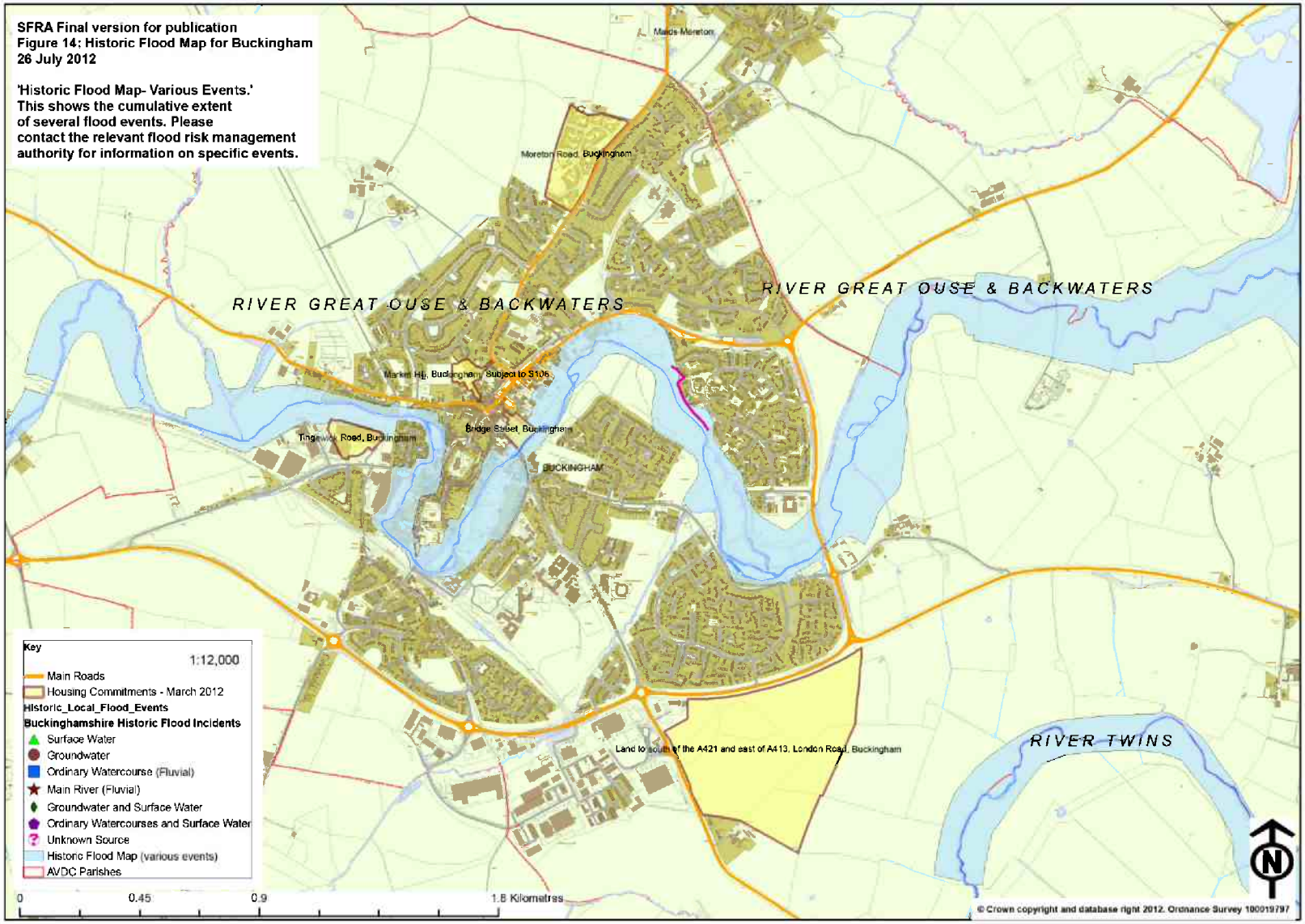



***Figure 3.2 Housing commitments and historic flood map for Buckingham (taken from the AVDC Level 1 SFRA, July 2012)***

Note: No past incidents of flooding were formally recorded in the database used to generate the above map. The database will be updated as a result of Table 3.1 in this SWMP

## 3.6 Sustainable Drainage

Sustainable Drainage Systems (SuDS) are designed to control surface water run off close to where it falls and mimic natural drainage as closely as possible. The BCC Local Flood Risk Management Strategy[12] promotes the use of SuDS to reduce the rate and volume of surface water runoff. Where practical, the design of SuDS will be encouraged to provide some natural removal of pollutants and sediments, promote aquifer recharge, enhance biodiversity and add aesthetic value to local communities.

The AVDC SFRA states that while a single incident of Main River flooding has the potential to cause disruption to a large number of properties, heavy rainfall results more regularly in large numbers of individual local floods. Therefore, surface water run-off management in Aylesbury Vale District, including Buckingham, is an important issue for developments of any size, clearly highlighting the need for SuDS and maximising the use of source control measures.

The suitability of different SuDS techniques has to be assessed for each individual site, based on available space, soil type, geology, groundwater levels etc. When the anticipated SuDS Approval Body (SAB) role commences in Buckinghamshire, the SAB will have responsibility to approve drainage plans for new development and adopt and maintain SuDS.

## 3.7 Flood Warning

The EA Floodline Warnings Direct service is available to properties within the areas highlighted in Figure 3.2. These warnings are based on rising levels in the River Great Ouse which could lead to fluvial flooding. However, given that groundwater levels can rise within the floodplain gravels to cause flooding of basements and low lying areas prior to any fluvial flooding, these warnings may be relevant for local flooding. Outside the zone shown in Figure 3.2, no warning service for flooding of any source is available to the public.

The Met Office and the EA jointly operate a Flood Forecasting Centre which provides Flood Guidance Statements to emergency responders, including BCC. The Flood Guidance Statements report the risk of all types of flooding – coastal, tidal, river, groundwater and surface water flooding. The likelihood of a flood is described as very low (<20%), low (20-40%), medium (40-60%) and high (60% or greater). These four likelihood levels map onto a flood risk matrix which considers recent weather conditions, rainfall forecasts, knowledge of catchment conditions within counties, detailed flood forecast models for the coast and flood flows for rivers are evaluated, seasonal factors and the combined effect of river flow and high tides. In light of this, flood risk levels are produced of very low, low, medium and high.

[12] http://www.transportforbucks.net/Flooding/Flood-Risk-Strategy.aspx

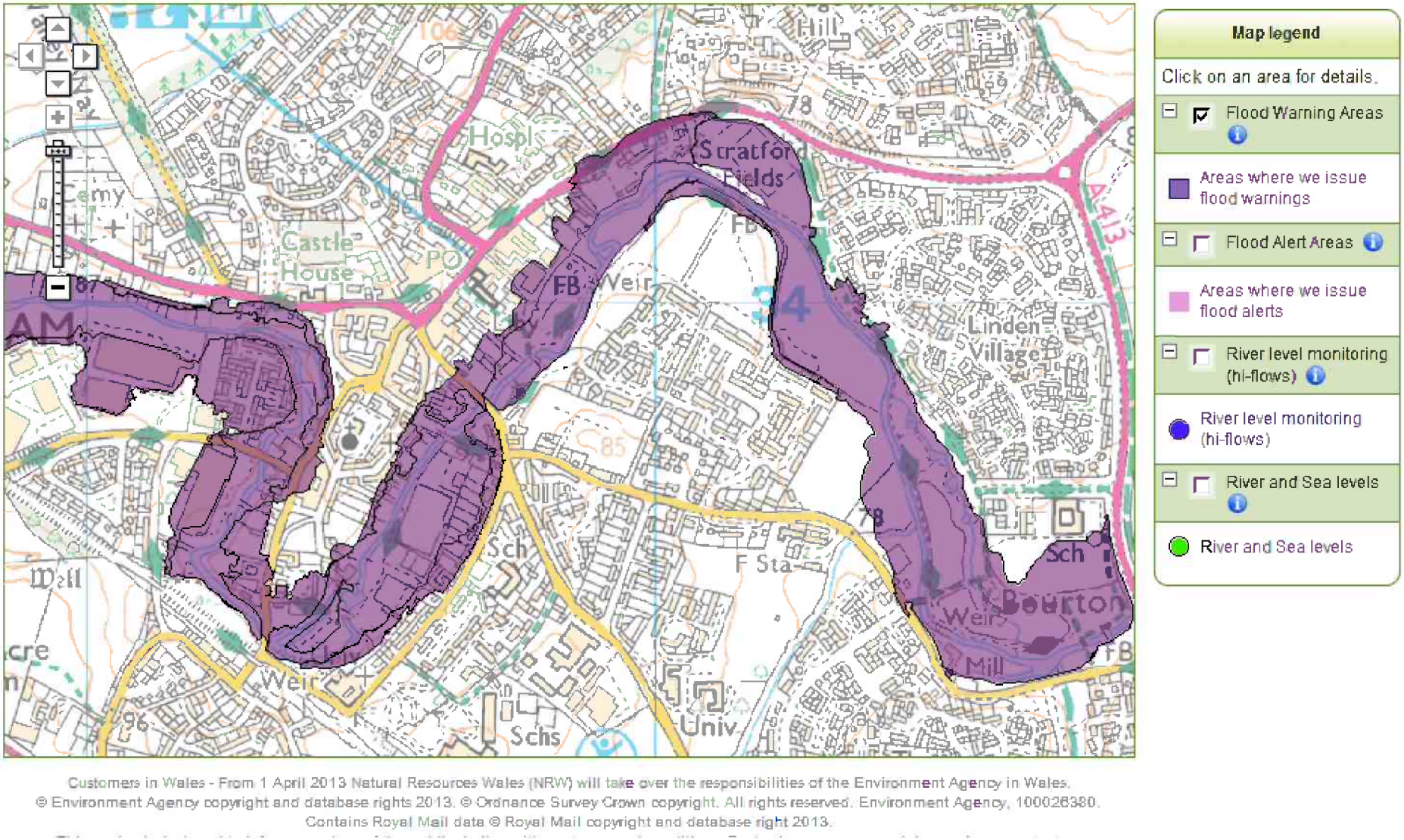



*Figure 3.2 Areas of Buckingham covered by the EA fluvial flood warning service*

# 4 Observations from Site Inspections

## 4.1 Introduction

A site walkover of Buckingham was conducted on 5 March 2013. The locations visited were selected from a desk-based review of the composite maps shown in Appendix A, as well as consideration of other evidence of past flooding. The inspections enabled an initial broad assessment to be made of areas that may be susceptible to local flooding. They also provided valuable verification of mapping and an initial idea of some of the measures that might be possible to reduce the risk of surface water flooding.

The preliminary risk assessment for each location visited is based on a simple scoring system to rate the perceived overall level of local flood risk at that location. The scoring assesses a number of characteristics including water depth and velocity, type of land use and number of properties at risk including critical infrastructure, rate of inundation and doorway threshold levels. An initial assessment is also made of potential risk to life. The Risk Assessment Matrix which has been applied is shown in Figure 4.1.

The results of the preliminary risk assessment are reported in the next sections. (Further detail is provided in the spreadsheet in Appendix B.) These also present a summary of the known occurrences and mechanisms of flooding across the area. Evidence has been collated from the various sources listed in Section 2. The evidence has been collated to identify the locations in the area with the *highest* risk of *local* flooding. Locations which are known to be *primarily* at risk of flooding from the River Great Ouse are not included unless there are likely to be interactions between flood sources (see Section 1.2).

## 4.2 Buckingham Town Centre

Along Buckingham High Street there are a number of listed buildings (used for commercial and residential purposes) with low thresholds which could potentially be at risk of surface water flooding. There are also some properties on Stratford Road, close to the town centre, which are at risk from local flooding as they are located in a shallow depression close to the River Great Ouse. Other properties on the north side of Stratford Road were observed to have temporary flood protection measures.

Well Street was another notable area close to the River Great Ouse with some low threshold properties and the potential for surface water flooding from runoff down, for example, Elm Street which has a moderately steep gradient. Local drainage engineers are aware of historic fluvial flooding in this area.

A depression at the southern end of Nelson Street, which becomes Hunter Street, was surrounded by a number of properties (residential and retail) with very low thresholds. If surface water were to flow down Nelson Street and Hunter Street, it would likely pond here and would then pose a significant hazard to the surrounding properties. Some properties have already benefitted from property level protection measures provided by AVDC. The area is also at risk of fluvial flooding from the River Great Ouse and several incidents of flooding have been recorded here. This area is known to local drainage engineers for its vulnerability to flooding, primarily for fluvial flooding, but also for surface water flooding in times of high river levels in the River Great Ouse which prevent water from draining away.

| Attribute | Hazard Level | Very Low | Low | Moderate | High | Very High |
|---|---|---|---|---|---|---|
| Sensitivity of Land Use | Description | Open areas that can be flooded without significant consequence. | Parkland, open ground or farmland where flooding would have some consequence. | Suburban residential / commercial / retail / industrial areas where flooding would have moderate consequence. | Central urban or town centre residential / commercial / retail / industrial areas where flooding would have high consequence. | Critical infrastructure present. Critical transportation links present. Basement flats present. |
| | Score | 0 | 1 | 2 | 3 | 4 |
| Depth of Flooding | Description | <0.2m | 0.2m to 0.5m | 0.5m to 1m | 1m to 2m | >2m |
| | Score | 0 | 1 | 2 | 3 | 4 |
| Extent of Flooded Area and Properties at Risk | Description | Localised <0.1ha<br>No properties potentially at risk | Localised <0.1ha<br>1 property potentially at risk | Moderate (up to 1ha)<br>Up to 10 properties potentially at risk | Extensive (up to 10ha)<br>Up to 100 properties potentially at risk | Widespread (>10ha)<br>More than 100 properties potentially at risk. |
| | Score | 0 | 0 | 1 | 2 | 3 |
| Flowpath feeds topographic depression ? | Description | No or Flowpath only. | Yes. Depth <0.5m | Yes. Depth 0.5-1m | Yes. Depth 1-2m | Yes. Depth >2m |
| | Score | 0 | 0 | 1 | 2 | 3 |
| Velocity of Flow | Description | Still Water (generally flat terrain). Any depth. | Velocity up to 0.5m/s (generally gently sloping terrain) and Depth less than 0.5m. | Velocity 0.5 -1m/s (generally moderately sloping terrain) and Depth less than 0.5m. | Velocity more than 1m/s (generally steeply sloping terrain) and Depth less than 0.5m. | Velocity more than 1m/s (generally steeply sloping terrain) and Depth more than 0.5m. |
| | Score | 0 | 1 | 2 | 3 | 4 |
| Doorway Threshold Levels | Description | Most above 0.2m above ground level | Most above 0.2m but some 0m to 0.2m above ground level | Most 0m to 0.2m above ground level | Most at ground level. Some below ground level. | Most below ground level |
| | Score | 0 | 1 | 2 | 3 | 4 |
| Total Score | | 0 to 2 | 3 to 4 | 5 to 7 | 8 to 10 | >10 |
| Overall Preliminary Risk Rating | | Not Significant | Low | Moderate | High | Severe |

*Figure 4.1 Preliminary hazard assessment matrix used in the site inspections*

The majority of the centre of Buckingham has a combined sewer system with pipes of a maximum diameter of 375 mm. There is one surface water drain, with a maximum pipe size of 525mm, originating north of the A422 (Stratford Road) on Mary McManus Drive which crosses Stratford Road before discharging into the River Great Ouse. Nelson Street and Hunter Street are served by a combined sewer. The maximum pipe size on these roads is 225mm, but this discharges into a 300mm pipe close to the River Great Ouse.

Locations throughout the town centre area were assigned preliminary hazard ratings of either moderate or high, largely as a result of low thresholds and the sensitivity of the properties. The town centre is densely populated and has little open space in locations which might be suitable for temporary storage of surface runoff. In a number of locations (e.g. Hunter Street and Stratford Road), shallow gradients between the properties at risk and the River Great Ouse mean that backing up of drainage is a risk during high river levels and therefore additional drainage may not be effective. Further resilience in the town centre is therefore most likely through property level protection measures where appropriate.

***High Street shops with low thresholds***

***Houses in a depression on Stratford Road, with thresholds below road level***

***Example low threshold house on Well Street opposite Elm Street***

***Depression near the junction of Nelson and Hunter Streets, with low thresholds***

***Figure 4.2 Photographs of key features in Buckingham Town Centre***

## 4.3 Moreton Road Area

There is a natural flowpath along Moreton Road as the land slopes downwards towards the River Great Ouse from the relatively large Maids Moreton catchment. There is a relatively new development on the west side of Moreton Road which forms part of AVDC's housing commitment. The majority of properties in this development have very low thresholds and there are no kerbs in some areas. As the natural flowpaths pass through this area, there is potential for surface runoff to

cause flooding. Surface runoff from Moreton Road itself is channelled down a ditch running alongside Moreton Road which is at a higher level than the properties in the adjacent new development. Therefore, if this ditch were to overflow, adjacent properties could be at risk. The FRA considered this ditch to pose a very low flood risk to the development. Nonetheless, there is a depression on Bradfield Avenue (off Moreton Road) in which surface water could collect in large rainfall events if the capacity of the ditch running along Moreton Road, or the culverted watercourse from Lincoln (off Whitehead Way), was exceeded. This could cause a flood risk to some adjacent properties.

The area is separately sewered, with the surface water drains discharging into the watercourse, which runs down from Moreton Road and Bradfield Avenue, at the bottom of Beech Close. The maximum pipe diameter of the surface water drain is 675mm. The FRA states the ground is unsuitable for infiltration and, accordingly, a SuDS pond was being constructed at the time of the site visit, although it was not clear how this was to receive and discharge surface water flows.

The FRA found no evidence of past flooding on the site. The local flood action group were aware of a flooding incident in this area which had affected the road and garden but not entered any properties. A local council officer from AVDC was able to confirm that this was due to a ditch between Bradfield Avenue and Lincoln (off Whitehead Way) not being maintained since the new development had been built. The ditch is the joint responsibility of the property owners who back onto the ditch. Ongoing maintenance of the ditch and culverted watercourses is, therefore, of primary importance to minimising the risk in this area. This could be linked with raising awareness of riparian ownership responsibilities to reduce the burden on AVDC and BCC of maintenance and possible enforcement in the future. There are also a number of large open areas which could be lowered to form shallow detention basins and provide temporary storage if warranted. This area was assigned a moderate preliminary hazard rating on the basis of the site inspection.

***The drainage ditch running along Moreton Road***

***The new housing development off Moreton Road has some areas without kerbs and many houses have very low thresholds***

*Green space which could be used to provide water storage at the end of Bradfield Avenue*

*Green space which could be used to provide water storage between Ronaldsay, Moreton Road and Whitehead Way.*

***Figure 4.3 Photographs of key features in the Moreton Road area***

## 4.4 Lace Hill Development

A major new development of approximately 700 houses is underway in the south of Buckingham, in the land adjacent to the A421 and the A413[13]. The green field area under development has five natural flowpaths. It shows some risk of pluvial flooding according to the FMfSW and an incident of surface water flooding immediately adjacent to the site, on the A421, was reported in the local newspaper in February 2013[14]. At the time of the site visit, approximately 5% of the development was complete and the land to the north adjacent to the A421 was being landscaped with heavy plant machinery.

A flood risk assessment was carried out as part of the outline planning permission for Lace Hill which was granted in 2009. A detention basin was proposed in the north east of the site (Figure 4.4) to attenuate water en route to the River Great Ouse before it entered the culvert under the A421 and into the ordinary watercourse observed to run past Osprey Walk and Badgers Way. This was proposed so that the planning application complied with Planning Policy Statement 25 (PPS25) in reducing the surface water run off to green field rates. Further information about the final drainage plan for the site was not available[15], although it is noted that the updated drainage statement (22 May 2013) makes reference to surface water drainage infrastructure to the north of the site which can accommodate unattenuated flows.

The following key observations (see Figure 4.5) were made during the site inspection:

- The existing drainage ditch along the A421 on the side of the new development appeared to have two culverts under the road in the vicinity of Osprey Walk. The culvert to the east of the Osprey Walk junction was not functioning and this may

[13] The relevant planning application is available from Aylesbury Vale District Council, application reference 09/01035/AOP.

[14] http://www.buckinghamtoday.co.uk/news/local/doubts-about-drainage-on-a413-development-after-torrent-floods-road-1-4816628

[15] Although the flow routes in Figure 4.4 are broadly consistent with those shown on mapping in Appendix A, minor differences are likely to be due to the different topographic model used. Significant re-landscaping of the development area was underway during the site inspection.

have resulted in ponding water between the road and the new development. It could not be determined where the outfall of this culvert was. A second larger culvert was observed further to the east and the connection to the watercourse running adjacent to Osprey Walk was observed. (Two 300mm pipes, one 450mm pipe and one 250mm pipe with a flapped outfall were observed emerging into the ditch.) Therefore, whilst the channel on the north side of the road appeared to have good capacity, arrangements for routing flow under the A421, and particularly from the proposed detention basin, should be checked.

- The houses on Osprey Walk back onto the A421 opposite the new development. The lowest lying of these had taken measures to protect the back fence using concrete and sandbags which could indicate an on-going problem of water flowing from the road, towards the houses.

Given the ongoing nature of the new development, the sewer maps provided by Anglian Water only showed the separate sewers on the north side of the A421, serving The Badgers area. In June 2013, Anglian Water applied for planning permission for the construction of a new sewage pumping station to serve the development on Lace Hill. It is noted that the Flood Risk Assessment associated with the outline planning application suggested that there could be an option to separate out some existing combined sewers in Buckingham into separate surface water and foul drainage systems. These would then be reconfigured to provide capacity to accommodate the Lace Hill sewerage as well. It is understood that there are no current plans to pursue this separation.

At the partnership meeting, local stakeholders raised concerns about the impact of the Lace Hill development on local flood risks. One participant stated that his understanding is that the surface water from the development will be piped under the A421 and then north along the A413, outfalling into the River Great Ouse (grid ref: SP 70862 33477). His concern was that this section of the river is already under pressure in high rainfall events and that this would increase the problem.

The area centred on the A421, and the existing properties to the north of the new development, was assigned a moderate preliminary hazard rating. Assuming the detention basin functions adequately and the new properties are designed to be at low surface water flood risk, it is recommended that the drainage connection under the A421 is monitored to ensure it is adequate.

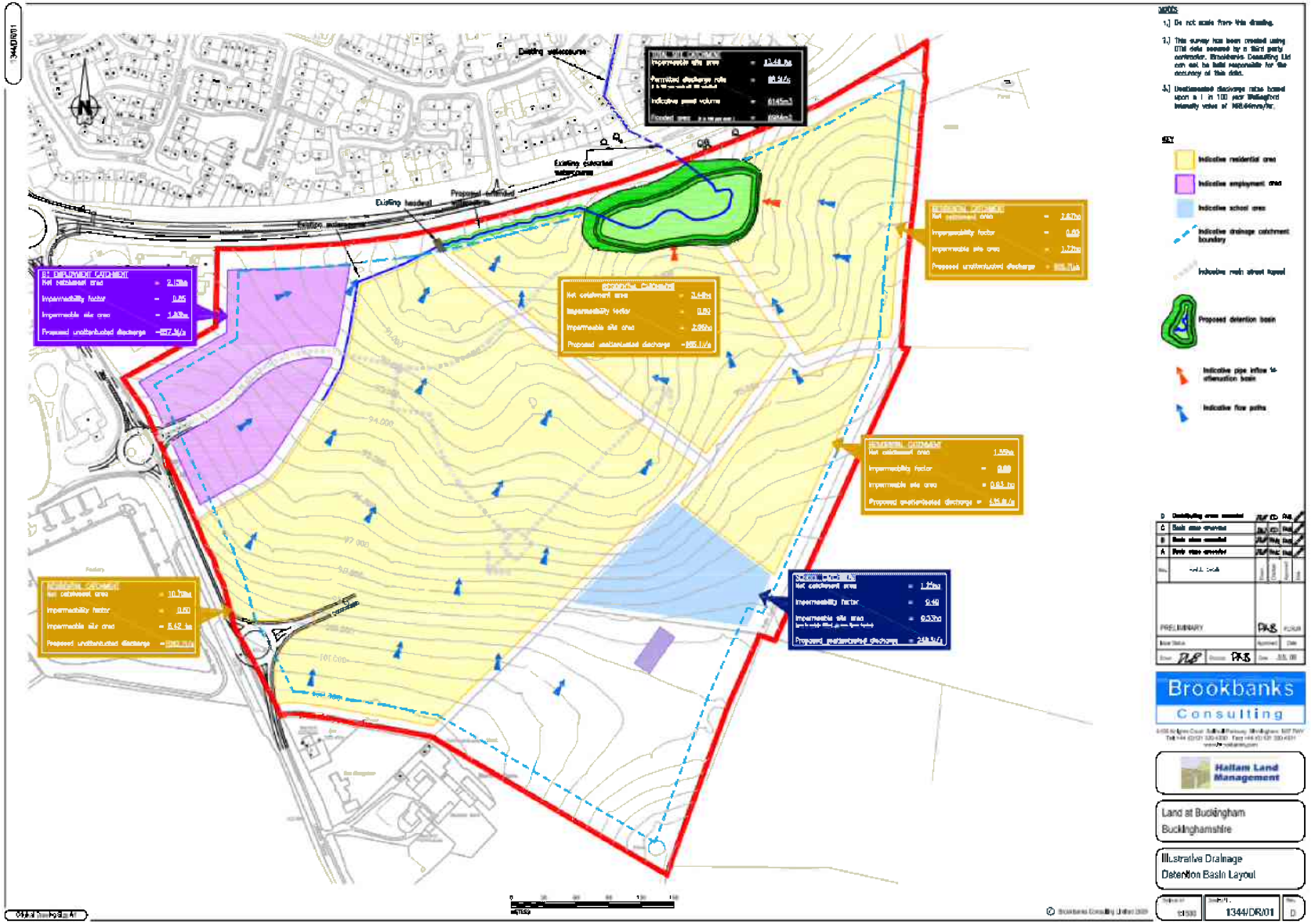
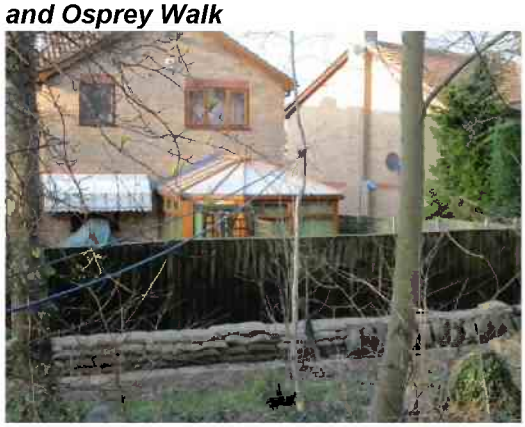



*Figure 4.4 Proposed surface water attenuation basin in the north of the Lace Hill Development*

*The A421 adjacent to new development and Osprey Walk*

*Landscaping of land prior to development at Lace Hill*



*Property level protection effort to the rear of a house on Osprey Walk*

*Roadside ditch by A421, with some evidence of water outflow towards houses on Osprey Walk in the foreground*

***Figure 4.5 Photographs of key features in the Lace Hill area***

## 4.5 Tingewick Road Industrial Estate

Tingewick Road Industrial Estate was identified as at risk of surface water flooding in the FMfSW and AVDC has identified it as a site for development. At the time of the site visit, the site had not been developed and, although the northern portion of the site slopes down towards the River Great Ouse, there is low vulnerability in its present use as industrial units. There are two natural flow paths through this area, down towards the river, which could convey runoff passing through the area from the relatively small upstream catchment areas. There were no sewers shown on the sewer network map provided by Anglian Water so runoff is assumed to be managed by highway drainage which discharges into the river. If the site were to be developed, the northern portion could be at risk from both fluvial flooding and surface water runoff from higher ground to the south and it would be important to consider appropriate protection. The Flood Risk Assessment to support the planning application focuses on fluvial flooding with no mention of a risk posed by surface water runoff. In anticipation of the redevelopment, given that it has been granted planning permission, the area was assigned a preliminary hazard rating of moderate.

*Existing land use is industrial units*

*Natural flowpath down towards the River Great Ouse*

***Figure 4.6 Photographs of key features in Tingewick Road Industrial Estate***

## 4.6 Other Locations

In addition to the observations in Section 3.2, the following is noted about other locations across Buckingham:

- **Bridge Street:** A new development of flats has recently been built on Bridge Street, close to the River Great Ouse. The development was designed to store water in an underground car park, should there be high levels in the River Great Ouse. However, groundwater accumulates in the basement at times of low river levels as well. This was evidenced by the presence of pumps which were in use at the time of the site inspections as well as verbal commentary from council officers and local residents. The area was assigned a moderate preliminary hazard rating.

- **Buckingham Industrial Estate:** the FMfSW suggests that this site could be at risk, but there is little vulnerability as the land use is light industrial. This area has separate surface water and foul drainage. The maximum surface water pipe size is 800mm and discharges to the nearby Badgers Brook. The area was assigned a low preliminary hazard rating.

- **Chandos Road:** Properties along this road are predominantly affected by fluvial flooding, but the local flood action group indicated that there is also a problem from groundwater flooding. Property level protection measures have been taken here, such as the installation of sump pumps and some basement flats have been tanked. No preliminary hazard rating was assigned to this area.

- **London Road:** According to the local flood action group, two properties are at risk from surface water runoff being channelled down Bourton Road and not being collected by the highway drains. The removal of a traffic island which used to divert the water down Ford Street has worsened the problem. No preliminary hazard rating was assigned to this area.

- **Linden Village:** In terms of surface water flooding, Linden Village was assigned a preliminary hazard rating of low during the site inspection. However, in addition to previous fluvial flooding in the area from the River Great Ouse which was connected with gaps in the embankment, properties along Burleigh Piece have experienced foul sewer flooding in their gardens and manholes on both foul and surface water networks have surcharged. According to AVDC, this could be

connected with low sewer gradients and backing up from the surface water discharge into the river, as well as gravity flows from the higher Page Hill estate.

- **Maids Moreton:** This area was assigned a low preliminary hazard rating although two listed properties on Main Street were noted to have low thresholds and could be at risk if runoff exceeds the highway drainage capacity. As shown by the FMfSW and the natural flowpaths, runoff from Towcester Road will flow on down towards Moreton Road and Buckingham town centre.

- **Radclive:** This area was visited as it was the only site within the Buckingham area to have a flood event recorded in the PFRA. The only information available suggested that flooding from the River Great Ouse may have affected roads in the village. Following a discussion with a local resident, it seems that flooding may also have affected gardens, but not any properties. The sewer map provided by Anglian Water did not have any data for this area. The area was assigned a low preliminary hazard rating.

# 5 Summary and Recommended Actions

Buckinghamshire County Council (BCC) is the Lead Local Flood Authority (LLFA) with responsibility for management of local flood risk in Buckingham. BCC has worked in partnership with Aylesbury Vale District Council (AVDC), Buckingham Town Council, the Environment Agency (EA), Buckingham & River Ouzel Internal Drainage Board (IDB), Anglian Water and others to produce this first preparation stage of a Surface Water Management Plan (SWMP) for Buckingham. The primary aim of this first stage has been to collate available information in order to understand the flood risk and other related issues in Buckingham. The wider aim of a full SWMP is to identify sustainable responses to manage surface water flooding and to prepare an Action Plan. The summary of flood history and the proposed actions were discussed at a SWMP Partnership meeting held on 24 July 2013.

The following conclusions can be drawn from the desk-based review of available information and the subsequent site visits:

- In addition to the history of fluvial flooding from the River Great Ouse (which continues to be managed by the EA), there have been some recorded incidents of flooding in Buckingham caused by local sources, predominantly surface water runoff caused by intense rainfall. However, the record of past flooding is dominated by fluvial flooding. Nonetheless, the risk of flooding from both sources occurring simultaneously should be carefully considered, particularly in future development.

- Site inspections based on available mapping suggest that there is generally a low to moderate hazard of local flooding across Buckingham, with the High Street being high hazard on the basis of the number of properties with thresholds near street level and its location between slopes which could generate runoff and the River Great Ouse.

- There are two key ordinary watercourses in the town. One drains Maids Moreton down to its confluence with the River Great Ouse opposite Tingewick Road Industrial Estate. The other drains from the Buckingham Industrial Estate and becomes the Badger Brook, under the management of the IDB.

- The typically undulating topography of the town supports the national Flood Map for Surface Water identification of isolated areas of risk in local low spots and depressions.

- Although few basements were observed in the study area, numerous properties – many which are listed - had low thresholds. Low thresholds were observed on old and new properties alike, as well as characteristically on retail and industrial properties. Although a number of properties have already had resistance or resilience measures fitted, further deployment of measures may be warranted. Furthermore, any future development should take account of natural flow paths for surface runoff and design property thresholds and access accordingly.

- The older parts of the town served by combined sewers, as well as foul sewers serving the newer areas, are pumped to the Waste Water Treatment Works via via a 400mm pipe passing near Bourton Meadow School. Anglian Water has recorded incidents of sewer flooding in the past and, anecdotally, the combined

system is understood to have limited capacity. Opportunities to separate the foul and surface water sewers should be sought.

Given (i) the limited history of local flooding (i.e. excluding flooding associated with fluvial events on the River Great Ouse), (ii) the limited predicted future risk and (iii) the dispersed and localised nature of local flood risk in Buckingham, further detailed assessment in this SWMP is not considered to be justified. Specifically, any more detailed modelling is not likely to offer substantial improvements over the forthcoming updated Flood Map for Surface Water. Instead, based on a review of the available information, site inspection and consultation with SWMP Partners, Table 5.1 lists the recommended actions to improve local flood risk management in Buckingham. The recommendations include actions relating to policy (e.g. planning and development control) as well as those which are more site specific (e.g. maintenance of drainage infrastructure). The table provides the following information:

- **What:** The description of the action.
- **How:** The suggested approach to implementing the action.
- **Who:** The partner organisation(s) best placed to lead implementation.
- **When:** An indication of the timescales within which the action is suggested to be implemented:
  - Priority 1: A 'quick win' or action urgently required within 12 months
  - Priority 2: Consider now for implementation in the next 1-5 years

  This priority therefore balances the degree of flood risk with the likely required timescale for implementation.

*Table 5.1 Proposed actions for improved management of local flooding*

| Action ('What?') | Priority Actions ('How?) | Primary Action Owners ('Who?')[1] | Priority ('When?')[2] |
|---|---|---|---|
| ***Regular maintenance of key highway drainage ditches and culverts***<br>BCC Highways should prioritise regular maintenance of key drainage infrastructure, including the ditch running alongside Moreton Road and culverts under the A421 between the Lace Hill development and Osprey Walk. | • Based on asset records, develop a prioritised maintenance plan for drainage infrastructure in Buckingham, focussed on highway drainage but linking with EA, IDB and other assets as required.<br>• Request clarification from Defra regarding which funding can be used for improved maintenance activities | • BCC | 1 |
| ***Facilitate new developments taking appropriate account of surface water runoff***<br>Adopt the SWMP maps indicating natural drainage routes which future development should respect. Development should also respect local landform to ensure sufficient property thresholds. | • AVDC planning team should familiarise themselves with the mapping produced in this SWMP, including the natural surface water flowpaths. Similarly, the SuDS Approval Body should adopt the maps in due course.<br>• The updated Flood Map for Surface Water should be reviewed when issued and used in the assessment of future planning applications to determine local flood risk | • AVDC<br>• BCC | 1 |
| ***Promote EA Fluvial Flood Warning Service***<br>AVDC should consult with those eligible to receive EA flood warnings from the River Great Ouse, particularly those with temporary resistance measures fitted, to check they receive and understand the service. This could also be relevant to provide alerts of groundwater flooding through the floodplain gravels. | • Identify properties eligible for the EA Floodline Warnings Direct in Buckingham, particularly those which have had temporary flood resistance measures fitted, and consult with them to raise awareness of the service. | • AVDC<br>• EA<br>• BTC | 1 |
| ***Raise public awareness of local flooding***<br>Raise awareness of local flood risk with the public and riparian owners. Particular issues are riparian responsibilities for maintenance, potentially high velocity flows down some roads, measures which can be taken to protect individual properties and appropriate responses to available flood warnings. Link with encouraging adaptation to climate change e.g. use of rainwater harvesting. | • Publicise responsibilities of riparian ownership, available flood warnings, guidance for property resistance/resilience measures and guidance for adaptation to climate change (e.g. rainwater harvesting) via AVDC website.<br>• Identify riparian owners and establish programme of awareness raising to encourage improved maintenance | • AVDC<br>• BTC | 2 |
| ***Local authorities to support retrofitting of property level protection***<br>Property level protection has been successfully installed in a number of areas. However as local flooding is likely to be concentrated in discrete areas, further targeted action is a useful strategy. Additional locations which may benefit from property level protection measures should be identified and AVDC should work with the property owners to apply for funding. Additional measures (e.g. improved technology, groundwater pumps) may be applicable in some properties which already have some measures fitted. | • Consult with property owners of at risk properties in Well Street, Nelson Street, High Street and Stratford Road to identify any flood history and/or appetite for property level measures. Also review suitability/success of measures already fitted to properties.<br>• For those with a flood history that would consider fitting measures, lead an EA/Defra FDGiA application for funding | • AVDC | 2 |
| ***Promote SuDS to reduce surface runoff and pressure on the sewer network***<br>New developments should prioritise appropriate SuDS. Opportunities for retrofitting SuDS in other locations should be taken to relieve pressure on the sewer network and promote integrated water management and adaptation to climate change. | • AVDC and BCC to provide up to date information on different SuDS types on their websites and ensure team members are briefed accordingly. Also promote individual rainwater harvesting techniques and guidance on adapting to climate change.<br>• AW, AVDC and BCC should collaborate on opportunities for retrofitting SuDS to relieve pressure on the sewer network. | • AVDC<br>• BCC<br>• AW | 2 |
| ***Support opportunities to modify the sewer network***<br>Local authorities should work together with Anglian Water to support opportunities to separate the combined sewers into the constituent surface and foul water sewers, with surface water being diverted to the nearest possible outlet. | • If shown to be feasible, support and guide the proposal by the Buckingham Canal Society to modify the surface water sewer network serving the Page Hill area. | • AVDC<br>• AW | 2 |

Notes: [1] BCC – Buckinghamshire County Council; AVDC – Aylesbury Vale District Council; BTC - Buckingham Town Council; EA – Environment Agency; AW – Anglian Water
[2] Priority 1: A 'quick win' or action urgently required within 12 months; Priority 2: Consider now for implementation in the next 1-5 years

# Appendix A SWMP Preliminary Hazard Assessment Maps

# Appendix B Site Inspection Matrix

BUCKINGHAM SITE INSPECTIONS 5 MARCH 2013

| Site No. | Location | Depression | Flowpath | Approx Extent and Estimated Properties at Risk | Approx Actual Depth Depression | Approx slope of flowpath | Approx width of flowpath | Outlet - watercourse / drainage / downstream flowpath | Observed surface flooding incident? | GIS Mapping of Depressions and Flowpaths | | | National Mapping of Areas Susceptible to Surface Water Flooding | | Critical Infrastructure | Average Doorway Threshold Levels | Possible Mitigation Measures for later consideration including possible Quick Win Measures | Land Use | Scoring Matrix for Preliminary Assessment of Surface Water Flood Risk | | | | | | | Potential Risk to Life based on observations? | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Depression Defined? * | Flowpath Defined? * | Depression Average Depth | Susceptibility Identified? * | Susceptibility Rating | | | | | Land Use Sensitivity Score | Depth | Extent and Number of Properties at Risk | Flowpath feeds Depression? | Slope / Velocity | Dororway Thresholds | Total Score | Preliminary Pluvial Flood Risk Rating | High velocity flowpath with large contributing area? | Depression depth >1m or basement flats? |
| 1 | Tingewick Road Industrial Estate | Housing commitment is lower than the land to the south west | Water would drain away to river unless very high | Depends on size of housing commitment - currently industrial units with no thresholds | n/a | Moderate | Width of road | River Ouze | No | n/a | Yes | n/a | Yes | Shallow | No | None currently. Unknown in new development | Nothing required now, dependent on development in future | Industrial | 2 | 1 (the main risk is fluvial) | 1 | 0 | 1 | 2 | 7 | Moderate (NB main risk is fluvial and this score takes some consideration of future residential land use) | No | No |
| 2 | Main Street, Maids Moreton | No | Towcester Road is start of catchment flod to Buckingham | Localised. <5 low threshold properties | n/a | Moderate, Towcester Road | Width of road | Highway drainage | No | n/a | Eastern end flows east | n/a | Yes | Two localised areas of deep adjacent to listed building and nursing home | No (nursing home) | Generally <0.2m a few below | None required | Residential | 2 | 0 | 0 | 0 | 1 | 1 | 4 | Low | No | No |
| 3 | Lincoln, Moreton Road | No | Yes, through pond area | <10 low threshold properties | n/a | Moderate | Width of road | Pond and drains draining to? | No | n/a | Yes | n/a | Yes | Shallow | No | 0-<0.2m | Green spaces -> detention, ensuring downstream embankment is high, highway drainage, maintenance of ditch by road | Residential | 2 | 0 | 1 | 1 | 1 | 2 | 7 | Moderate | No | No |
| 4 | Bradfield Avenue, off Moreton Road | Yes | Yes, culverted watercourse and flow from Moreton Road ditch | 2 - 3 properties | 0.2-0.3m | Low | Width of road | Highway drainage, 6 gullies observed | No | n/a | Yes | n/a | Yes | Deep | Electricity substation | >0.2m | Maintenance of Moreton Road ditch (300mm culvert), detention in green space enclosed by garden wall at the junction of Bradfield Avenue and Moreton Road | Residential | 2 | 1 | 1 | 1 | 1 | 0 | 6 | Moderate | No | No |
| 5 | West End Farm, Brackley Road | No | Yes, culverted through 900mm pipe under road | Road only | n/a | Low | 1 m | Downstream | No | n/a | Yes | n/a | Yes | Deep | No | n/a | Nothing required | Industrial/road | 1 | 0 | 0 | 0 | 2 | 0 | 3 | Low | No | No |
| 6 | A421 / Windsor Park | No | Yes, culverted through 300mm pipe under road, then two 300mm, one 450mm and one 250mm pipes appear | 1 or 2 from rear, potential for more in new development | n/a | Low to Moderate | 10m on road | Stream next to Osprey Walk | Yes | n/a | Yes | n/a | Yes | Deep | No | Not visible | Improve drainage under road if required following finalisation of detention basin | Residential/road | 2 | 1 | 1 | 1 | 1 | 1 | 7 | Moderate (final assessment based on risk to A421 and existing properties to the north) | No | No |
| 7 | Stratford Road | Shallow | Yes, hillside | 5 - 10 properties | 0.3 | Low | Diffuse | to River Ouse | No | n/a | Yes | n/a | Yes | Deep | No | 0.2m | Individual property level resilience if required | Residential | 2 | 1 | 1 | 0 | 1 | 0 | 5 | Moderate | No | No |
| 8 | Buckingham Old Gaol | No | Yes, down A413, Moreton Road | 5 - 10 properties | n/a | Moderate | Width of road | Highway drainage | No | n/a | Yes | n/a | Yes | Shallow | No | 0 | Individual property level resilience if required | Retail | 3 | 0 | 1 | 0 | 1 | 3 | 8 | High | No | No |
| 9 | Well Street | No | No | <5 | n/a | Moderate | Width of road | River Ouze | No | n/a | No | n/a | No | N/a | No | 0 | Individual property level resilience if required | Residential | 3 | 0 | 1 | 0 | 1 | 2 | 7 | Moderate | No | No |
| 10 | Nelson Street | Yes | Yes, roads | 10 | <0.2 | Low | Width of road | Highway drainage | No | n/a | Yes | n/a | Yes | Shallow | No | 0 | Individual property level resilience if required and extreme rainfall warnings | Residential/retail | 3 | 0 | 1 | 0 | 1 | 2 | 7 | Moderate/high | No | No |
| 11 | Linden Village | No | No | Road only | n/a | n/a | n/a | Highway drainage | No | n/a | No | n/a | Yes | Shallow and deep | No | 0.2+ | Not needed | Residential | 2 | 1 | 0 | 0 | 0 | 0 | 3 | Low | No | No |

# Appendix C Notes from Buckingham SWMP Meeting

JACOBS

# Meeting Notes

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| | | | |
|---|---|---|---|
| **Meeting Location** | Buckingham Council Chambers | **Client** | Buckinghamshire County Council |
| **Meeting Date/Time** | 24th July 2013 9.30am | **Project** | Buckingham and Marlow SWMP |
| **Subject** | Buckingham SWMP | **Project No.** | B1279843 |
| **Participants** | Lee Stevens (BCC), David Cobby (Jacobs), Alexia Rogers-Wright (Jacobs), Ivan Crome (AVDC), Emma Chilton (AVDC), David Smith (TfB), Terry Cavender (Local Area Forum / Buckingham Canal Society), Najem Montadhar (Anglian Water), John Oldfield (IDB), Claire Jouvray (EA), Cllr Robin Stutchbury (County Cllr), Chris Wayman (Buckingham TC), Cllr Paul Hirons (Buckingham TC) **Apologies:** Cllr Warren Whyte (County Cllr), Sophie Williamson (BCC) | **Notes Prepared By** | Alexia Rogers-Wright & David Cobby |
| | | **File** | Buckingham SWMP Meeting Minutes.doc |

| **Notes** | **Action** |
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| **1. Introduction**<br>*Lee Stevens, Buckinghamshire County Council*<br>• Brief introduction to meeting and background to meeting; surface water, groundwater and other local sources of flooding.<br>• As reported in the PFRA in 2010, Buckingham had the highest reported occurrence of sewer flooding in the county.<br>• Brief outline of work undertaken to date. | |
| **2. Full brief of study to date**<br>*Dr David Cobby, Jacobs*<br>Presentation delivered with the following contributions relating to occurrences of past flooding:<br><br>**Buckingham Town Centre**: | |

- Flooding occurred in November 2012 in Chandos Park and Cornwalls Meadow (likely to be fluvial flooding).
- Flooding in 2007 at March Edge was sewer flooding and at Fishers Field was surface water flooding.
- It was suggested that 90% of the flooding in Buckinghamshire is derived from fluvial sources.
- Water is known to flow down West Street and flood the White Hart pub and the off licence – plans are already underway and TfB are addressing the camber of the road here to resolve this.
- Buckingham Ford, Ford Street, Buckingham, MK18 1AQ – manholes are lifted in the road during flooding
- Highway drains are blocked up to Buckingham Community Hospital, High Street, Buckingham, MK18 1NU and this floods the roads.
- AVDC point out that Hunter Street and Nelson Street are the first to flood in the town. This area flooded in November 2012.

**Moreton Road**:

- Moreton Road developers diverted a watercourse – BCC are investigating.
- 144 Moreton Road – garden floods – there is a surface water pipe but the location is unknown. It is likely to be damaged. TfB are in the process of addressing this issue.

**Lace Hill**:

- Osprey Walk – there were problems before the new development at Lace Hill. Development on the land enclosed by the A421 and the A413 is called “Lace Hill” not “Windsor Park”.
- On Osprey Walk, the houses either side of the house who has built up some defences also flood, but do not report the issue.
- Terry Cavender stated that there is a new outflow from the Lace Hill development that has been piped across the A421 and then alongside the A413 to the river Great Ouse. The discharge pipe has been placed (SP 70862 33477) between two bridges being the A413 road bridge over the river (SP 70843 33467) and the old farm bridge (SP 70875 33498). TC stated that these two bridges form a tight pinch point which backs up the fluvial river flow and all other surface water discharge from the town between the A413 at SP 70845 33469 and London Road at SP 69704 33823. TC suggested that the discharge should be moved further east to the floodplain at possibly SP 70883 33510 in order to reduce the impact of the surface water on the Great River Ouse between the A413 at SP 70845 33469 and London Road at SP 69704 33823.

Jacobs to replace all reference to Windsor Park development with the Lace Hill development.

**Other areas**:

- Villages surrounding Buckingham should be included in the study as they also flood, eg. Preston Bissett, Gawcott, Tingewick, Thornborough.
- Jacobs will endeavour to update the report with an indication of the scale of each flood event reported.

**Other matters**:

- Environment Agency gave a short briefing on its fluvial flooding activities: It is currently in the process of updating the Flood Map for Buckingham and would appreciate input of any data other organisations might like to contribute to improve accuracy. No indication of the anticipated scale of change could be given at this stage. The EA is in the process of producing the Flood Risk Management Plan (as required by the Flood Risk Regulations) which will be produced by December 2013.
- Buckingham Town fire station keeps photographic records of every incident that they attend. Contact: Bob Overley. Thames Valley police have a lot of data on flooding, road closures etc, but it is held as free text and not codified, it needs sorting out in order to be useful.
- Surface water flooding seems to be dependent on the direction of the weather i.e. Oxfordshire or Northamptonshire
- Some discussion about funding levels followed. It was pointed out to council members that if they want more works to be undertaken by officers they need to provide political support for their work. They need to lobby their member representative at the RFCC.

LS will provide contact details of the cabinet member for flooding (David Schofield) to Robin Stutchbury.

**3. Round table discussion**

- **Maintenance:**
    - Badger Brook – well maintained and without issues in the IDB area, but contrasts with the upstream side of London Road which is neglected. Some discussion over whose responsibility it is – Latin school is now an academy and responsibility is thought to lie with the academy.
    - Council member stated that dredging of the River Great Ouse could provide extra water storage.
    - There are groundwater tanks under the Tesco car park, London Rd, Buckingham MK18 1AB, which overtop at times of high water and affect flooding on the A421. These are understood to require maintenance which may need to be enforced by BCC/AVDC. Furthermore, BCC/AVDC should persuade Tesco to improve drainage under the road when planned road works are undertaken.
    - There is a tank near Bourton Meadow School which had not been cleared out for 10 years. It was suggested that the issue of poor funding being available for maintenance should be raised with Defra. The EA will provide a plan of maintenance of the River Great Ouse through Buckingham.

Jacobs to follow up with Defra regarding funding for maintenance

- **Consenting/enforcement:**
    - Discussion of responsibility of riparian ownership for maintenance and the fact that it should be reinforced.

- Linked to this, there was a general acknowledgement of a poor understanding of the drainage systems in Buckingham, with past knowledge having been lost. For example, there are understood to be storm tanks in the town centre which are likely to be full of silt, but little else is known.

- **Agricultural Practices:**
  - The practice of farmers digging out their ditches to reduce pressure on the highway drainage was raised. However, there are contradictory policies - farmers are encouraged by Stewardship schemes not to do works which would contribute to FRM e.g. environmental policy encourages them not to clear ditches but to reserve them as wildlife strips.

- **Planning & Development Control:**
  - A council member pointed out that many issues seem to relate to a systemic failure of the planning system to take into account drainage issues in Buckingham. Again, contradictory legislation requires properties to have disabled access, which encourages flat thresholds on properties where you can't fit a ramp, but this can then act as a flowpath for flood water into a house.

- **Sewers:**
  - Anglian Water outlined its FRM activities in the area; offered to work together.
  - Eight DG5 properties were noted in the town, and the DG5 register will be supplied to BCC/Jacobs
  - The difference in timing to peak flow in the river compared with peak flow in the sewers was noted.
  - There is general concern over the capacity of the existing sewer system and plans for new development to connect into the system. Anglian Water is currently undertaking a Water Cycle Study which will inform the capacity of the sewers to receive additional flows from planned new development.
  - AVDC stated that on Nelson Street all properties had been fitted with non-return valves to prevent sewer flooding.
  - The Buckingham Canal Society has documented all the surface water drains in Page Hill and Linden Village. They currently discharge to the river, but the Trust proposes redirecting this water into the canal. The works are estimated to cost £30k. The Buckingham Canal Society also suggests a transfer tunnel for surface water from the west of Buckingham (Tingewick) to the east, to avoid carriage in the

Anglian Water to supply up to date DG5 register to Jacobs for inclusion in SWMP

River Great Ouse.

- **HS2:**
    - A Council member stated that farmers have been putting water into the old Great Central Railway drainage network, but when HS2 is built they will no longer be able to and this water will have to be dealt with.
    - The Canal and River Trust representative stated that HS2 will create lots of gravel beds which could be used as balancing ponds. In Buckingham some of this water could then drain into the canal which could be used as a flood management asset itself too.
- **Flood Warning:**
    - AVDC currently monitors river levels at Brackley and uses this as an indicator of likely river levels in Buckingham 4-6 hours later. AVDC promoted EA flood warnings when they installed PLP and had good uptake.
    - There was a general discussion of number of people signed up to the EA flood warning service in Buckingham. The EA offered to provide figures showing the number of people currently signed up to the service.
    - The AVDC emergency plan is launched when more than 20 properties flood.
- **Funding:**
    - AVDC announced that they have received more than £194,000 from a Section 106 agreement with the developers at Lace Hill to spend in Buckingham Town Centre. To date, a small proportion of this has been spent on property level protection in Nelson Street.
- **Other issues:**
    - AVDC and BTC noted that new springs/spring lines have been emerging across Buckingham e.g. one emerged in 2001 and they are now more prevalent than before. It was hypothesised that this increase could be linked to new development.

Environment Agency to provide figures for uptake of flood warnings in Buckingham