Basingstoke (Buckskin area) Drainage Strategy

Stage 1 - Initialise/Prepare

Thames Water

At the heart of daily life

Introduction

Why sewer flooding

Britain's first sewerage systems were constructed 150 years ago in the Victorian era, and have served us well for generations. The sewer network Thames Water operates today has been much improved and vastly extended over the years; yet it remains under increasing pressure.

Everyday our network manages the demands of one of the world's busiest and most densely populated capital cities, and its urbanised surrounding areas; together with the equally complex challenges arising in our predominantly rural catchments in the Thames Valley, Surrey and Kent.

A number of factors including population growth, less frequent but heavier rainfall, the urbanisation of green spaces and changes in agricultural land practices, and utilised machinery, occasionally overwhelm our sewer network. The result can be unwanted sewer flooding for customers and our neighbouring natural environments.

This document contains:

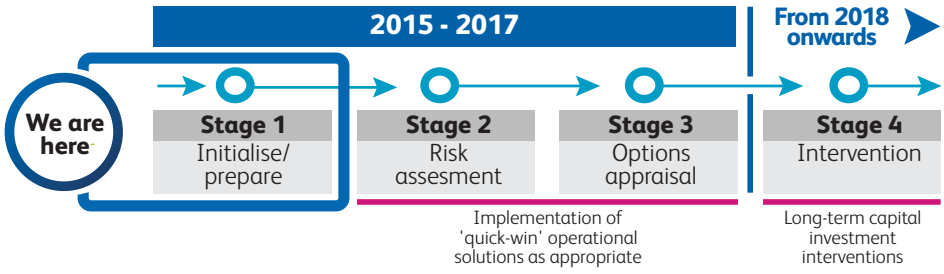
- an Introduction to the work we are undertaking to alleviate sewer flooding in our region
- a Feedback: Q&A section addressing key questions from customers and stakeholders
- The Basingstoke (Buckskin area) Drainage Strategy technical document.

What can be done and when?

Sewer flooding is unacceptable. We have undertaken extensive customer research and initiated a programme of work to improve drainage and alleviate sewer flooding issues across our region.

We are adopting the good practice Drainage Strategy framework* developed by the Environment Agency and Ofwat, the water industry economic regulator, to produce a drainage strategy for our affected catchments with a primary focus on our sewerage network, but working with other key stakeholders where we can. As outlined in Figure 1, the strategies will develop throughout the 4-stage framework to define how we intend to alleviate sewer flooding or to address growth related issues in each area sustainably, and economically, over the next few years.

Figure 1 High-level Drainage Strategy framework* and estimated delivery and intervention timeline**



* The detailed 4-stage Drainage Strategy framework can be found in the following Drainage Strategy document. ** The estimated delivery timeline is dependent on factors including weather conditions and is, therefore, open to change. The intervention timeline includes the implementation of 'quick-win' operational solutions throughout Stage 2 & 3, and long-term capital investment interventions in Stage 4.

Who will resolve the sewer flooding?

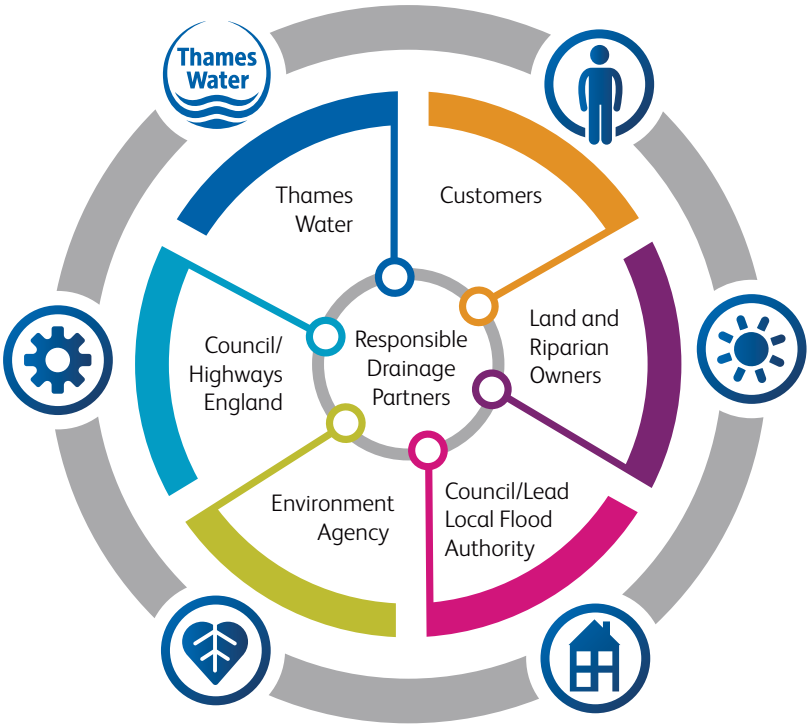
There are a number of stakeholders who, like us, have important drainage responsibilities and therefore, can play an essential role in contributing to the resolution of sewer flooding in our region. These stakeholders include customers, private land owners and the Environment Agency; to name but a few. We are seeking to work in partnership with all stakeholders to ensure that together, we implement and maintain the most effective and sustainable drainage strategies.

Just as our responsibilities to improve drainage and alleviate sewer flooding focus on removing and treating wastewater; other stakeholders' responsibilities include managing local flood risk on riverbanks, groundwater, land and highways, utilising appropriate agricultural practices and maintaining private drains.

We take full responsibility for resolving all drainage and sewer flooding issues that fall within our remit. If the causes of sewer flooding sit outside of this, we will support the responsible stakeholder to resolve the issue and to reduce the impact on customers.

Figure 2 provides a high-level view of the stakeholders responsible for drainage in each catchment area, more detail regarding responsibilities can be found in Section 1 of the following Drainage Strategy document.

Figure 2 Partners with Drainage Responsibilities



Next steps

Over the coming months we will undertake the following activities as this drainage strategy develops:

2015 - 2017

Customer Focus Actions

- Continue to consult with customers during this stage and every stage, through meetings, communications and surveys. We have gained important customer feedback during this first stage, which we are using to shape our activities
- Publish strategy documents for comment and contribution, throughout this framework process.

Partnership Actions

- Continue to establish partnership working with the regional drainage stakeholders, and agree ongoing consultation processes.

Other Key Actions

- Define catchment flooding uncertainties
- Prepare flooding risk data
- Undertake ongoing repair work to our sewer network, as the strategy develops and our investigations identify reparation work linked to drainage and flooding issues.

We will **regularly consult with customers and stakeholders, update and republish** this document throughout this 4-stage framework process.

Feedback: Q&A

Your questions answered

We are committed to listening to, consulting and collaborating with customers and stakeholders on our sewerage network activities and plans. We have addressed key feedback and questions raised by stakeholders and customers in the Buckskin area of Basingstoke, and customers affected by flooding throughout the region, in this Feedback Q&A section. As far as possible, and as is relevant to Stage 1 in the framework process, we have incorporated feedback from customers and stakeholders into our network strategy development. More detail can be found throughout the following Drainage Strategy document.

Q1 Will undertaking this Drainage Strategy framework process defer essential work in our area?

Answer

It is essential for us to complete this drainage strategy process, which has been developed and recommended by the water industry economic regulator Ofwat, and the Environment Agency. This will enable us to better understand the root cause of the sewer flooding issues affecting the catchment, before any major investment can be considered. However, we may carry out some repair works as this strategy develops, in the event that our investigations identify faults or problems with the sewerage network that are highly likely to have caused flooding, as outlined in Section 7 of the Drainage Strategy document. Our previous investigations have identified some sources of inflow, such as the misconnection of surface water to foul sewers. However, as stated in the following strategy, we are not yet able to say how much this impacts on flooding and will update this as our plan develops through Stage 2 to Stage 3 – Option Appraisal. Therefore, this more detailed approach is required to ensure that the most effective and sustainable drainage strategies are implemented in the Buckskin area of Basingstoke.

We are committed to **listening to, consulting and collaborating** with customers and stakeholders on our sewerage network activities and plans.

Q2 What drainage actions are you undertaking in our area, and when will they be happening?

Answer

As stated above, we are developing our plan for this area and will provide further details as our plan develops through Stage 2 to Stage 3 – Option Appraisal. The following drainage actions have already been undertaken, or are underway, in the Buckskin area :

Actions completed include: (For more information please see Table 2)

1. Area reconnaissance
2. Sewer cleaning and root cutting
3. Sewer and manhole surveys
4. Installation of permanent depth monitors
5. Localised sewer rehabilitation
6. Manhole cover replacement
7. Borehole logger installation.

Actions underway or planned include: (For more information please see Table 4)

1. Stakeholder engagement activities
2. Permanent monitoring of sewer levels
3. Sewer and manhole surveys
4. Connectivity surveys
5. Ongoing sewer network rehabilitation
6. Innovative solution analysis.

Q3 Are you renovating the sewers in our area?

Answer

In April and May 2014, to establish the operational condition of the Buckskin sewer network we surveyed 4km of sewers, equating to 143 sewer lengths. Our findings indicated evidence of infiltration in 7 of the sewer lengths and minor structural defects, or evidence of root ingress, in a further 17 sewer lengths. In response, we have rehabilitated 850m of the local sewers using a combination of relining and patch repairs. We will incorporate more detailed insight into our sewer rehabilitation activities to date, and those planned, in Stage 2 of this Drainage Strategy framework document.

Additionally, as per Question 2 above, we will continue to target and repair localised sewer defects identified, where possible, through our investigations as contributing to, or causing, drainage and flooding issues in the catchment, throughout this 4-Stage framework process.

Q4 What are the improvement plans for Basingstoke's sewage treatment works to manage capacity?

Answer

The Basingstoke sewage treatment works operates a fully-compliant permanent storm overflow which permits us to discharge into the River Loddon during storm events. The treatment works has undergone a number of operational upgrades over the years to meet changing performance criteria, and to ensure its compliance with all of our regulatory measures. The most recent major upgrade programme was undertaken at the sewage treatment works in 2014.

We have incorporated the prospect of new housing developments within this catchment into our drainage strategy activities, and we are tracking key proposed developments as outlined in Section 5 of this document. The capacities of the sewage treatment works has been assessed to be more than adequate under normal design flow conditions to manage current demand and therefore, we do not plan to enhance the treatment capability of the sewage treatment works at this time. We will continue to track these proposed developments and consider them in any proposals in the latter stages of the Drainage Strategy process.

Q5 Are you working with the Highway Authority to resolve blocked gullies, sewers and ditches, and with landowners to reduce field run-off, as both affect drainage and our sewers?

Answer

In Section 1 of the following Drainage Strategy document, we outline the other stakeholders who, like us, have important drainage responsibilities and therefore, play an essential role in resolving sewer flooding issues in this catchment area. As Highways maintenance activities and agricultural land maintenance practices sit outside of our remit we will work with the responsible stakeholders, to highlight these issues where this is found to have a major influence and impact on our sewerage network.

We will continue to work closely with the Council and Highways England to understand the extent to which flood waters may be escaping from highway or land drainage systems; and impacting the foul sewer network. An update on this issue will be shared with customers and featured in the later stages of this Drainage Strategy document if relevant.

Q6 How are you planning for future development in the catchment?

Answer

As per Q4 and Section 5 in the following Drainage Strategy technical document, we will continue to closely monitor development applications in the catchment and assess the impact that they may have on the capacity of our operations in the future.

We will seek to work with all involved stakeholders through our stakeholder engagement activities, to monitor local council plans and planning applications and to incorporate current and projected developments into our business planning cycle, to ensure that our service is maintained for customers throughout the catchment's development.

Q7 Is an Infiltration Reduction Plan (IRP), required for this catchment?

Answer

Ensuring that our drainage strategies fully meet the requirements of an Infiltration Reduction Plan, as set out in the Environment Agency's Regulatory Position Statement, is a fundamental consideration in their development. Therefore, to maintain our service to customers during future wet weather events, if we need to discharge to watercourses through temporary overflows, a dedicated section will be included in each affected strategy, providing details of their location and intended use. This section will be included and /or revised when each strategy is updated.

Specifically regarding the Buckskin area of Basingstoke, in the event that temporary overflows are required, as stated above, we will describe their location and the circumstances under which we would use them. Together with plans to reduce infiltration, this drainage strategy would then fully meet the requirements of an Infiltration Reduction Plan.

Q8 Why are costs a consideration within your Wastewater outcomes?

Answer

The service we provide is the most fundamental of all – at the heart of daily life for the 15 million customers we serve. Getting it right is our focus every day, and we never forget it is paid for by customers.

As a regulated company we have to carefully balance service and cost in order to keep customer bills affordable, whilst delivering our outcomes and customer service commitments.

Q9 Are growth and urban creep minor factors in these catchments?

Answer

As per Q4 and Q7 above, we are working closely with the Local Planning Authority to track a number of ongoing and proposed developments in the Basingstoke catchment, and to assess their potential impact on our current and future assets and service.

Similarly urban creep, and in particular misconnection of surface water and change of land use, can have a significant impact on sewer flooding; particularly when permeable areas such as grass are replaced with hard-standings and driveways. When compared against the rest of the Thames Water region, the urban creep rate for Basingstoke is about average for the Thames Water Operational Area.

More growth and urban creep information can be found in Section 5 of the following Drainage Strategy document.

Q10 Are best practice techniques already used by other water companies being considered?

Answer

We are constantly reviewing and improving our business to meet and exceed industry standards, to implement best practice and to drive innovation. We lead and participate in a large number of industry forums both in the UK and worldwide, to share and expand our learning; with the ultimate aim of improving services for customers.

We are deploying industry best practice techniques throughout our Drainage Strategy work, and also trialling new technology that is innovative within our industry, to achieve the best possible drainage outcomes for customers and their local environment.

Q11 Why are you collecting climate change data rather than 'climate proofing' assets?

Answer

We are committed to responding to climate change and to reducing our contribution to it by reducing emissions in accordance with government policy. Our voluntary target is to achieve a challenging 20 per cent reduction in emissions (compared to 1990 levels), for our Scope 1 and 2 emissions*. We continue to assess and collect climate change data and its impact on assets across our region, to ensure that we are fully informed and can prioritise our plans, targeted actions and investments. For more information please see the Climate Change section on the Homepage of our website.

*Scope 1 emissions refer to greenhouse gas emissions associated with the operation of our assets. Scope 2 emissions are emissions associated with the use of grid electricity.

Q12 What is the impact on local rivers of overflow points?

Answer

During extreme weather conditions foul sewers may become overwhelmed through a combination of surface water or groundwater, resulting in a much diluted sewage. The impact on local rivers is dependent on the nature and size of the river, and on the overflow.

To reduce the environmental impact on local watercourses we will only use overflow points when groundwater and river levels are high, and therefore sewage dilution rates are also high. Additionally, as per Table 4, we are also investigating deploying mobile biological filters to prevent litter and other matter from entering local rivers. If during the development of our drainage strategy we consider that temporary overflow points are necessary in the local network, we will update the Drainage Strategy document to reflect this position.

Basingstoke (Buckskin area) Drainage Strategy

Technical Document

Thames Water

At the heart of daily life

Stage 1: Initialise / Prepare

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About this document

Based on customer research

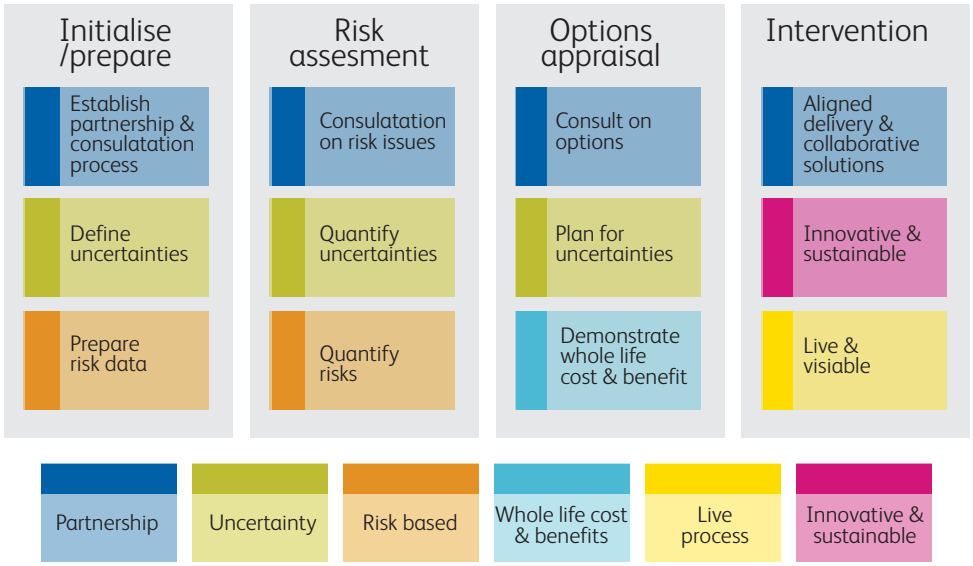
Undertaking extensive customer research has been a fundamental step in our business plan preparation for 2015-20. Our research findings have informed our business planning activities, and contributed to the development of a set of long-term customer 'outcomes'.

The water industry economic regulator, Ofwat, defines 'outcomes' as "High-level objectives that company actions, activities and achievements are intended to help deliver..[they] represent what customers and society value". As a company, we are committed to achieving our customer outcomes, a number of which are focussed on alleviating sewer flooding issues within our region, through effective, economic and sustainable drainage. This document describes the strategy that we will follow in delivering our long-term customer outcomes for drainage, specifically in the Buckskin area of Basingstoke, in a sustainable and economic manner.

Approved approach

We have adopted the Drainage Strategy Framework[1] outlined in Figure 1 below, developed by the Environment Agency and Ofwat. It identifies 4 key stages to producing a good-practice drainage strategy. Drainage strategies typically focus on the sewerage network, and not the performance of sewage treatment works. The drainage strategy for the Buckskin area of Basingstoke is currently at the first stage of this framework - the Initialise/Prepare stage. In this document, we describe the activities that we plan to undertake to address current issues and future challenges facing the catchment, and the data that we need to gather to complete the risk assessment and options appraisal stages.

Figure 1 The Drainage Strategy Framework



[1] http://www.ofwat.gov.uk/future/sustainable/drainage/rpt_com201305drainagestrategy.pdf.

Consultation and publication

We will update and republish this document to provide the results of our risk assessment, options appraisal and our selected strategy for intervention, once data from instrumentation and other fieldwork has been collected and analysed.

Throughout this process we will attend local flood forums for ongoing communication and consultation with customers and stakeholders. We will also make the Drainage Strategy documents available on the Drainage Strategies webpage of our website.

Meeting the Infiltration Reduction Plan (IRP)

To ensure that this Drainage Strategy meets the requirements of an Infiltration Reduction Plan, as set out in the Environment Agency's Regulatory Position Statement on discharges made from groundwater surcharged sewers, we have included a section in this document which defines if, how and when we propose to operate temporary overflows. This is in addition to our plans to reduce infiltration over time, where it has been identified as a root cause of sewer flooding. Please see Section 8 in the Drainage Strategy document below.

Executive summary

This drainage strategy for Basingstoke focuses on the foul sewerage system in the Buckskin area as illustrated in Figure 2 below. This area experienced particularly elevated groundwater levels during the winter of 2013/14, resulting in extensive groundwater flooding to properties and highways, and the overwhelming of the local drainage systems; including the public foul sewer network.

The surveys we have carried out suggest that the foul sewerage system in the Buckskin area has surcharged and flooded predominantly due to a combination of groundwater infiltration into the foul sewerage network when groundwater levels are high, via submerged manholes and via structural defects, surface water run-off from surrounding saturated land and surface water inundation from highways, public spaces and properties. Surface water misconnections (i.e. downpipes from roofs), into the foul sewerage network may also be a contributing factor, however further analysis is required to determine the extent to which this has contributed to sewer flooding in the area. Drainage systems managed by other agencies, such as highway and land drainage systems, were also impacted during this period, as they were unable to infiltrate water into the saturated substrata.

The root causes of sewer surcharges are therefore numerous and the resolution of the issues complex, requiring all stakeholders responsible for drainage in the catchment to work together to resolve them. The Floods and Water Management Act 2010 places a responsibility on lead local flood authorities (LLFAs), to manage flood risk from surface and groundwater, plus a duty on all risk management authorities (RMAs), to cooperate regarding flood risk. Hampshire County Council, as lead local flood authority, has undertaken modelling of the existing surface water infrastructure and identified a number of options to reduce the flood risk in the Buckskin area. In our role as an RMA, Thames Water will work with Hampshire County Council, Basingstoke and Deane Borough Council and the Environment Agency on a multi-agency flood plan for the area, to ensure that a collaborative approach can be developed to address the problems.

In response, this drainage strategy follows the Environment Agency and Ofwat 4-stage framework. The strategy for the Buckskin area of Basingstoke is currently at Stage 1 (Initialise/Prepare). We describe in this document the actions that we plan to carry out to complete the following risk assessment and options appraisal stages. We will update and republish this document once this work has been completed.

In preparing our company business plan for the 5 year period 2015 to 2020 we have listened very carefully to the views of customers. Beyond being able to maintain the current service that we provide, customers have told us that they would like to see a reduction in instances of sewer flooding and odour nuisance and an improvement in river water quality. Our research indicates that customers are willing to pay for these improvements to service ; a summary of our related customer research can be found on our website via the hyperlink below.

We have therefore developed a set of company outcomes that we are committed to working towards over the next 5 years and beyond. The outcomes relevant to the drainage strategy for the Buckskin area of Basingstoke are:

- Asset health - a composite range of measures against which we will manage the health of our sewerage network
- Properties and public areas protected from sewer flooding
- River water quality meets customer's expectations and regulatory requirements.

This drainage strategy must also address future challenges to the Buckskin area. We assess these to be:

- Climate change – analysis of the latest data suggests that rainfall could become 15% more intensive by 2080 increasing the likelihood of flooding. Longer wetter winters may also mean groundwater levels are high more often; this could also exacerbate fluvial flooding from local watercourses

[2] http://www.thameswater.co.uk/cr/Howwedobusiness/Engagingwithourstakeholders/Publicconsultationresearch/index.html.

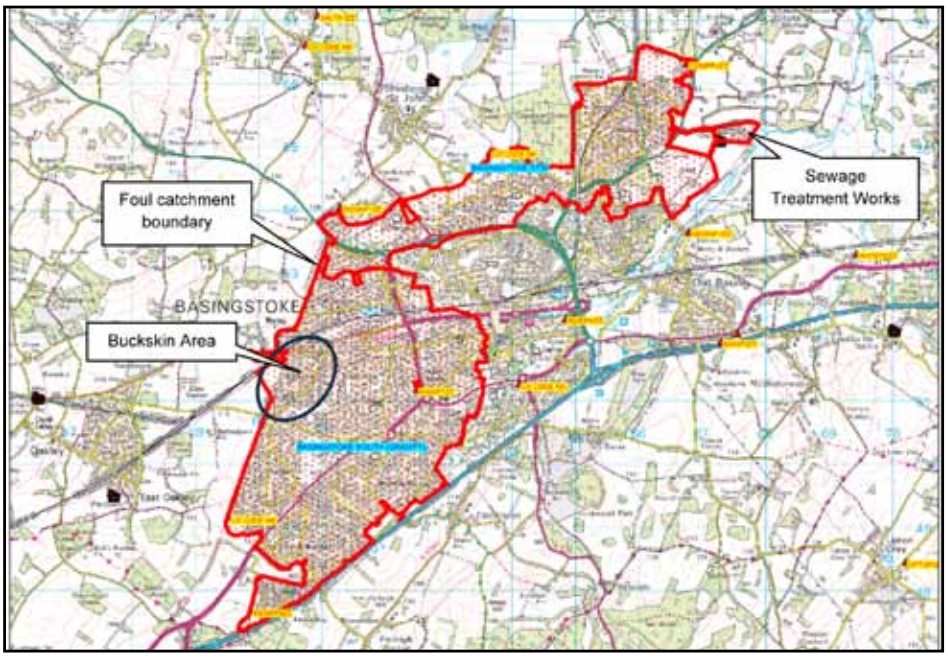
- Urban creep – paving over of front gardens and loss of green space results in more strain on the sewerage network when it rains heavily. Modelling we have undertaken suggests urban creep rates in Basingstoke are about average for the Thames operational area
- Population growth – the population in the South East is set to grow rapidly. Significant growth and possible developments are identified over the next 10 years around Basingstoke. We will continue to track these and any other emerging applications for this catchment arising in the future.

Our strategy is to understand the relative impact of overland flow from saturated land, groundwater infiltration and surface water misconnections and how this effects the performance that our network has in respect of flooding. We will then try to identify cost beneficial solutions to the network to reduce the risk of flooding using customer willingness to pay research. We carried out sewer repair work following the events of 2013/14 including root cutting, sewer lining and manhole sealing. We may carry out further sewer rehabilitation works as the strategy develops, in the event that our investigations identify further faults or problems with the sewerage network that are highly likely to have contributed to flooding.

Our next steps are to continue to collect real-time sewer depth information from the permanent depth monitors that we installed in the sewerage network in December 2014. The data that is provided by the depth monitors will enable us to further understand where, and how surface and groundwater is making its way into the foul sewerage network. The depth monitors will remain in place for a minimum of five years as we move through this 4-stage framework and develop our plans. For more information on their location please refer to Figure 8.

Figure 2 Basingstoke priority subcatchment

The focus for this drainage strategy is the Buckskin area of Basingstoke that is circled on the diagram below in blue.



1 Thames Water and drainage

1.1 Our statutory responsibilities

Thames Water is a regulated Water and Sewerage Company. We supply water to 9 million customers in London and the Thames Valley and provide wastewater services to 15 million customers across an area that stretches from Gloucestershire to Essex. We operate 108,000km of sewer through which an average of more than 4.4bn litres of wastewater is collected and treated every day at our 350 sewage treatment works.

The primary legislation that sets out our role and responsibilities is the Water Industry Act (1991), which describes the duties and services that we are responsible for and the powers that we have to connect, operate, maintain and extend the sewerage network. We are regulated by the Water Services Regulation Authority (Ofwat). The original 1991 Act has been amended by further legislation in recent years, transferring some drains and sewers that were hitherto in private ownership to Thames Water's responsibility[3].

Other recent pieces of legislation relevant to this Drainage Strategy are the Flood & Water Management Act (2010) and the Water Act (2014). These set out new responsibilities for Thames Water to manage flood risk in partnership with local councils and the Environment Agency, with more emphasis on Sustainable Drainage Systems (SuDS), such as swales and permeable paving to mimic natural drainage.

Thames Water also has a statutory obligation to comply with environmental legislation, including European Directives. The Water Framework Directive establishes a strategic approach to managing the water environment, which the Environment Agency achieves through River Basin Management Plans and setting environmental objectives for groundwater and surface water. The environment is also protected from adverse effects of discharges of urban wastewater through the Urban Wastewater Treatment Directive, which requires us to improve and extend the sewerage system according to section 94 of the Water Industry Act (1991).

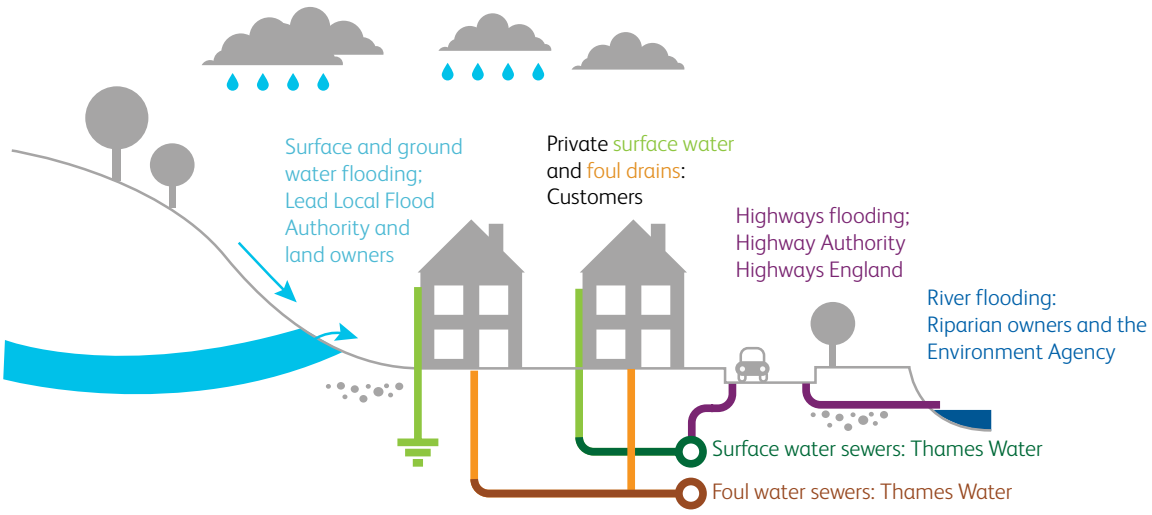
A comprehensive and detailed list of all legislation relevant to Thames Water can be found in the 'statement of obligations' published by Defra[4].

[3] See http://www.thameswater.co.uk/help-and-advice/8654.htm for more information.
[4] See https://www.gov.uk/government/publications/statement-of-obligations.

1.2 Working in partnership with other stakeholders

Other stakeholders responsible for managing various forms of drainage need to work together with us to reduce the risk of flooding. Each has specific responsibilities as summarised in Figure 3 below.

Figure 3 Stakeholder responsibilities for drainage



Thames Water

We are responsible for removing and treating wastewater which includes foul and in some areas combined sewers that exist in the older large urbanised areas, such as London[5]. We also manage and maintain surface water sewers where they exist, these will typically discharge to a watercourse or river. In some cases, the cause of sewer flooding may not fall under our responsibility. In these circumstances, we will explain what we can do to help and continue supporting the relevant authorities or third parties to reduce the impact for customers.

Environment Agency

The Environment Agency is responsible for main rivers and part of its remit includes monitoring and informing the levels of ground and river water. The Environment Agency also investigates pollution incidents and monitors the quality of the water in rivers.

Local Council - Lead Local Flood Authority and District Council

Hampshire County Council is the Lead local flood authority has the responsibility under the Flood & Water Management Act 2010 for managing the local flood risk from groundwater and surface water runoff e.g. ordinary watercourses and culverts[6]. They work with landowners to maintain privately owned ditches, drainage and watercourses, keeping them clear of blockages. They are also responsible for managing the risk of groundwater flooding, both inside and outside of properties. Water from these local authority gullies and drains and privately owned ditches can also feed into Thames Water sewers, so Thames Water works with all parties to deal with the excess flow. Basingstoke and Deane Borough Council is the local Planning Authority responsible for approving new development, but equally may have responsibility for ensuring maintenance of watercourses; particularly on council-owned land.

Highway Authority

Hampshire County Council is the Highway Authority and is responsible for highway maintenance and highway drainage, and for clearing roadside gullies. Highways England is responsible for the drainage of motorways and certain trunk roads.

Customers

Customers own and are responsible for the maintenance of private drains within the curtilage of their property, which did not transfer to Thames Water ownership in October 2011[7].

Riparian Owners

Riparian Owners are landowners who own land with watercourses or land adjacent to watercourse (i.e. road side ditches). The responsibility for the operation and maintenance of ditches, local watercourses and general land drainage lies mostly with riparian owners.

Land Owners

Land owners include farmers and both residential and commercial customers, but includes trusts etc. They are responsible for ensuring the adequate drainage of their land, such that it is not a nuisance to others.

[5] Thames Water is responsible for the collection and treatment of commercial and domestic sewage. Typically this will be the foul sewerage. Domestic or commercial roof and paved drainage will often go to a soakaway or directly to a water course/river, which if so is not the responsibility of Thames Water.

[6] Some local watercourses and/or culverts are termed as 'Riparian' meaning that a land owner, possibly adjoining or owning the land containing the watercourse/culvert is responsible for the maintenance and free-flowing of the watercourse/culvert.

[7] See http://www.thameswater.co.uk/help-and-advice/8654.htm for more information.

2 Catchment description

2.1 Geology and topography

Basingstoke is located in Northeast Hampshire approximately 20 miles (32km), Southwest of Reading. It is an old market town that expanded significantly in the 1960s under an agreement between London County Council and Hampshire County Council. It includes the large suburban villages of Chineham, Old Basing and Lychpit. The Buckskin area is located in the South West of the catchment and is one of the original districts of Basingstoke, dating back to the expansion in the 1960s by the Basingstoke Development Group.

The Buckskin subcatchment is generally made up of chalk bedrock and very permeable soils. Basingstoke and Deane Borough Council commissioned a Hydrogeological assessment of the Buckskin area in 2014[8]. This report identifies that Buckskin lies within a chalk valley at the headwaters of the River Loddon; the valley acts as a preferential route for groundwater, which moves southwest to northeast towards the river. Fissures and bands of highly permeable geological formations were identified which may enhance the transmission of groundwater. These findings conclude that the Buckskin area is prone to significant seasonal changes in groundwater levels, as well as being prone to rainfall induced infiltration owing to its permeable underlying geology.

The Hydrogeological assessment report also noted the presence of ephemeral streams and rivers which rise throughout the catchment, most notably at Buckskin Lane and Worting Road. The emergence of these springs is dependent on levels of excess groundwater in the geology below, they can disappear for a year and then reappear and can continue to discharge for weeks or months after rainfall has ceased. This can mean that flooding and infiltration issues can continue in this catchment for long periods after the original rainfall event due to rainfall induced infiltration[9] owing to its permeable soils.

Appendix B includes maps showing the geology and fluvial, pluvial and groundwater flood risk areas in the catchment.

The Environment Agency identifies several watercourses within the Basingstoke catchment. The current ecological status of these rivers ranges from 'Poor' (The River Loddon) to 'Good'[10] (The River Lyde).

[8] Buckskin Groundwater Flood 2014, Hydrogeological Assessment, Report for Basingstoke and Deane Borough Council, July 2014, Project Ref: 1407-074-03BDBC-TM.

[9] Rainfall Induced Infiltration is the term given to sewer infiltration that occurs as a result of rainfall percolating into the ground impacting the sewer on route to recharging the groundwater table.

[10] Environment Agency website, interactive map, Basin Management Plans.

2.2 Sewage treatment works

The Basingstoke sewage treatment works is located to the north east of the town, near to Chineham and supports a population equivalent of circa 130,600. The works serves the Basingstoke town area, Chineham and Old Basing via a number of sewage pumping stations. It treats a maximum daily flow of up to 65,000m^3/day, with typical average dry weather flows of 21,253m^3/day.

The treated effluent from the works is discharged to Petty's Brook, approximately 1km upstream of the confluence with the River Loddon. Storm tanks store excess flows above the maximum flow to treatment and return the stored flow through the works, if possible. In the event of the storm tanks becoming full and unable to be returned, the excess flow is transferred through a land treatment area to discharge into the River Loddon.

The Basingstoke sewage treatment works has undergone a number of operational upgrades over the years to meet changing performance criteria and to ensure its compliance with our regulatory measures. The most recent major upgrade programme was undertaken at the treatment works in 2014. The capacities of the works have been assessed to be adequate under normal design flow conditions for the current population equivalent.

Further developments to be undertaken at the works includes a trial project to be delivered in partnership with the Environment Agency, to assess the feasibility of reducing the amount of phosphorous in the River Loddon. Additionally, there is to be a programme of work to deliver an enhanced digestion process for the sludge stream at the treatment works. Neither of these two projects will affect the foul drainage in the Buckskin area of Basingstoke.

2.3 Foul sewers

The Basingstoke sewer system is predominantly served by a separate system with foul sewers intended to only receive foul sewage. The catchment comprises 258 km of foul sewer draining from west to east, to the sewage treatment works for treatment and disposal. The majority of the foul system gravitates to Basingstoke sewage treatment works, together with some specific peripheral areas that are pumped.

Sewer design criteria ensures the appropriate sizing and laying of pipes at an appropriate gradient to maintain a satisfactory self-cleansing characteristic. The capacity of the sewer is typically set to cater for six times Dry Weather Flow (DWF), and a 10% allowance is included for infiltration[11]. In terms of design capacity, a 225mm sewer laid at a gradient of 1 in 150 will have sufficient capacity to cater for the foul sewage for around 1,500 houses, which based on average occupancy rates of 3 people per house equates to 4,500 people. Problems in sewers smaller than 300mm in diameter tend to be as a result of blockages in the pipes. However, occasionally surface water can be misconnected into the foul sewerage network – problems then arise when it rains heavily.

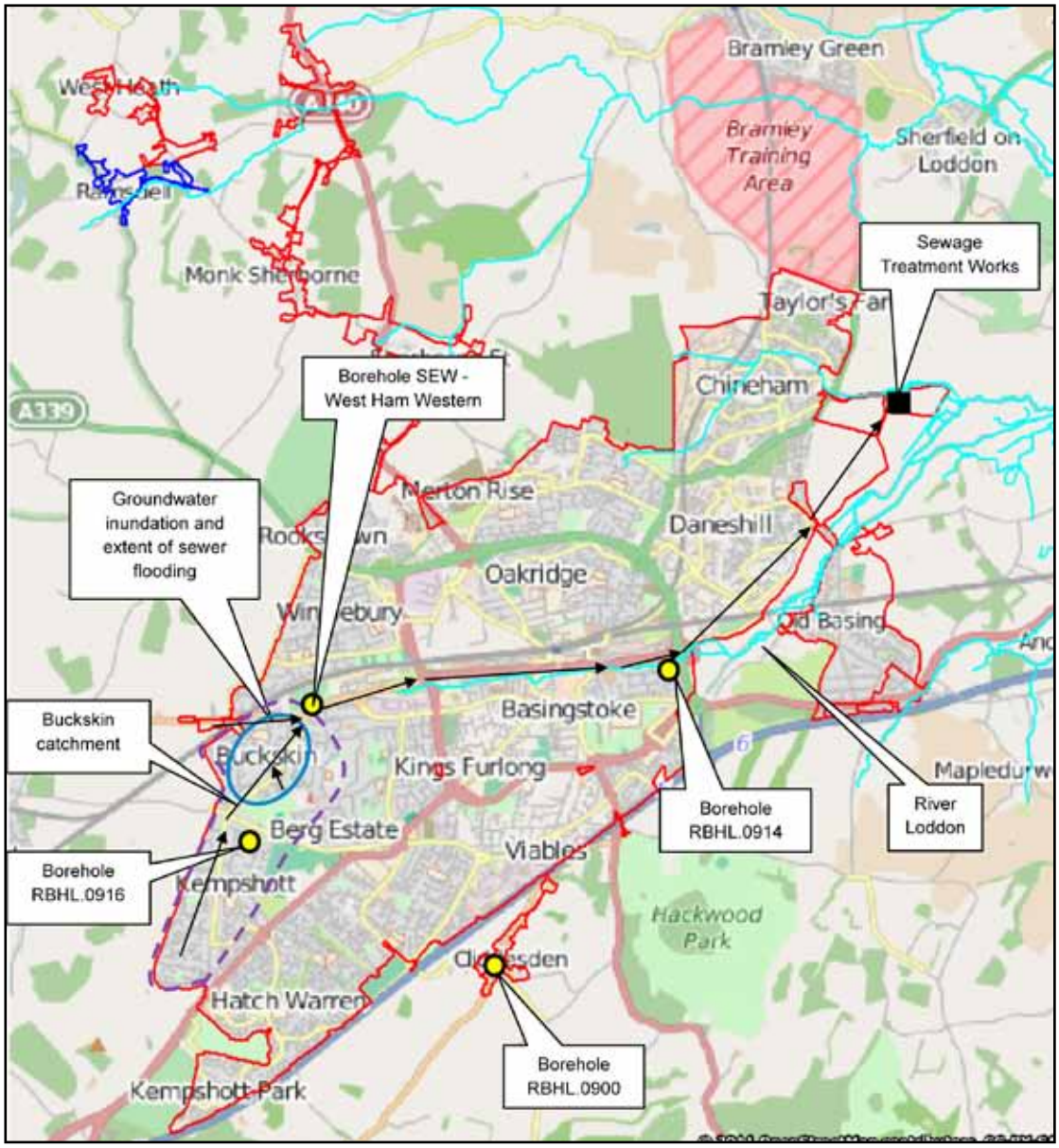
The sewers in the Buckskin area serve approximately 3,700 properties and are predominantly configured in a network of 150mm diameter pipes that discharge to a 375mm sewer that runs along Buckskin Lane. The capacity of the sewers serving the Buckskin area are considered to be adequate under normal weather conditions to manage current demand.

The sewers in the Buckskin area were constructed in the 1960s by the Basingstoke Development Group. Materials used in the construction of the sewerage system are vitrified clay pipework and brick and concrete manholes. The clay pipework can have a very long service life, but sometimes the joint seals deteriorate over time and can therefore let in groundwater, if levels allow. The pipes were typically laid on bedding material such as pea shingle, with the trenches likely to have been backfilled with 'as dug' excavated material. More recent drains and sewers, i.e. since the 1980s, are typically surrounded with pea shingle. This protects the pipe but can also act as a good conduit for groundwater.

The main sewers in the catchment were adopted by the local authority and have been maintained as public sewers by Thames Water since the 1970s. Much of the sewerage around the properties remained the responsibility of Sovereign Housing association and only transferred to Thames Water in October 2011, when the Private Sewers Transfer Regulations came into force. As per Section 1.2 the private foul water drains within the property boundaries in the Basingstoke catchment, are the responsibility of the property owners unless they serve two or more properties.

[11] Dry Weather Flow is the term given to the average flow rate observed over a 24 hour period and based on Sewers for Adoption, the industry standard, includes an allowance for infiltration of 10% of the calculated flow rate.

Figure 4 Basingstoke sewerage catchment, indicating principal assets



The extent of the Basingstoke foul sewerage catchment is shown in red, the area serving Buckskin is in purple and the flooding extent is in blue. The black arrows indicate the principal route of the sewers from Buckskin.

2.4 Surface water sewers

Whilst there are some surface water sewers in the Basingstoke catchment, these mainly serve the more recent developments in Chineham and Daneshill. There are very few surface water sewers in the Buckskin area. As with the foul sewers, the surface water drainage in Buckskin was constructed as part of the 1960s development. Plans recently provided by Hampshire Highways Authority reveal the only recorded public surface water sewer as a 'flood relief sewer', that appears to drain from a redundant subway beneath Buckskin Lane as well as possibly taking overflows from the highway drainage system. This 'flood relief sewer' is currently mapped as a Thames Water asset and therefore under Thames Water's responsibility, however there may be evidence to suggest that it does not serve customers' homes and therefore, should be maintained by the Local Authority. We will aim to clarify this as part of Stage 2 of the drainage strategy in conjunction with the Local Authority.

In Buckskin and the surrounding area, the majority of surface water drainage is likely to be disposed of via soakaways, drainage ditches and other sustainable drainage techniques. Soakaways can only function satisfactorily when ground conditions allow soakage and may be completely ineffective at times of high groundwater levels. The Hydrogeological assessment report[8], previously referenced in Section 2.1, commissioned by Basingstoke and Deane Borough Council, indicates that some soakaways were found to reverse flows during the extreme groundwater levels experienced in February 2014.

The catchment is mostly urban and incorporates a network of highway drainage and minor watercourses that are intended to receive the non-property related surface water in the area. As per Section 1.2 the responsibility for the operation and maintenance of local watercourses and general land drainage is with the riparian owners. Hampshire County Council as lead local flood authority has overall responsibility for managing groundwater and is also responsible for the highway drainage, roadside gullies and for any culverts crossing the highway. The Environment Agency has the duty and the authority to ensure that the River Loddon, River Lyde and Petty's Brook are maintained appropriately. The responsibility for the maintenance lies with the riparian land owners.

3 Long-term outcomes

We have listened very carefully to the views of customers before developing our plan for the Asset Management Period 6 (AMP6), regulatory period. Between 2009 and 2013 we carried out over 50 separate customer research and engagement activities across our region.

Beyond being able to maintain the current service that we provide, customers have told us that they would like to see a reduction in instances of sewer flooding and odour nuisance and an improvement in river water quality. These are areas where customers are prepared to see, and pay for, an improvement in the current level of service.

In response to this, we have developed 4 company outcomes and 11 service outcomes for our wastewater service that we are committed to working towards over the next 5 years and beyond, further details can be found in Table 1 below and on our website[12].

Table 1 Wastewater outcomes

Company outcome	Wastewater service outcome	Why is this service outcome chosen
We will provide a safe and reliable wastewater service that complies with all necessary standards and is available when our customers require it.	Asset health: maintaining our assets to ensure we can provide a safe and reliable service in the long-term.	We must ensure an appropriate balance between reducing costs today and not compromising our future service.
	Properties and public areas protected from flooding.	Flooding is one of the worst service failures for customers.
	Resilient sewage treatment service that minimises the impact of extreme events on river water quality.	We need to be able to provide service against a variety of pressures such as climate change and population growth.
Our customers and stakeholders can trust us, we are easy to do business with and we care.	Do the basics excellently by getting things right first time.	This service outcome ensures our wholesale activity is completely aligned to our objective to improve our Service Incentive Mechanism (SIM) scoring.
We will provide the level of customer service our customers require, in the most economic and efficient manner, to ensure that bills are no more than necessary.	Reduced dependence on energy from the grid.	Reducing dependence on energy from the grid is one of a range of measures across our entire plan to keep costs down to an affordable level for customers.
We will limit our impact on the environment and achieve a socially responsible, sustainable business for future generations, including reducing levels of leakage.	Minimising our carbon footprint.	There is an expectation from society that we will play our part in reducing carbon emissions.

[12] See http://www.thameswater.co.uk/tw/common/downloads/about%20us%20-%20corporate%20responsibility/AMP6_-_Outcomes_Reporting_Policy.pdf for more information.

Company outcome	Wastewater service outcome	Why is this service outcome chosen
	River water quality meets customers' expectations and regulatory requirements.	We must meet environmental regulations, and river quality is a visible indicator to citizens of our environmental stewardship.
	Satisfactory sludge disposal.	Sludge is a resource that we should manage effectively to keep bills down.
	Corporate responsibility.	We will act as a responsible company, meeting expectations from wider society.
	Reduced odour from wastewater operations.	Odour is a problem for some of our customers.
	Compliance with new environmental regulations.	We must meet environmental regulations, and river quality is a visible indicator to citizens of our environmental stewardship.

Below we provide more information about our asset health, properties and public areas protected from flooding and river water quality service outcomes, as these are relevant to the Basingstoke (Buckskin area) Drainage

3.1 Asset health

Our Asset Health performance commitment encompasses a composite range of measures against which we will manage the health of our sewerage network. This commitment underpins our outcome of a safe and reliable wastewater service. It includes sewer collapses, blockages, unconsented category 1 to 3 pollution incidents and properties internally flooded due to operational problems (such as blockages, collapses or equipment failures).

3.2 Properties and public areas protected from flooding

There are two performance commitments that underpin the delivery of this service outcome:

1 We commit to protecting properties from flooding due to rainfall. We estimate that our plan for 2015-20 will result in over 2,100 properties being alleviated from internal flooding, external flooding and also from restricted toilet use (for example when groundwater levels are high following prolonged periods of wet weather). Our customer research indicates that our sewer flooding programme will deliver £20m of benefit to customers every year by 2020.

2 We commit to reducing the risk of sewer flooding and pollution from combined sewers (i.e. those that convey both foul and surface water), by slowing down surface water run-off and re-routing the flow through sustainable drainage measures such as water butts, permeable paving, rain gardens and green roofs. We aim to retrofit over 20 hectares of sustainable drainage measures by 2020. We may also apply this commitment to areas where the network was designed to take foul flow only, but investigation shows that a substantial amount of surface water is in the foul sewer.

3.3 River water quality meets customers' expectations and regulatory requirements

We have a performance commitment to reduce the number of pollution incidents as a result of discharges from our sewerage network and treatment works. Pollution can occur as a result of blockages, collapses or failure of our equipment and also following heavy rainfall when our sewers have insufficient capacity to cope with the flow. All pollution incidents are reported to the Environment Agency's National Incident Recording System (NIRS).

4 Current issues

4.1 Recent wet weather events

The Buckskin area of Basingstoke experienced particularly elevated groundwater levels during the winter of 2013/14, resulting in extensive groundwater flooding to properties and highways, and the overwhelming of the local drainage systems; including the public foul sewer network.

Although the foul sewers are intended to receive wastewater only, the surveys we have carried out suggest that the foul sewerage system in the area has surcharged and flooded predominantly due to a combination of groundwater infiltration into the foul sewerage network when groundwater levels are high entering via submerged manholes and via structural defects, surface water run-off from surrounding saturated land and surface water inundation from highways, public spaces and properties. Surface water misconnections (i.e. downpipes from roofs), into the foul sewerage network may also be a contributing factor, however further analysis is required to determine the extent to which this has contributed to sewer flooding in the area.

We are confident that this is a comprehensive list of factors that have caused sewer flooding in the Buckskin area.

During recent events, the following incidents have been observed with respect to the sewerage network:

- Surcharging sewers causing spills out of many public manholes
- External foul flooding to properties in the Buckskin area of Basingstoke
- Depth monitors in the network within the Kempshott area of Basingstoke displayed several periods of high flows indicating a problem with unplanned inflows.

During these events, other sources of flooding have also been observed:

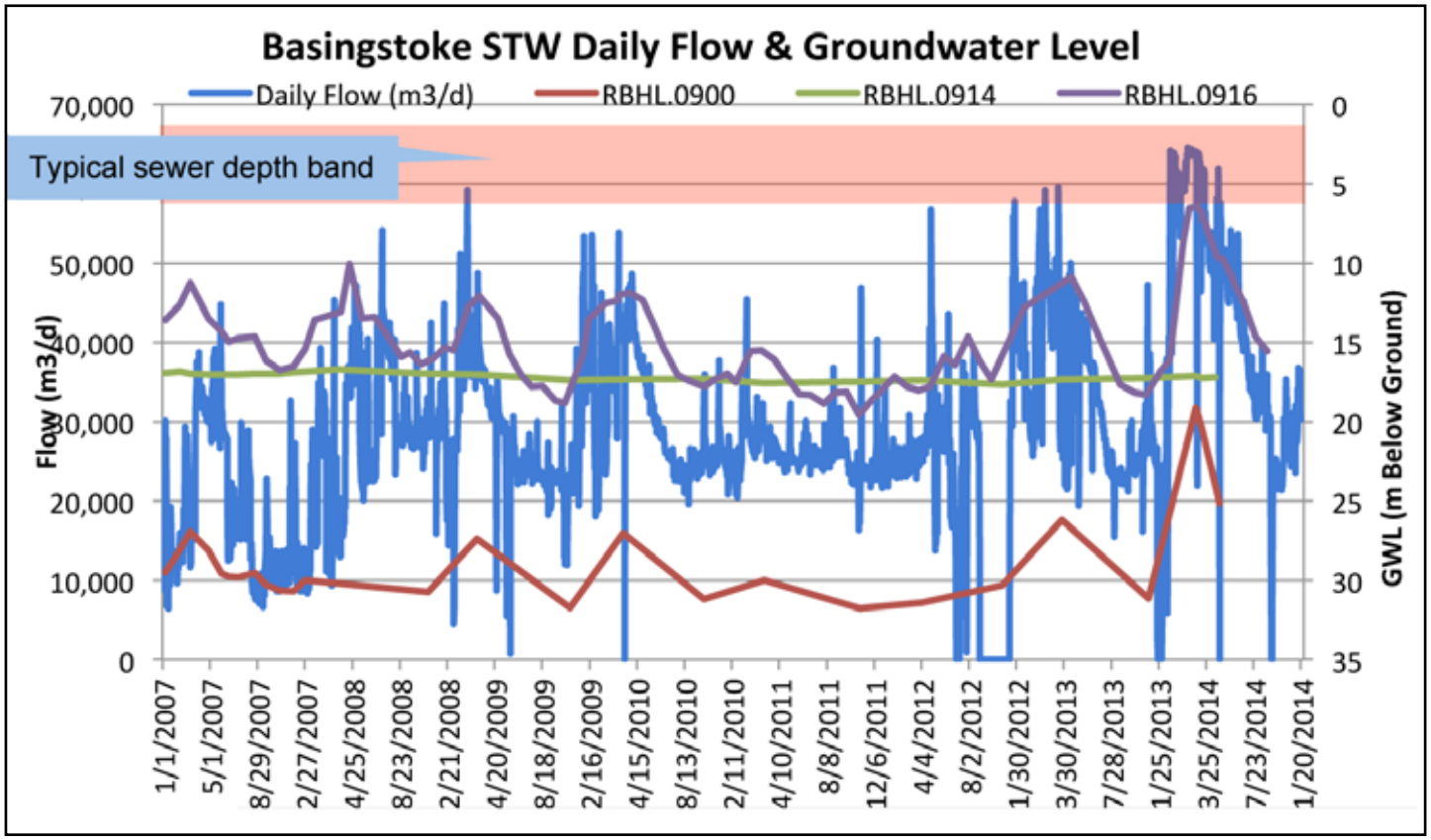
- Emergence of ephemeral springs leading to groundwater flooding
- Highway drainage overwhelmed causing highway flooding
- Extreme rainfall between October 2013 and March 2014
- Overland flow at Sperrin Close, Exmoor Close and Eastrop Park
- Internal flooding of properties either as a result of groundwater rising through the floors or entering from overland routes.

To reduce the risk of flooding, a few residents had to pump floodwaters onto the highway or into public manholes and also to use sandbags to protect their properties. Photographs taken around the time of these events can be found in Appendix A of this document.

During extended wet periods, flows received at the Basingstoke sewage treatment works can be in excess of 65,000m3/day, which is over three times the average daily dry weather flow of 21,253m3/day. Figure 5 below compares the treated flows at Basingstoke sewage treatment works with groundwater levels recorded at three Environment Agency boreholes RBHL.0900, RBHL.0914 and RBHL.0916. The latter is located in Pack Lane and closest to the Buckskin area. The locations of these boreholes are also identified in Figure 4 above.

Figure 5 suggests that the between 2007 and 2014, groundwater varied between 6m to 32m below surface for much of the time. However, there is a corresponding trend between the groundwater level in RBHL.0916 and the treated flow at the Basingstoke sewage treatment works. Although the Environment Agency records indicate that in 2014 the groundwater at this borehole did not reach a height of more than 5m below surface, the ground level is approximately 10m higher here than at Buckskin, where the flooding occurred. Evidence suggests that the groundwater level rose even higher at Buckskin and broke through the surface, therefore, the drains and sewers (which are typically between 1m to 6m deep), are likely to have been below groundwater levels.

Figure 5 Basingstoke Sewage treatment works (STW) treated flows and groundwater levels



4.2 Our operational response

Due to the significant impacts of fluvial and groundwater flooding across our region during the winter event of 2013/14, we decided to mobilise our tanker fleet of nearly 100 vehicles to protect our customers suffering from or most at risk of internal property flooding. Tankers were used in some cases to clean up pumping stations and outside properties which suffered from flooding during these periods of extreme wet weather.

Basingstoke and Deane Borough Council deployed tankers in February 2014 to reduce external foul water flooding of properties and to clean-up contaminated flood waters. The tankers were then emptied at Basingstoke sewage treatment works.

Temporary over pumping was used during March 2014, to transfer excess flows from Grampian Way to parts of the sewer network that were less affected by the flooding. No contaminated water was discharged to local watercourses or to the wider environment as a result of this activity.

Towards the end of the groundwater event in 2014, when water levels had started to fall, groundwater was diverted into the foul sewers and over-pumping was employed to speed up the drainage of floodwater. Some residents have expressed frustration that groundwater was not diverted to the foul sewers sooner and in greater quantity, believing that such action would have prevented the flooding. However, we shared the view of all other involved agencies that doing so would have had no noticeable impact whilst the groundwater was still rising, other than to exacerbate capacity problems for other customers connected further downstream in the sewerage network.

Our investigations so far have identified the presence of some infiltration into our sewers and we have taken measures to reduce the impact by lining the effected lengths of sewer. We also noted that many of our manholes had become submerged by the emerging groundwater that was ponding on the highway and we have now replaced these with low leak covers to reduce the possibility of further groundwater/surface water ingress. Whilst these measures may help to lessen the consequences of flooding in the Buckskin area, we acknowledge the need to work in partnership with other stakeholders in the catchment to develop long-term solutions to the underlying causes of flooding.

4.3 Investigations and activities completed to date

Table 2 details the investigations and actions that we have completed in recent years within the Buckskin area. These form the extent of our current understanding of issues.

Table 2 Investigations and activities completed

Activity	Purpose	Date complete	Outcome
Site reconnaissance	Photographic evidence was collected during the floods of 2014.	March 2014	Sources of floodwater were documented and impacts on Thames Water assets were noted.
Jetting, Root Cutting and Sewer Cleaning	Extensive sewer cleaning operations were carried out in 2014 to remove silt and detritus.	March 2014	Ensure sewers are free from obstructions and have capacity to convey flows.
Borehole logger installation	A pressure transducer and logger on the 142 Pack Lane Borehole.	March 2014	Allowed for more accurate monitoring of groundwater levels.
Sewer and manhole surveys	4km of foul sewer and 900m of surface water sewer surveyed to ascertain sewer condition and gain evidence of infiltration and blockages.	April 2014	Identified lengths of sewerage requiring rehabilitation or repair.
Installation of permanent depth monitors	Installation of permanent depth monitors into the foul and surface water sewers at strategic locations in Basingstoke. We plan for the monitors to remain in situ for at least 5 years as a minimum, to enable us to capture future wet weather events such as those which impacted the Buckskin area which will improve of understanding of how the catchment reacts to groundwater and rainfall. We will analyse the recorded depths and compare them with other catchment variables, such as rainfall events and changes in groundwater levels.	Winter 2014	Permanent monitoring of sewer levels.

Activity	Purpose	Date complete	Outcome
Localised sewer repairs	Repairs undertaken following review of CCTV data to address roots and ingress of groundwater and to ensure service is maintained. 850m of sewer lined or patch repaired and 4 manholes sealed.	March 2015	Reduce infiltration into the public sewers.
Manhole cover replacement	Replacement of 48 manhole covers with leak tight covers where identified through survey work.	March 2015	Stop ingress of surface water through manholes located in flood plain.

In summary, following the impact of the 2013/14 winter considerable action has been taken to better understand the sources of infiltration and inundation in the area, to assess the impact on our assets and to ensure that our sewers are more resilient. On occasions where customers have brought flooding issues to our attention, we have reacted to clean-up any residual pollution.

We have also aimed to maintain the health of our assets by performing maintenance and clean-up work on our network to minimise potential problems. As previously stated, we have installed depth monitors in the sewers which we will continue to monitor as our strategy develops and we are working with the other stakeholders, notably Hampshire County Council and Basingstoke and Deane Borough Council, to ensure that a suitable approach is adopted to addressing future drainage issues in the catchment.

4.4 Activities carried out by drainage partners

Table 3 below, details the activities carried out by other stakeholders with drainage responsibilities within the Buckskin area, to reduce the risk of flooding in the area. For more detail on the other organisations responsible for managing various forms of drainage within the catchment, please see Section 1 of this Drainage Strategy document.

Table 3 Actions by other stakeholders to prevent flooding

Activity	Purpose	Impact on sewerage
Temporary Pumping	Temporary pumps were used on Ochil Close and Grampian Way to remove flood water and alleviate sewer surcharge.	Reduce the volume of floodwater entering the foul drainage network.
Routine maintenance of River Loddon, watercourses and local ditches	Ensure free flow of river and ditches.	Less risk of surface water inundation into the foul sewers and hence less risk of sewer flooding, pollution incidents and storm tank overflows at the sewage treatment works.
Routine maintenance of private surface water drainage and soakaways	Ensure adequate surface water drainage from properties.	Less risk of surface water inundation into the foul sewers and hence less risk of sewer flooding, pollution incidents and storm tank overflows at the sewage treatment works.
Routine maintenance of highway drainage	Ensure adequate highway drainage.	Less risk of surface water inundation into the foul sewers and hence less risk of sewer flooding, pollution incidents and storm tank overflows at the sewage treatment works.
Routine maintenance of land drainage	Ensure effective land drainage.	Less risk of surface water inundation into the foul sewers and hence less risk of sewer flooding, pollution incidents and storm tank overflows at the sewage treatment works.
Strategy for infiltration through private drains*	Consider a strategy for reducing infiltration into the sewer network via private drains if investigations and permanent monitoring identifies this as a significant cause for concern.	Less risk of groundwater infiltration into private drains and hence less risk of sewer flooding, pollution incidents and storm tank overflows at the sewage treatment works.
Monitoring and control of construction standards for private drains	Local Authority Building Control to ensure private drainage is fit for purpose.	Less risk of groundwater infiltration into private drains and hence less risk of sewer flooding, pollution incidents and storm tank overflows at the sewage treatment works.
Sharing of information	Agencies to share information to ensure collaborative approach to groundwater infiltration, surface water inundation, pluvial and fluvial flooding. Use forums as appropriate, e.g. River Loddon flood forum.	Identification of most cost beneficial solutions and quicker resolution of issues.

Activity	Purpose	Impact on sewerage
Incident Investigation into Buckskin Flooding[13]	Hampshire County Council employed consultants CH2MHILL to investigate the flooding in the Buckskin area that occurred in 2014 and are developing proposals to address the surface water issues.	The feasibility report identifies a number of options to address excess surface water.
Hydrogeological Assessment[8]	Basingstoke and Deane Borough Council have assessed the hydrogeological conditions in the Buckskin area.	The report makes a number of recommendations and suggests that a joint agency flood response plan is developed.

*Thames Water does not have powers to compel customers to repair defective private drains at their cost. At this stage, we do not know how significant infiltration from private drains is within the Basingstoke catchment, but we will develop an appropriate strategy as part our of Stage 2 risk assessment, when information becomes available and this document is updated. We note that local authorities are only able to instigate action under Section 59 of the Building Act where evidence is provided of a defective private drain.

As summarised above, both Hampshire County Council[13] and Basingstoke and Deane Borough Council[8] commissioned reports into the flooding incidents that occurred in the winter of 2013/14.
The Hampshire County Council Report concludes that the primary flooding mechanism was due to groundwater and surface water which lead to secondary foul water flooding due to inundation of the foul sewerage system. The Basingstoke and Deane Borough Council report supports this stating that groundwater levels were exceptionally high as "a result of exceptionally high rainfall sustained over at least three consecutive winter months" Page 65, 6.1.1[8], but that "…the rate and volume of groundwater storage release may have been exacerbated as the elevated groundwater levels rose to the level of the sewers, drains, ditches and soakaways, leading to groundwater infiltration into these structures. Some of this groundwater infiltration may potentially have also exacerbated groundwater flooding downstream through reduction of the effective capacity of these structures to drain surface water and sewer flows." Page 65, 6.1.4[8].

The two reports are slightly contradictory, one suggests that foul flooding was a secondary measure of the groundwater flooding, and the other suggests that the flooding may have been exacerbated by groundwater entering the foul sewers (and other non-TW assets), and flooding further downstream. The Stage 2 Drainage Strategy investigations that we will undertake, will enable us to gain a greater understanding of the impact groundwater has on the foul sewers in the Buckskin area, and to develop measures to reduce inflow and ingress where identified.

Further details on the Hampshire County Council Report[13] can be found via the following link:

http://documents.hants.gov.uk/flood-water-management/investigation-reports/buckskin-final-report-1a.pdf

Hampshire County Council has undertaken further modelling of the existing surface water infrastructure and identified a number of options to reduce the flood risk in the Buckskin Area. They have produced an initial feasibility report and are now engaging with all flood risk management authorities, including Thames Water, as well as other stakeholders and residents, to ensure that a collaborative approach can be developed to address the flooding issues.

[13] Technical Report - Final report on Incident Investigation into Buckskin Flooding, Hampshire County Council, July 2014.

5 Future challenges

In 2011, Ofwat commissioned Mott MacDonald to look at factors likely to affect sewerage networks in the future. The report 'Future impacts on sewer systems in England and Wales' (June 2011)[14] looked at the likely relative impact of climate change, population growth and impermeable areas up to around 2040. In preparing our plan for 2015-2020, we have also carried out research into these factors across the Thames Water region. We summarise our findings in this section for the Basingstoke catchment.

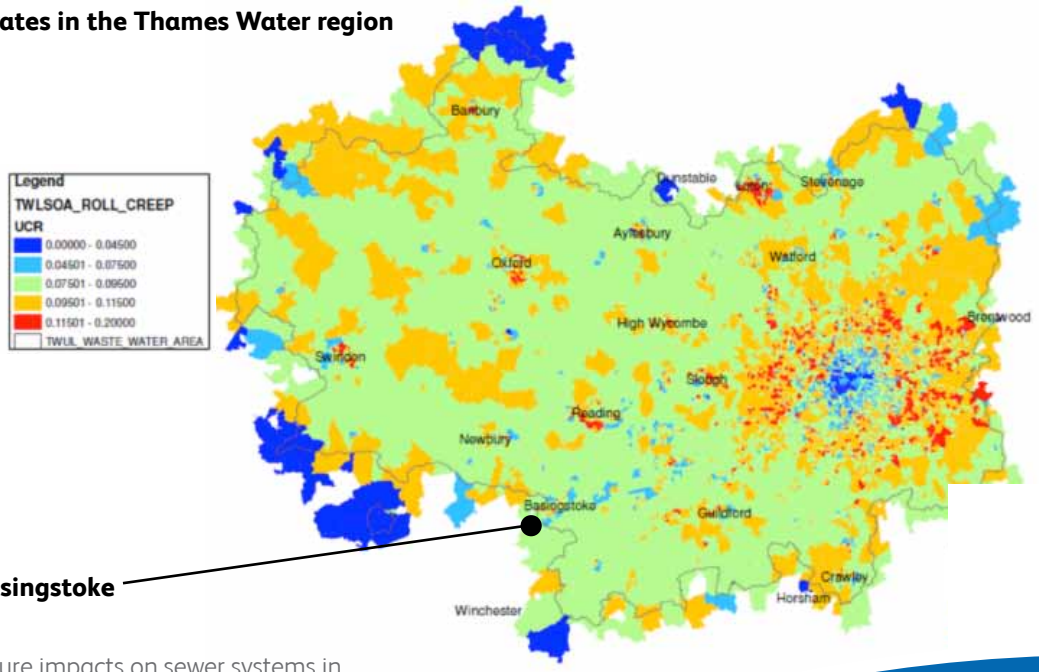
5.1 Urban creep

Urban creep is defined as the transformation of a catchment by the paving over of previously permeable areas and excludes extensions to existing properties and other land use changes. Rather than surface water soaking into the ground when it rains heavily, more water runs off into the sewerage network and can cause the sewers to surcharge and flood. It is therefore important to understand the rate at which urban creep is occurring.

We have studied aerial photography and satellite imagery across 11 catchments across the Thames Water region using data from two periods in the late 1990s and mid-2000s to determine the rate at which urban creep is occurring. We then carried out a statistical analysis and built a model to predict the rate of urban creep for the entire Thames Water region, taking account of factors such as property age, land use, demographics such as family sizes and financial income, need and available space. We found that affluent suburban areas with detached and semi-detached properties, where families have young children, are most likely to have high urban creep rates.

The results for the Thames Region are presented in Figure 6 below. The urban creep rate for Basingstoke is 0.0906%. In other words, this is the increase in impermeable area per year as a percentage of the total area connected to the sewerage network. When compared against the rest of the Thames Water region, Basingstoke is about average on the scale, but not as high as suburban areas around central London and major towns. Whilst the immediate issues in Basingstoke appear to be strongly related to groundwater, we will continue to monitor change in impermeable area as the strategy continues to develop. If we observe an increase in urban creep, we will raise the issue with Hampshire County Council who is responsible for managing surface water. We may then also look to work with other partners to retrofit sustainable drainage measures (such as permeable paving and water butts), in the area to counter the increased run-off following rainfall, to reduce the risk of flooding.

Figure 6 Urban creep rates in the Thames Water region



[14] Mott MacDonald, Future impacts on sewer systems in England and Wales, June 2011.

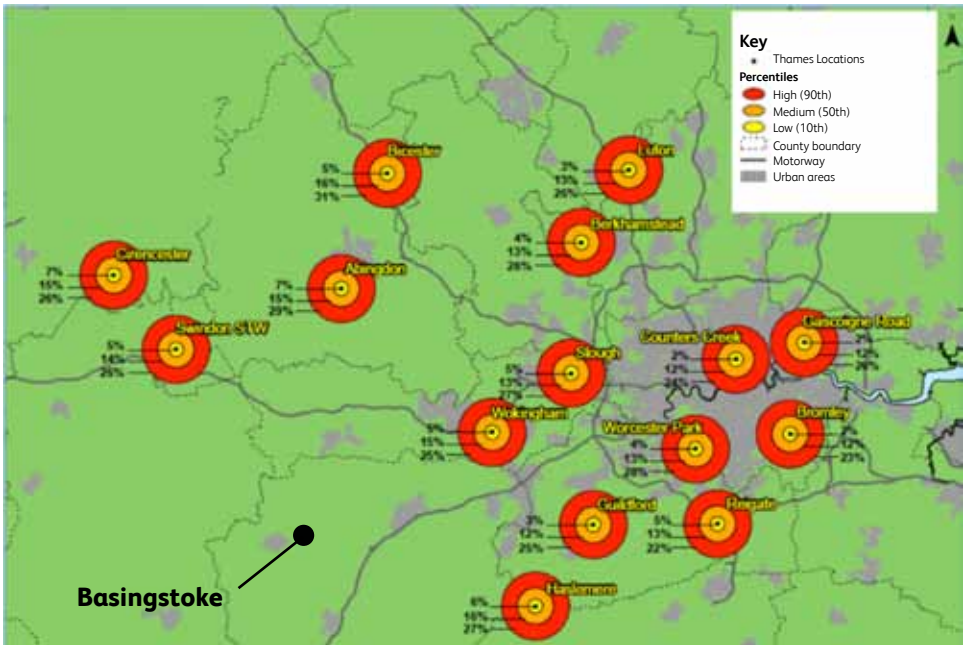
5.2 Climate change

We have analysed the 2009 UK Climate Projections (UKCP09), to determine the likely increase in rainfall intensity due to climate change in 15 catchments across our region[15]. More intensive rainfall in the future will increase the peak flow in sewerage networks and with it the likelihood of sewer flooding.

Fifteen catchments across our region were selected to give a representative sample of inner London, outer London and more rural areas in the Thames Valley. A number of these catchments are also areas which experience sewerage related issues like pollution, flooding and urban creep.

We assessed different combinations of emission scenarios and climate change percentiles for each of the 15 catchments. The nearest catchment to Basingstoke that was analysed for climate change was Wokingham. The results show a central estimate of an increase of 15 % in rainfall by 2080, but in some scenarios this could be as high as 25 % or as low as 5 % as shown in Figure 7 below. We will ensure that our strategy takes account of these potential increased peak flows as it develops.

Figure 7 Locations assessed for increased rainfall intensity by 2080



Increased rainfall intensity may not be the only consequence of climate change. UKCP09 data also suggests that the UK is likely experience longer wetter winters in future. Further research is needed to understand whether high groundwater levels, such as those observed in the winters of 2012/13 and 2013/14 are likely to become more frequent in future. As the recent experience of prolonged rainfall and high groundwater levels have been shown to be the principal factors, this research will be very significant in informing any risk assessment and appraisal of costs and benefits of solutions.

[15] Atkins, Thames UKCP09 Rainfall Intensity Assessment Revised Report, October 2012.

5.3 Population growth and new development

We use a combination of top-down and bottom-up information to ensure that our forecast of population and new development is as robust as possible to keep costs down, in order to minimise the bill impact of any investment that may be necessary.

Our forecast of the number of new households is taken directly from Experian data. We have used the 'Plan-Based' projection which uses information provided by local authorities about planned numbers of new dwellings in their respective areas and developer enquiries. During the period 2015 to 2020 we expect to see an increase in new development across the Thames Water region and are forecasting a total of 263,000 new connections to the sewerage network during this time.

Our Development Tracker System (DTS), is used to track developer enquiries through the planning process to construction. When we are contacted by a developer, we typically carry out preliminary modelling to determine whether our network or treatment works has the capacity to accommodate the increase in flow. Where it does not, we propose planning conditions for consideration by the Planning Authority, although we encourage developers to contact us as early as possible in the planning process to avoid this.

The independent review into the causes of the 2007 floods (The Pitt Review), concluded Sustainable Drainage Systems (commonly known as SuDS), are an effective way to reduce the risk of 'flash-flooding' which occurs when rainwater rapidly flows into the public sewerage and drainage systems, causing overloading and back-up of water. Typically, SuDS slow the rate of surface water run-off entry into the drainage system and improves the percolating feature, i.e. rainfall recharging the groundwater system, thus mimicking natural drainage processes. In April 2015, the Government made changes to the planning process effecting planning policies and decisions on planning applications of 10 dwellings or more (or equivalent non-residential or mixed development), to ensure that sustainable drainage systems are put in place, unless demonstrated to be inappropriate. This requires that when considering planning applications, local planning authorities should consult the relevant Lead Local Flood Authority (County Council or Unitary Authority) on the management of surface water, to satisfy themselves that the proposed standards of operation are appropriate and ensure, through the use of planning conditions or planning obligations, that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

In the case of Basingstoke, whilst SuDS might help to reduce the risk of flooding following heavy rainfall when groundwater levels are low (i.e. typically during summer months), they will not be effective in reducing flood risk when groundwater levels are high. We will take account of this when we come to assess options as part of this drainage strategy.

The Basingstoke and Deane Borough Council Local Plan identifies a number of potential development sites. In particular there is a large 333ha site immediately to the west of Buckskin at Manydown, Worting offering potential development of up to 4000 properties. We will continue to monitor future plans for the catchment through our stakeholder engagement work.

A key element of our assessments will be to establish the extent to which future developments may be significant in the context of the sewer flooding challenges currently experienced in the catchment. This assessment work will be undertaken and findings shared in an update to this Drainage Strategy document.

6 Strategy development

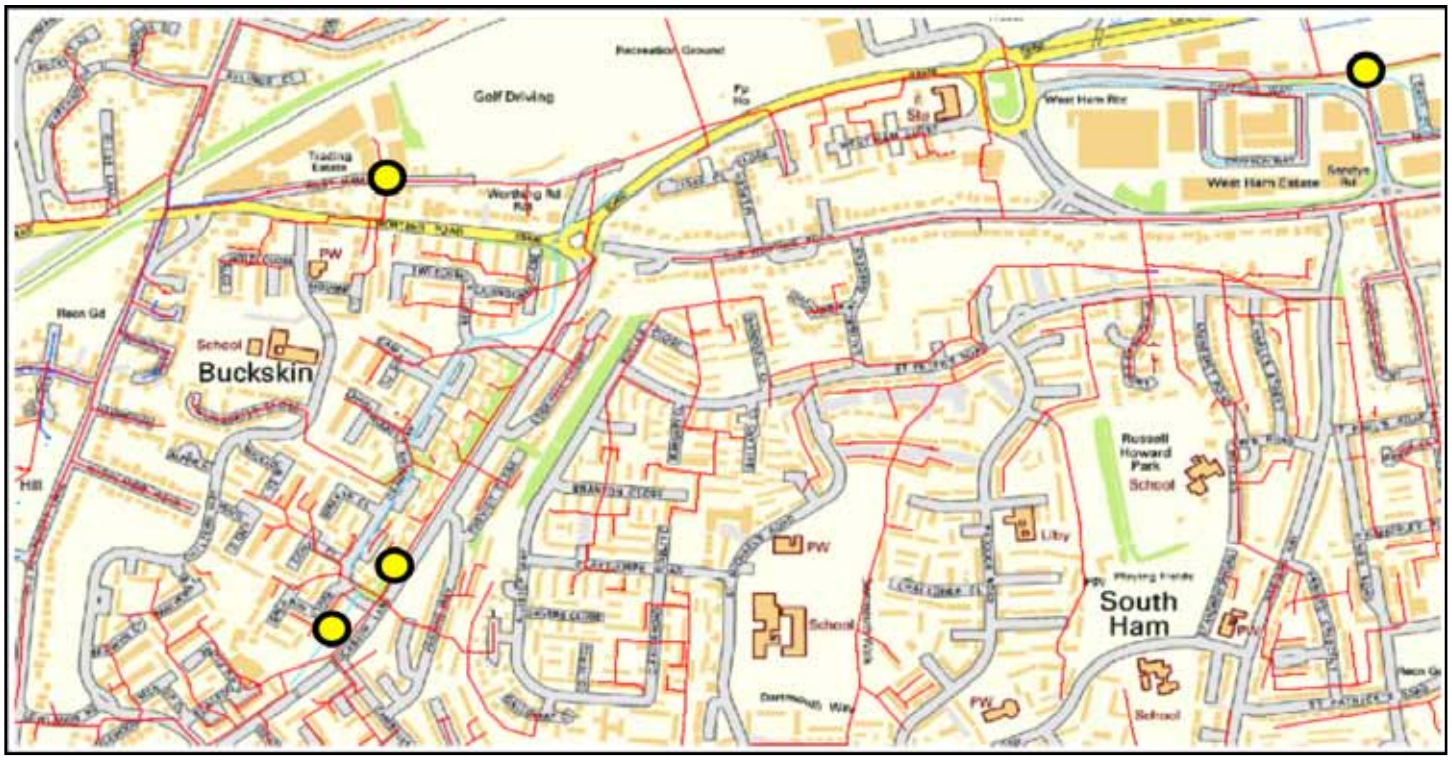
The Drainage Strategy for the Buckskin area of Basingstoke is currently at Stage 1 (Initialise/prepare), of the 4-stage framework process. The following activities in Table 4 are planned and ongoing, in order to carry out the risk assessment and development of our strategy options.

Table 4 Activities planned and ongoing to enable strategy development

Activity	Purpose	Date planned	Outcome
Stakeholder engagement	Circulate this document to the Environment Agency, Hampshire County Council and Basingstoke and Deane District before being published on our website for formal consultation. The Local Flood Forum will continue to be used as the primary route for stakeholder engagement.	Ongoing	Stakeholders informed about progress and timing of works to reduce the risk of flooding. Work carried out by Thames Water is coordinated with activities of other partners involved with drainage.
Permanent monitoring of sewer levels	Continue to monitor sewer depth monitors installed into the foul sewers. Our plan is for the monitors to remain in situ for at least 5 years, and to capture the next wet weather event as a minimum. We will analyse the recorded depths and compare them with other catchment variables, such as rainfall events and changes in groundwater levels.	Ongoing	Use information to identify additional actions for inclusion in the drainage strategy for Buckskin area of Basingstoke. Share information with other agencies.
Sewer and manhole surveys	Ascertain sewer and manhole condition and evidence of infiltration via CCTV survey and manhole "lift and look" surveys when appropriate.	From winter 2015	Use information to identify additional actions for inclusion in the drainage strategy for Basingstoke. Share information with other agencies.
Connectivity surveys	Carry out visual inspection of properties to determine the extent of roof drainage and other surface water drainage that discharges into the foul sewer network when appropriate.	From winter 2015	A better understanding of the contribution that misconnections make to sewer flooding in the area.
Pilot trials of mobile treatment plant	As part of our wider approach to managing high groundwater levels, we are trialling the use of mobile package treatment plant within other catchments. If successful, these could be used to abstract dilute sewage from surcharged sewers and discharge safely to a watercourse.	Ongoing	Service may be restored for customers without the need for tankering.

Activity	Purpose	Date planned	Outcome
Sewer rehabilitation	Continue to rehabilitate the sewer network in this area as we progress through this 4-Stage framework process, based on our investigations identifying defects that are considered to be contributing to, or causing, drainage and flooding issues in the catchment.	Ongoing	Reduce ingress of groundwater into the sewer network.
Update drainage strategy	Improve the drainage strategy based on the initial results from the permanent monitoring, customer surveys, misconnection surveys and feedback from stakeholders.	2017	Risk assessment, options appraisal and preferred strategy to be completed, subject to capturing weather events through monitoring and surveys.
Consider innovative solutions	Identify quicker / cheaper / collaborative options that improve the benefit to cost ratio in order to keep customers' bills down and to prioritise investment to ensure greatest benefit to customers.	Ongoing	Enhanced toolkit available to reduce the risk of sewer flooding and then apply this once data becomes available.

Figure 8 Depth monitor locations



7 Preferred strategy and plan

We believe that the foul sewerage system in the Buckskin area of Basingstoke has surcharged and flooded predominantly due to a combination of groundwater infiltration, surface water run-off from saturated land, surface water inundation from highways, public spaces and properties, and potentially, surface water misconnections. Our network strategy is to understand the relative impact that each of these factors has on the risk of sewer flooding, and then to develop a plan to identify cost beneficial solutions using customer willingness to pay research. In parallel, we will assess the extent to which proposed new developments may be significant in the context of challenges currently experienced and where necessary, we will develop solutions to accommodate the proposed future development in the catchment.

We may carry out some repair works as this strategy develops, in the event that our investigations identify faults or problems with the sewerage network that are highly likely to have caused flooding. Table 5 below, details the repair activities that we have identified to date.

Table 5 Activities identified in preferred plan to date

Activity	Purpose	Date planned	Outcome
Drainage survey	Ascertain details of private drainage chambers and waste gullies in flood vulnerable area to determine what further measures may be required to ensure greater resilience to surface inflow.	Ongoing	Use information to identify additional actions for inclusion in the drainage strategy for Basingstoke. Share information with other agencies.
Localised sewer rehabilitation	Undertake localised sewer rehabilitation to include lining, patch repairs, localised pipe replacement and manhole repairs identified through survey work and where considered cost effective in reducing ingress of groundwater and to ensure service is maintained.	When identified	Reduce infiltration into the public sewers.
Manhole cover replacement	Replace manhole covers with leak tight covers where identified through survey work.	When identified	Stop ingress of surface water through manholes located in flood plain.

Our plan will be updated once the Risk Assessment and Options Appraisal sections have been completed in accordance with the Drainage Strategy framework.

8 Temporary overflows

We have not installed temporary pipework and pumps in the sewerage network during wet weather events in the Buckskin area of Basingstoke to maintain service, but we would consider doing so to prevent the backup of sewerage into customers' properties and uncontrolled spilling from the sewer system into the environment.

As part of the Stage 2 risk assessment and Stage 3 options appraisal, we will be investigating the circumstances under which emergency discharges would be required in future, such as the use of temporary overflows, to pump out from the sewerage network through biological filters to maintain service to customers and prevent homes from flooding. As this Drainage Strategy develops, in this section we will describe the location of any proposed temporary overflows and the circumstances under which we would use them, in order that this Drainage Strategy, together with our plans to reduce infiltration, fully meets the requirements of an Infiltration Reduction Plan as set out in the Environment Agency's Regulatory Position Statement. We will continue to identify sewer rehabilitation and other permanent works to reduce groundwater infiltration alongside refining the use of temporary overflows.

Appendix A
Glossary of terms

Term	Definition
Blockages	Obstacles or the build-up of fat and grease, block or obstruct our sewerage pipes. This is normally caused by things which should not be flushed, or poured, into drains and sewers.
Combined sewer	A pipe conveying the combined rainwater and contaminated wastewater from two or more properties. A combined sewer is designed to carry wastewater to a sewage works for treatment but during periods of heavy rainfall or snowmelt, the volume in a combined sewer system can exceed the capacity of the sewer system or treatment plant. For this reason, combined sewer systems are designed to overflow occasionally and discharge excess wastewater directly to nearby streams, rivers, or other water courses.
Dry weather flow	The average flow rate observed over a 24 hour period in dry weather and based on Sewers for Adoption, the industry standard, includes an allowance for infiltration of 10% of the calculated flow rate.
Foul drain	A pipe conveying the contaminated wastewater from a single property. If the pipe extends beyond the property boundary, the portion of the pipe outside of the boundary is termed a lateral drain. The portion of the pipe inside the boundary is a private drain. On 1 October 2011 water and sewerage companies in England and Wales became responsible for lateral drains, which were previously the responsibility of property owners. Private drains remain the responsibility of property owners.
Foul sewer	A pipe conveying the sewage from two or more properties. On 1 October 2011, water and sewerage companies in England and Wales also became responsible for private sewers, which were previously the responsibility of property owners. A foul sewer is designed to carry contaminated wastewater to a sewage works for treatment. It disposes of wastewater from sources including toilets, baths, showers, kitchen sinks, washing machines and dishwashers.
Infiltration	Groundwater finds its way into the sewerage system (including private drains), via defective pipes or pipe joints and through the brickwork or defects in manhole structures.
Inundation	Accumulated surface water from rain and/or river floodwater that has resulted in localised flooding, finds its way into the sewerage system through manhole covers and drains. These may be public or private.
Lateral drain	See definition for Foul drain.
Misconnections (surface water to foul water)	Property owners have connected rainwater and/or land drainage to our sewers (e.g. roof drainage, paved driveways drains, soakaway overflows), and can cause major issues for the performance of the sewerage system.
Misconnections (foul water to surface water)	A plumbing mistake resulting in wastewater appliances being misconnected to the surface water system.
Private sewers	See definition for Foul sewer.
Rainfall induced infiltration	Sewer infiltration that occurs as a result of rainfall percolating into the ground impacting the sewer on route to recharging the groundwater table.
Riparian owner	If you own land adjoining, above or with a watercourse running through it, you have certain rights and responsibilities. In legal terms you are a 'riparian owner'. If you rent the land, you should agree with the owner who will manage these rights and responsibilities.
Soakaway	Surface water from a roof and driveway of a property is piped to an underground pit, usually filled with gravel or similar material. Some soakaways are situated within the boundary of the property.
Surface water drain	A pipe conveying uncontaminated rainwater from a single property.
Surface water sewer	A pipe containing uncontaminated rainwater from two or more properties. A surface water sewer is designed to dispose of rainwater from roofs, driveways, patios, roads, etc to a local watercourse.
Sustainable Drainage Systems (SuDS)	Measures designed to attenuate and slow down surface water before it enters sewers to reduce the risk of flooding following heavy rainfall. Includes green infrastructure such as raingardens, green roofs as well as other measures, such as permeable paving and water butts.

Appendix B
Supporting figures and photographs

Figure B1 Fluvial flood risk for Basingstoke based on Environment Agency plans

This flood risk map information has been sourced from the Environment Agency website. For more detailed flood map information for this catchment, please access the Environment Agency website.

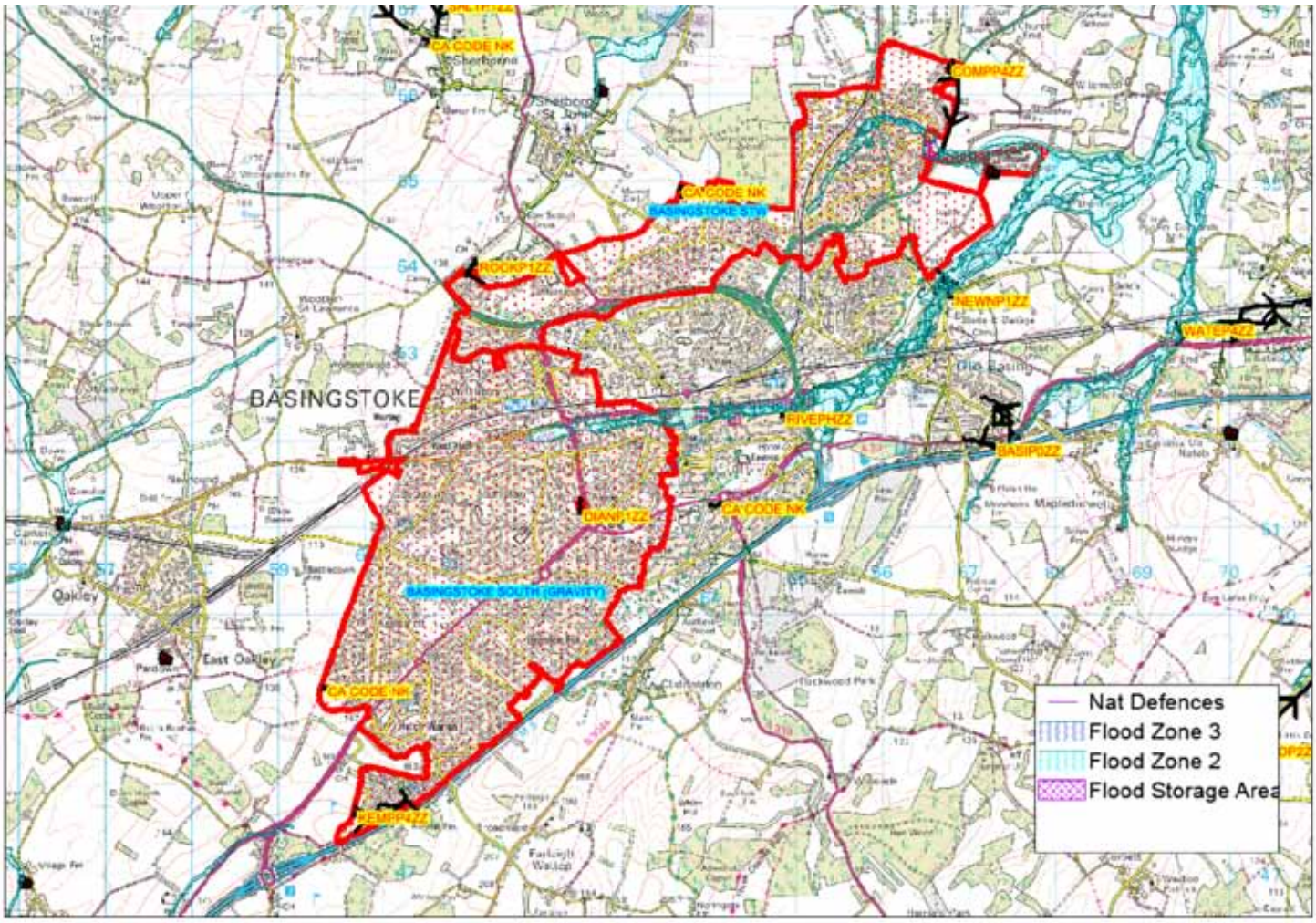


Figure B2 Surface water flood risk for Basingstoke from Environment Agency plans

This flood risk map information has been sourced from the Environment Agency website. For more detailed flood map information for this catchment, please access the Environment Agency website

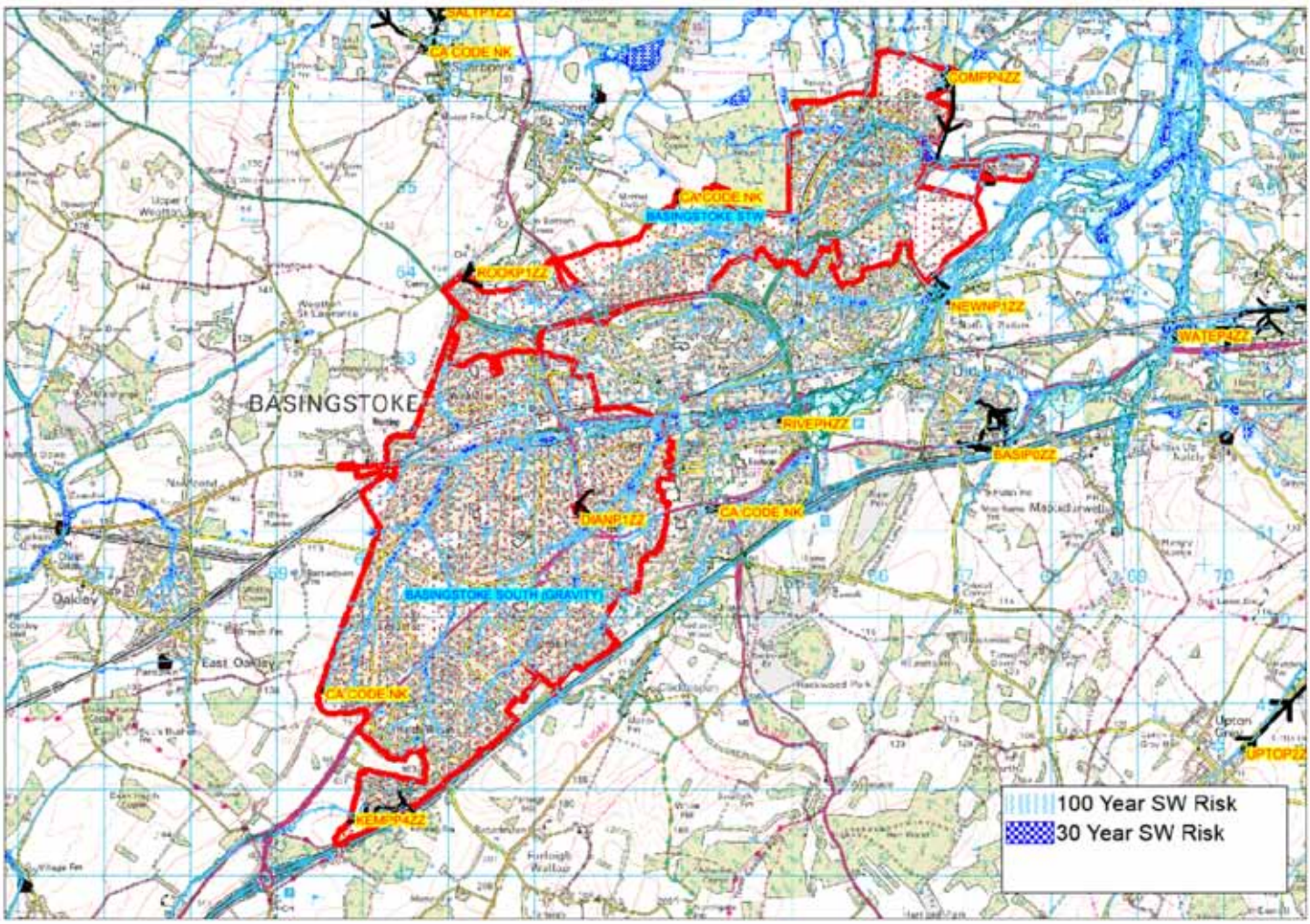
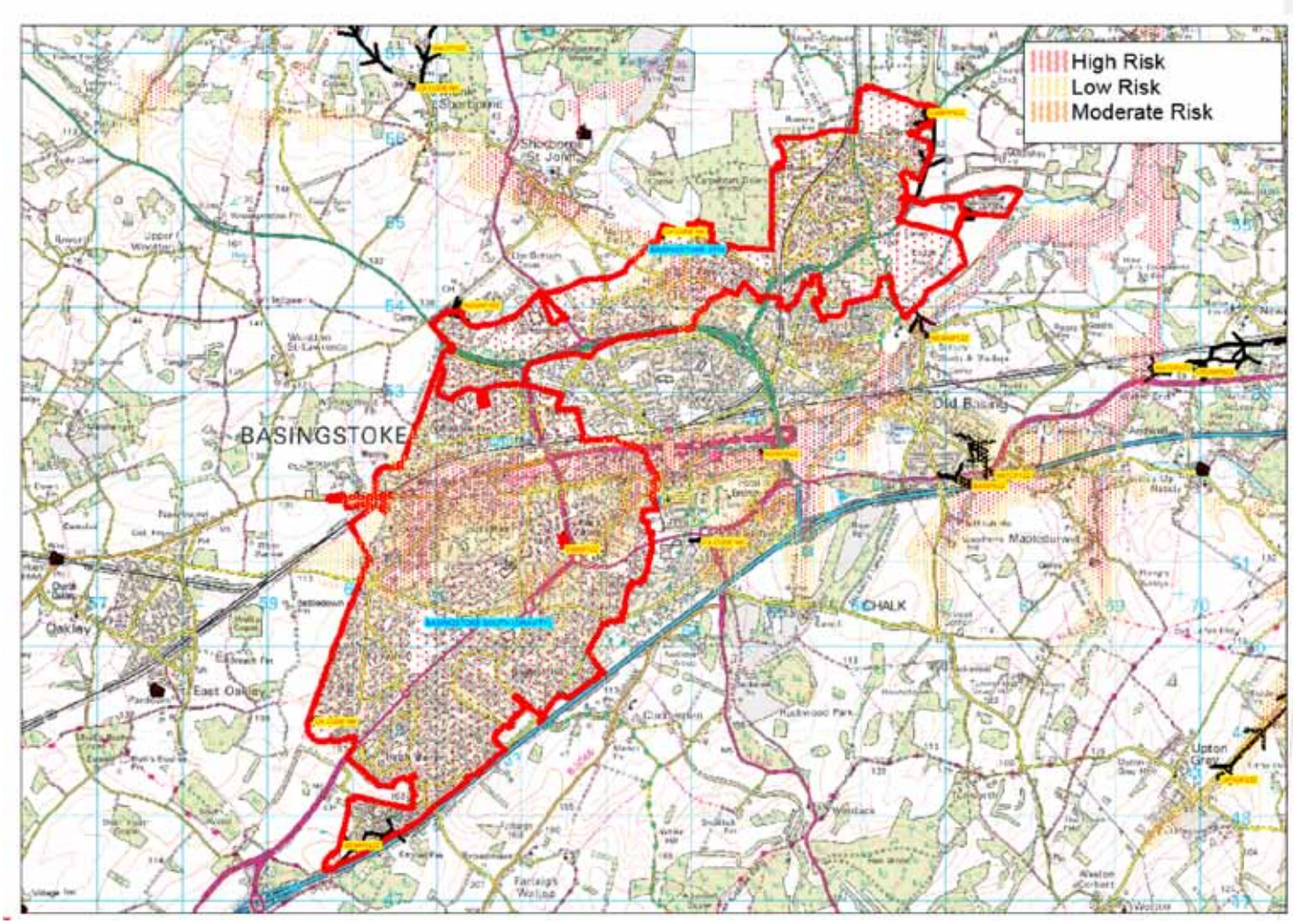


Figure B3 Groundwater flood risk for Basingstoke

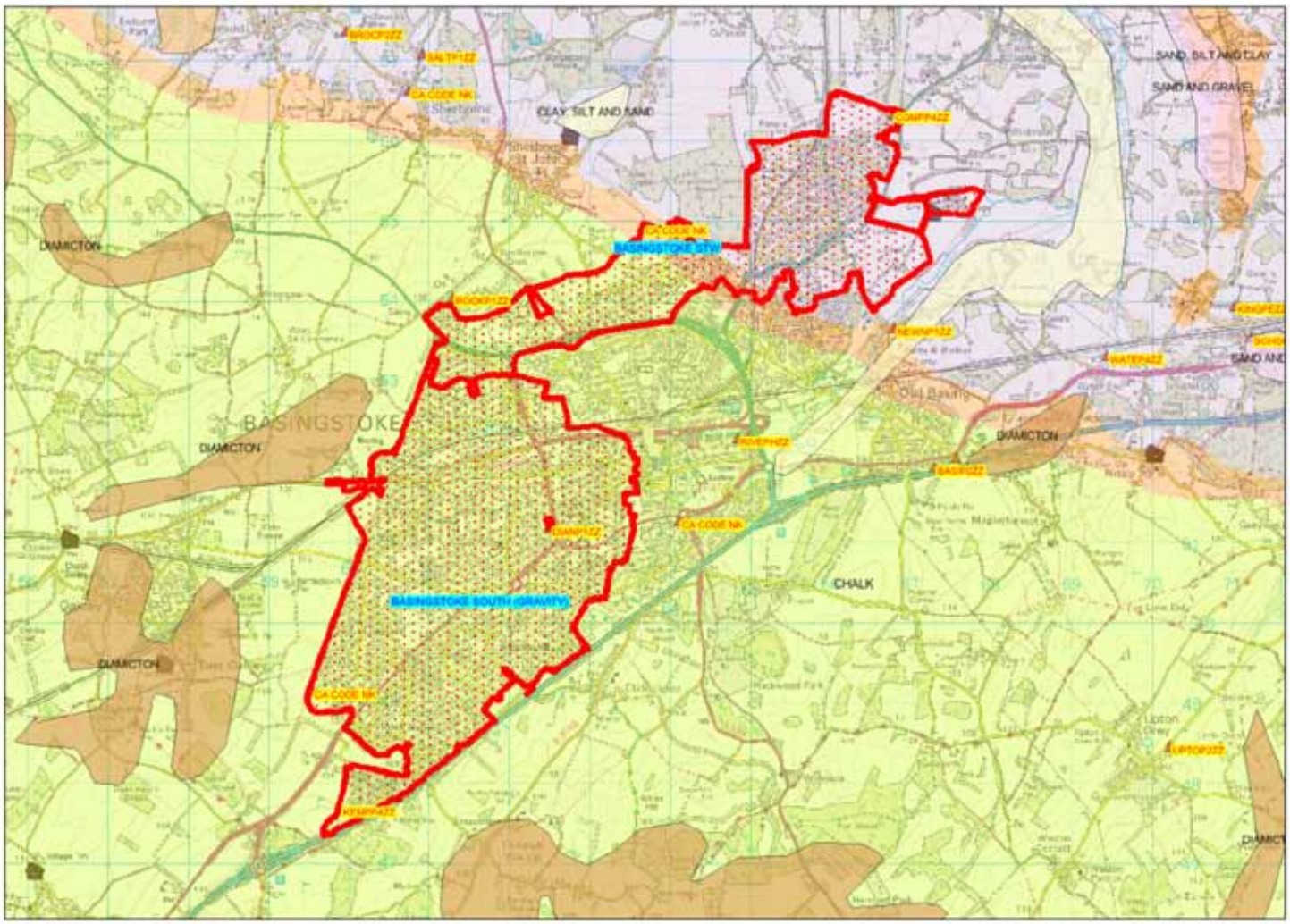
This groundwater flood risk map information has been sourced from ESI Ltd.



ESI Groundwater Flood Risk Map of England and Wales © www.esinternational.com

Figure B4 Basingstoke bedrock and drift geology

This geological map information has been sourced from the British Geological Survey website. For more detailed flood map information for this catchment, please access the British Geological Survey website.



Photographs taken during wet weather of 2013/14

Photo 1 – Resident pumping flood water into highway (Buckskin).

Photo 2 – Sandbags used by resident's shows extent of flooding (Buckskin).

Photo 3 – Highway flooding on Grampian Way submerging foul water manholes (Buckskin).

Photo 4 – Garden and property flooding at Quantock Close submerging foul water manholes (Buckskin).

Photo 5 – Highway flooding on Cleveland Close and road adjacent (Buckskin).

Photo 6 – Grampian Way closed due to flooding (Buckskin).

Photo 7 – Temporary traffic system for flooded highway (Buckskin).

Photo 8 – Tankering used to pump out manhole (Buckskin).

Photo 9 – Surcharged manhole (Buckskin).

Photo 10 – Residents pumping flood water into public foul sewer manhole (Buckskin).

Photo 11 – Debris cleared from watercourse at surface water sewer outfall (West Ham).

Photo 12 – Surcharged surface water manhole near old subway off Buckskin Lane (Buckskin).

Photo 13 – Emergency measures to protect SSE substation (West Ham).

At the heart of daily life