Sutton Courtenay FRA Evaluation

February 2013

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Background

Hydro-GIS Ltd was commissioned by **Keep Sutton Courtenay Rural** to undertake a critical evaluation of the flood risk assessments submitted on behalf of Pye Homes and Redrow Homes as part of the planning applications for development of new residential areas in land to the north of Milton Road, Sutton Courtenay, Oxfordshire. The report is divided into three sections: Part 1 considers the current characteristics of the site in terms of hydrology and flood risk; Part 2 looks specifically at the risk of flooding of the Ginge Brook to properties in Sutton Courtenay; and Part 3 is the critical evaluation of the development site flood risk assessments.

All measurements given in this report are in metric units: distance in metres (m) or kilometres (km); area in hectares (ha); volume in cubic metres (m^3); rainfall depth in millimetres (mm); flow in cumecs (cubic metres per second) or litres per second (l/s); elevation data expressed as metres above ordnance datum (m AOD).

Part 1 : Site Characteristics

Location

The Milton Road development site is located in Oxfordshire in the village of Sutton Courtenay, some 2.5km north west of Didcot. The development sites in total covers an area of 4.53 ha in the south west of the village, but immediately to the north of properties along the Milton Road. . The Pye Homes site to the west covers 1.66 ha and the Redrow Homes site to the east covers 2.87 ha. The site is situated on the flood plain of the River Thames, as evident from the descriptions of topography and geology in the following sections. The flood plain in this sense refers to the landscape unit rather than the flood outlines which are often incorrectly used as defining land to be within the flood plain. In terms of the local hydrology, the site is within the catchment area of the Ginge Brook, a tributary of the River Thames, which flows in a southwest-northeast direction. The detail of the site location is shown in Figure 1. The site in relation to the Ginge Brook catchment is shown in Figure 2. Both development sites are bordered by the existing residential area to the south with farmland to the north and west. The eastern border of the Redrow site is also delineated by existing properties.

Figure 1: Aerial photo of Sutton Courtenay showing the development sites in red: 1) Pye Homes, 2) Redrow Homes. Source: Infoterra 2013 scale 1:2500

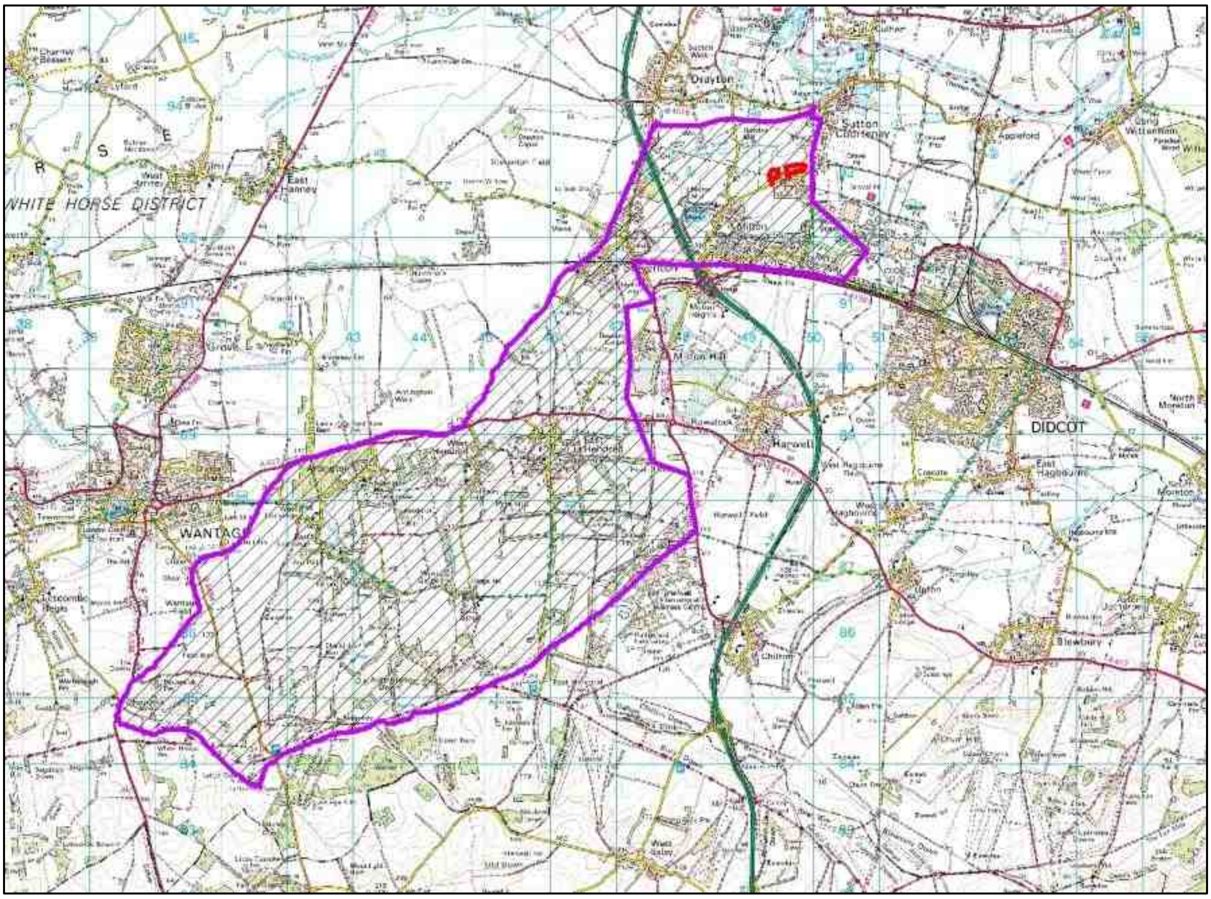

Figure 2: The location of the Sutton Courtenay development sites (red outline) in relation to the Ginge Brook catchment (purple outline). Background Map OS 1:50000 Sheet 174.

Catchment Hydrology

The development sites are within the Ginge Brook catchment, which drains an area of 39 km^2 and flows from the foot of the Berkshire Downs some 8km to the south. The watershed on the Downs has an altitude of over 200m AOD and the Ginge Brook emerges at springs with an altitude of around 125m AOD, and flows to meet the Thames at below 50m AOD. Over half of the catchment area is over the permeable Chalk, while the remainder drains areas underlain by Greensand and impermeable Gault and Kimmeridge Clays to the north. The northern areas of the catchment, around Sutton Courtenay and Appleford also have extensive superficial deposits of river alluvium, sand, gravel and claysfrom terraces deposited as part of the former course of the River Thames. The areas of sand and gravel in particular give rise to more permeable areas locally. The Ginge Brook catchment has a base flow index of 0.85, meaning that the brook is predominantly groundwater fed due to the large contribution form the chalk.

The catchment has an annual average rainfall of 674mm which is low compared with the UK as a whole and is in one of the drier regions of the country. The catchment is essentially rural with no major urban areas, just small villages which cover approximately 2% of the land area. The majority of the area is used for farming with roughly half of the area under arable on the more freely draining soils over the Chalk, with permanent grazing on the wetter clay soils. Flows in the Ginge Brook are not regularly monitored although there is a flood warning station which responds to raised water levels at Steventon. Generally given the size of the catchment and relatively low rainfall, flows in the

Ginge Brook would be low but because of the groundwater contribution when flooding occurs, flows would remain high for a period of over some days or even weeks. Likewise the contribution of groundwater is able to sustain flows during dry periods.

Topography

The site is an area of rough grazing with sparse bushes and bordered by larger trees. It is generally flat to undulating in terms of the surface topography with an altitude of approximately 57m AOD. A more detailed representation of the topography is shown by the contour map in Figure 3. The contours are taken at 0.25m intervals from a digital terrain model (DTM). This is a computer representation of the ground surface with spot height measurements at regular 5m intervals from an aerial survey generated by Infoterra. The development sites both slope in a general south to north direction The Redrow site levels range from 58m AOD along the south western edge to 56.25m AOD along the north-eastern boundary. There is also a circular depression of below 56m AOD in the south-eastern corner, and the land does rise again by 0.5m just after the northern boundary. The Pye homes site has a similar range of levels but slightly higher from 59m AOD in the south-west to 56.25m AOD along the northern boundary. Both sites are downslope from the houses along Milton Road, and the road itself is marginally higher at a maximum of 59.25m AOD. The general slope continues northward 300m from the site boundaries to the Ginge Brook at 54m AOD. Land to the south of Milton Road is lower again in altitude dropping below 59m AOD apart from a small area south of the Pye Homes site where levels rise up to 59.25m AOD.

Figure 3: The topography of the development sites and surrounding area.

Soils and Drainage

The site is poorly drained and surface ponding is common during the winter or following periods of heavy rain (Figure 4). The Soil Survey of England and Wales maps (1981) show the sites to be at the boundary of the Thames and Sutton 1 soil series. Thames soils are poorly drained clays which are seasonally waterlogged located close to rivers and overlying impermeable alluvium and clay. The Sutton 1 series are more freely draining clay loams overlying sands and gravels but can be affected by rising groundwater during wet periods. Thames soils are left for grazing but Sutton 1 soils are used for arable farming. Infiltration tests on the soil in the garden of no. 64 Milton Road at a point 7m from the Redrow Homes site during February 2013 found the soils to be saturated with infiltration of just 10mm/hr. A nearby hole showed water at a depth of 0.16m (Figure 5), and the mottled grey/light brown colour of the soil would suggest this is the Thames series and water has seeped out from the topsoil and ponded over the impermeable clay. It is not possible to precisely define the soil type without reference to a proper soil profile from a trial pit or soil auger cores.

Figure 4: View across the development site from 64 Milton Road looking east, showing water logging.

Figure 5: Water at 0.16m depth in the garden of No. 64 Milton Road, 7m from the southern boundary of the Redrow Homes site.

Areas of standing water were visible in both development sites and in particular standing water was at a depth of 0.2m along the edge of the Pye Homes site next to the north-west corner of the development. These could also be on areas of Thames soils with the impermeable clay or in the Sutton 1 series where depressions make the rising groundwater pond over the surface. High groundwater would be expected given the time of year and the very wet conditions experienced in 2012 from April through to December. Residents at 90A Milton Road, on the eastern border of the Pye Homes site also experienced considerable surface water ponding of their garden in February 2013, which extended into the neighbouring paddock in the land between the two development sites, as shown in Figure 6.

Drainage ditches flow around the western perimeter of the Pye Homes site and along the northern perimeter of the Redrow Homes site then north into Ginge Brook approximately 300m away. In February 2013 the ditch along the western edge of the Pye Homes site was observed to be spilling over its banks with standing water in the development site (Figure 7). There was no obvious flow of water and vegetation growth had contributed to reducing the ditch capacity and its ability to convey water away from the site. From the topography it is clear that with the general south-north slope the natural drainage pathway would be from Milton Road and the houses along its northern side to the development sites. This would include both surface runoff over impermeable and saturated areas and sub-surface flow through the unsaturated permeable soil layers. The surface depression areas in the Redrow Homes site would be particularly susceptible to standing water.

Figure 6: Surface water in the land between the two development sites, looking east towards the Redrow Homes site.

Figure 7: The ditch flowing along the western boundary of the Pye Homes site, currently exceeding capacity with the houses on Milton Road in the background.

Historical Flooding

It is difficult to find quantitative records of historical flooding as the flows on the Ginge Brook are not monitored and the flood level warning station has only been in place since 2006. Also as the River Thames flows through Sutton Courtenay records of historical flooding in the village from sources such as the British Hydrological Society Chronology of Extreme Hydrological Events (Black and Law, 2004) tend to discuss the floods on the River Thames and overlook the impact of Ginge Brook. There is mention in the database however of floods at Steventon from the Ginge Brook in November 1903, and also flooding of East Hagbourne in December 1903 and May 1908 which is also attributed to the Ginge Brook. It is also most likely that the Ginge Brook flooded in March 1947, when the worst flooding of the 20th Century was experienced on the Thames and many of its tributaries caused by the melting of snow following severe cold weather from January to early March when snow accumulations reached 2m in places (Holford, 1978).

Other documented evidence of flooding in Sutton Courtenay include a report in the Oxford times of flash flooding in September 2006 and reference to a flood extent from September 1992 in the Strategic Flood Risk Assessment (SFRA) for South Oxfordshire and Vale of White Horse District Councils (JBA Consulting, 2009). The SFRA also lists an occurrence of groundwater flooding in Sutton Courtenay and describes the risk of surface water flooding (directly from heavy rainfall) as medium.

There is however very good documented evidence of flooding from the Ginge Brook in July 2007. The summer of 2007 was remarkable for the wettest May/June/July on record for the UK with widespread flooding experienced across the country. The flooding at Sutton Courtenay occurred over 20th- 21st July following extreme rainfalls in the area approaching 100mm in the preceding 24 hours. A total of 95mm was measured at the Environment Agency rain gauge at Standford between 23:00 on 19th July and 15:00 on 20th July and 77mm was measured at Abingdon over the same period

(McKnight, 2008). This is considerably more than the long term average rainfall over the Thames catchment for the full month of July at 49mm. The Environment Agency documented that 73 properties flooded in Steventon, but many properties were also flooded further downstream in Sutton Courtenay (Figure 8).

Figure 8: Flooding of the Ginge Brook in Sutton Courtenay, July 2007.

The flow of the Ginge Brook was particularly high for the 20th July event as the flows were already high following the very wet period over May, June and early July. The wet weather meant that soils which were normally dry at this time of year were saturated and the flow from the chalk fed springs was also high due to high inflow of groundwater. There was very little storage capacity for the ensuing extreme rainfall so much surface water flooding occurred, drains were overwhelmed and rivers burst their banks.

Current Flood Risk

The Environment Agency flood risk maps show the predicted 1 in 100 year and 1 in 1000 flood outlines (Figure 9), which cover a significant part of Sutton Courtenay. The flooded area affected by the River Thames is generally to the north of the Drayton Road, while the Ginge Brook affects an area to the south of the Drayton Road. Although the River Thames flood outlines have been the result of a rigorous study using channel cross sectional surveys and detailed computer modelling, the flood outlines for the Ginge Brook have been generated from a general countrywide methodology which is not particularly accurate and only estimates the extent of flooding assuming a bankfull state of the river. This lack of accuracy is demonstrated by the fact that the predicted flood outlines for the Ginge Brook are not consistent with the course of the river as shown by the dark blue line on Figure 9. These maps on their own are not reliable enough to quantify the risk of flooding required for allowing development or insurance of property and a site specific study of the Ginge Brook should be made.

Furthermore the maps only cover the main rivers which are those shown by the dark blue lines. The flood risk from the smaller ditches flowing from the development sites (e.g. Figure 7) is not shown.

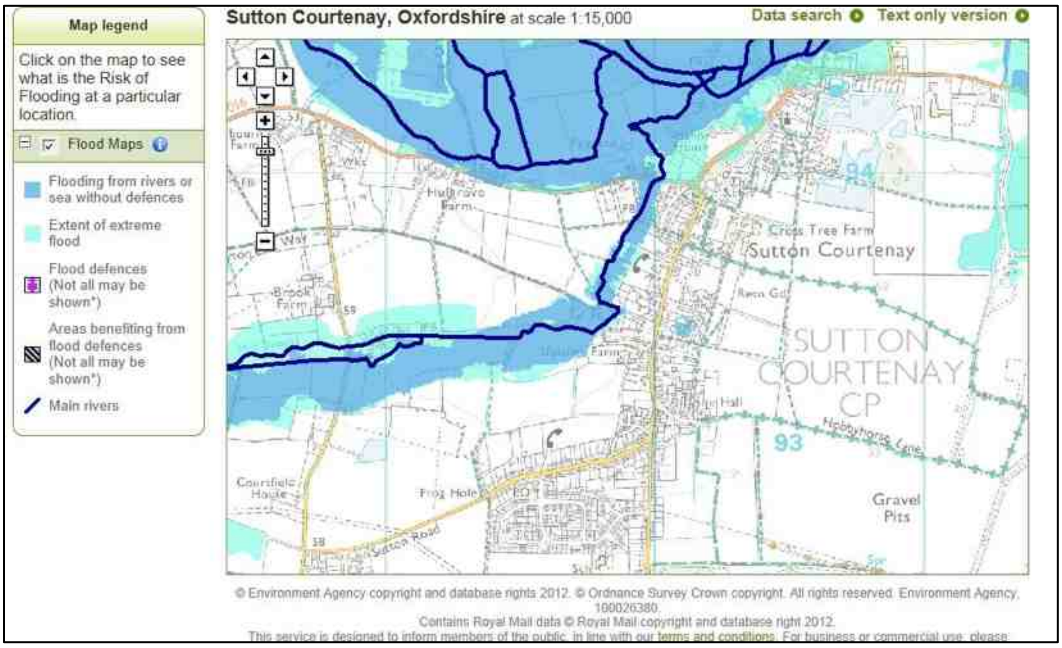

Figure 9: Environment Agency flood risk maps for the Ginge Brook at Sutton Courtenay.

Part 2: Current Flood Risk at Lower Mill, Ginge Brook

Introduction

An assessment was made of the flood risk at Lower Mill, the property shown in Figure 8 and 10, where the Ginge Brook actually flows in a culvert under the house, as shown in Figure 10. It should be stressed that the following text is just an initial assessment using rough measurements and estimates made during an inspection February 2013. A proper assessment would require detailed measurements of the channel and culvert at a number of cross sections along a reasonable reach length of the Brook (e.g. 500m) made using calibrated surveying equipment to an approved height datum. Hydrodynamic modelling would then be required, using specialist computer software to calculate the levels associated with different flows within the channel given the complexity of the channel shape.

Figure 10: View of Ginge Brook in February 2013

Channel Characteristics

At the Lower Mill culvert, the channel is constrained so for the same flow to pass through the culvert as is observed in the river channel, the velocity must increase since the flow is the velocity multiplied by the cross sectional area. However at times of high flow, the increase in velocity cannot satisfy the confines of the culvert to convey the required flow so water will back up upstream of the culvert inlet, which is what happened in 2007. Water entered Lower Mill and neighbouring properties, as shown in Figure 11.

Figure 11: Flood water on the Ginge Brook immediately upstream of the Lower Mill culvert, showing the flooding of the neighbouring property.

The channel just downstream of the culvert was measured as 2.8m wide with the current water levels (measured from the bed) of 0.4m at the edge and 0.5m in the centre of the channel. The current water levels were 0.35m below the top of the banks, as shown by the position of the low stone wall to the left in Figure 9. The flow in 2013 was high as it was during a period of flood alert issued by the Environment Agency. Using the cross sectional measurements and an single simple measure of velocity by timing the movement of a floating object over a measured reach the flow for the conditions in Figure 9 was estimated at 1.3 cumecs (cubic metres per second). Under low flow conditions (Figure 12) the culvert is clearly visible. The 2007 flood was considerably more than February 2013. Water is shown flowing over the footbridge in Figure 8, and the top of the footbridge is a further 0.25m above the bank top.

Figure 12: The Ginge Brook at Lower Mill during low flow conditions.

Flood Frequency

An indication of the frequency of flooding can be inferred from the flood warning records on the Ginge Brook at Steventon. The Environment Agency has a three tier warning system going from *flood alert*, *flood warning* to *severe flood warning* in severity. From November 2006 a total of 23 flood alerts have been issued, corresponding to flows near to or at bank full at Lower Mill. The flood alert was raised to a severe flood warning (meaning immediate danger to lives and property) during the event of July 2007. No other flood warnings or severe flood warnings have been issued over the period. The number of warnings over the six full years (2007 – 2012) is shown in Table 1. Flood alerts can be in place for a period of up to a week, depending on the conditions. It is difficult to assume an average per year value based on these as 2007 and 2012 were exceptional years, with 2007 having the wettest May/June /July on record and 2012 being the second wettest year on record for the UK. The flooding in 2007 was the first time residents had observed any flooding of the properties in approximately 50 years. Analysis of the 2007 flood event (Marsh and Hannaford, 2007) estimated the flood in the nearby Letcombe Brook (7.5km to the east) to have a return period of 1 in 200 years, given the proximity of the river it is reasonable to say the flood on the Ginge Brook would have been a similar severity.

Table 1. Flood Warnings on the Ginge Brook at Steventon from EA data

Year	Flood Alerts	Flood Warnings	Severe Flood Warnings
2007	6	1	1
2008	4	0	0
2009	2	0	0
2010	0	0	0
2011	0	0	0
2012	8	0	0

However, it is the case that such extreme events are going to become more likely due to the effects of climate change, so an average of 3-4 flood alerts per year would be a valid assessment over the next couple of decades. Observations from the residents of Lower Mill and neighbouring properties would support these findings, having described the Ginge Brook to be at or just above bank full during the winter once every 2-3 years and the culvert under the house flowing at full capacity about 2-3 times a year. With extreme events becoming more frequent, the chance of a 2007 flood, currently occurring on average just once in 200 years would be reduced so events of such magnitude would occur perhaps once every 50 or just once every 20 years.

Climate change is not the only impact to increase the risk of flooding on the Ginge Brook, the effect of land use change and in particular the planned developments in Sutton Courtenay and future developments in the catchment area will increase the area of impermeable surfaces. Quantifying the actual effects of the Sutton Courtenay developments would again require a more detailed study using a computer model and information on the proposed drainage layout. However, because the of the ground water component of flow in the Ginge Brook the river levels do remain high so flood alerts can be in force for up to a week. There is a chance therefore that during the alert period a further rainfall event promoting rapid surface runoff from the new urban surfaces into the Ginge Brook could cause what would currently be a bank full situation, to spill out of bank and flood the properties. A detailed assessment of this risk should be provided by the Flood Risk Assessments submitted as part of the development site planning applications, the contents of these are discussed in the two following sections.

Part 3: Evaluation of Development Site Flood Risk Assessments

Pye Homes Development Site

A flood risk assessment (FRA) and proposed drainage strategy for the Pye Homes site was submitted by Infrastruct CS Ltd in December 2012. The submitted FRA looks like a considerable report of 48 pages but only 12 pages have actually been written in the report on the flood risk and the proposed measures to reduce the flood risk, and much of this information amounts to maps, photos or text extracted from other reports. Three pages are extracted from the National Planning Policy Framework (NPPF) guidelines, which is somewhat superfluous given the Environment Agency (EA) or local authority staff reading the FRA will be familiar with these guidelines. The remaining pages are further maps and drawings plus information provided by third parties such as the EA and Thames water.

The EA response has been to request that a simple proforma is to be completed giving values of the pre- development (greenfield) and post development flow and volume draining from the site under the design storm conditions and the measures implemented to show how the post development flow will be limited so as to not to exceed the greenfield values. This response from the EA is disappointing since its guidelines on producing FRA's state that the level of detail given in a FRA should be in line with the scale of the development. In general the FRA is very brief for the size of the development (i.e. a residential area of some 30 dwellings). The EA is apparently passing the review of FRAs for developments between 1 and 5 ha to the Local Planning Authority (Vale of White Horse District Council) who do not have the necessary staff expertise and have always relied entirely on the EA's assessments for all matters relating to flood risk.

Specifically there are a number of areas where the FRA is lacking in detail, these are: 1) the hydrology of the site itself and its situation within the wider landscape; 2) evidence for historical flooding at the site; 3) a detailed description of the methods used for the drainage design; and 4) the impact of the development and drainage design on the wider area.

These points are discussed in the following sections.

Hydrology

The FRA gives very little detail on the hydrology of the site in terms of the catchment where it is situated and the catchment characteristics, such as the climate, topography, geology, soils and land use. There is a brief mention of the nearby water-courses and the topography is described but only in relation to the site itself rather than the overall topography of the area. The FRA asserts that land to the west of the side is at lower levels and that the ditch flowing alongside the site would therefore flood the land to the west of the site (FRA Section 6.1) but since the presented topographic survey only covers the extent of the site there is no evidence to support this. Figure 7 of Part 1 of this report shows the ditch water to be flooding into the development site, disproving the FRA's assertion. No details are given on the ranges of flows and flow regime of the river to which the site area drains, or on the rainfall. No use has been made of the Flood Estimation Handbook (FEH -Institute of Hydrology 1999) which is the standard approved methodology for estimating flood risk in the UK.

For the site itself the underlying geology and soils are noted but there is no explanation in terms of how this would affect the movement of water on the site. Also no locations are shown for where the trial pits were dug to identify the soil type and there are no results of infiltration rates having been tested, which is a particular important parameter in relation to the drainage design. The description of the site drainage is only given in terms of the ditches and existing artificial drainage, there is no assessment of the natural drainage pathways making use of the topographic survey. The FRA assesses the risk of surface water flooding at the site to be low (FRA Section 6.2) stating that the area draining to the site is limited. However the topographic map presented in Part 1 and field evidence of standing water would suggest that there is a risk of surface water flooding since it is downslope from the Milton Road and the existing properties so the overall flow of any surface water would be towards the site.

The issue of groundwater flooding is given a medium risk in the FRA, which also states how groundwater levels were 0.3m below the surface in December 2012. No information is given on how many groundwater observations were made, but in February 2013 even higher groundwater levels were measured close to the site (0.16m see Figure 5), and the surface ponding observed on the site could have been where the groundwater reached the surface. Groundwater at a depth of 0.3m would have a significant effect on the infrastructure of the new development, such as causing drains to back up, soakaways to fail and difficulty in any foundation constructions. A better assessment would be a high risk of groundwater flooding.

The report would benefit by having a better presentation of the topographic survey. It is currently included as a CAD drawing with spot height levels. Converting this into a DTM would give a much clearer picture of the topography. In addition the survey should extend over a wider area to identify the levels of existing residential areas relative to the new development.

Historical Flooding

FRAs should always consider what flooding has occurred at the site in the past and provide information on the causes and characteristics of this flooding. The FRA gives no information on historical flooding at the site and does not even mention that some parts of the site were observed to be waterlogged, during the autumn and winter of 2012-2013. A wide range of published sources can be used to identify historical flooding at the site, such as the British Hydrological Society chronology of extreme hydrological events, British Rainfall, Environment Agency Section 105 Flood Risk studies, TV and newspaper reports and also information from the Local Authority and accounts from residents. Discussions with local residents have shown that flooding has been a common occurrence during the past year with frequent water-logging of the development site and Part 1 of this report presents further details of historical flooding in Sutton Courtenay, including some information from those sources listed above. The only reference to historical flooding in the FRA is through the South Oxfordshire and Vale of White Horse District Council Strategic Flood Risk Assessment.

Evidence from historical flooding is particularly important when flood alleviation measures such as the site drainage scheme are proposed based on computer modelling rather than using observed values. Any details of historical events, such as the observed rainfall could then be used to verify the design values taken for the computer modelling. For this purpose observations of extreme rainfalls in the vicinity of Sutton Courtenay would be useful. The FRA has no such information.

Methods Used for the Drainage Design

The FRA quickly moves on to describe a proposed drainage layout for the site making use of the reported soil conditions at the site to convey any excess surface water from the impermeable surfaces of the development into the groundwater. A major concern about the use of this method would be the naturally high groundwater observed at the site. In addition, in the FRA the description of the soil conditions at the site listed 0.3m of sandy clay over 0.5m of river gravel below which was the impermeable Gault (bedrock). Assuming the sandy clay topsoil is permeable (sandy loam would perhaps be a better description), the total depth of permeable material is 0.8m which is not a significant thickness of aquifer to which excess water could be discharged. During the winter the depth to the water table has been measured at 0.3m depth, so the volume of storage would be significantly reduced.

The drainage design is based on conveying surface runoff through permeable paving to cellular soakaways. Again the discussion of this in the FRA is lacking in detail and in particular calculations of the required storage volume or cross sectional drawings of the designs are not presented. The only drawing is a plan shown in Appendix D of the FRA and some dimensions are mentioned in the text with reference to modelling but no information is given on the design rainfall depth, the total void volume of the celluar features and the required storage volume. The text states that 50% of the roof areas will drain into the soakaways. It is normal practice for SuDS design to assume a worst case scenario that 100% of the rainfall on impermeable surfaces will be conveyed as surface runoff which will require some form of attenuation. The FRA givens no details on what will happen to the rain falling on the other 50% of the roof areas.

The drainage layout has been tested using the Micro-Drainage software and results from these simulations are given in the appendix. However no detail is given describing this software and how it is applied. One immediate concern is that the results of the software list the rainfall as being calculated using the FSR. This is the Flood Studies Report, a UK Government research report produced in 1975 (NERC, 1975), giving a method to calculate design floods and rainfalls for any location in the UK. However this method was replaced by the FEH in 1999, which is now accepted as the standard approved methodology. The FEH included a further 20 years of observed data, improved calculation techniques, and the use of proper computer modelling software to give more accurate estimates. Any drainage design should be tested using FEH derived rainfalls.

The lack of detail in the drainage design leads to concerns as to whether the cellular soakaway volume given in the drainage layout is sufficient to store all of the water draining from the new development. The FRA requires some simple calculations in the text showing the depth of design rainfall, depth of soakaway, storage of volume soakaway (assuming a permeability of the fill) and the total volume of the design rainfall and surface runoff conveyed to the soakaway. Under conditions of high groundwater, it is likely that the capacity of soakaways will be significantly reduced giving rise to more rapid surface water runoff at the site into Ginge Brook and the potential to cause flooding to the vulnerable properties as described in Part 2 of this report. The values entered in the EA proforma as shown in Appendix G of the FRA are also questionable. The current flow from the greenfield site is listed as zero over a range of return periods. Under wet conditions, as observed in February 2013 surface water was evident on the site. As there is an overall 2m slope from south to north this water will flow to the lower ground levels. Under extreme conditions such as a 1 in 100 year rainfall event significant surface water flow from the site would be expected. The same is likely from the developed site due to the lack of storage volume in the soakaways confounded by problems of a high water table, and the fact that the soakaways on account for 50% of the roof area.

The drainage layout drawing shown on page 27 of the FRA does however include a proposed flood exceedance route for events which are more severe than the design event. This shows water flowing into the boundary ditch. This is the likely route that excess surface water would take when the cellular soakaways are partially filled with groundwater and the capacity is then exceeded following a rainfall event. The flow into ditches and then into Ginge Brook would generate a rapid response in the Brook and potential flooding.

Impact on the Wider Area

One of the major concerns about the proposed development is the impact that the drainage layout will have on the surrounding area. The ditch along the site perimeter will eventually feed the Ginge Brook and ultimately all shallow groundwater in the gravel layer will also find its way into the Brook. The FRA assumes that the drainage from the new development once conveyed through soakaways into the shallow groundwater will simply be removed from the system.

Further studies are required to find out how water enters the Ginge brook, such as a walk-along survey to identify inputs to the channel. The report needs to quantify the likely impacts using hydraulic modelling to define how the increase in flows from the new development will affect the flood risk in the Brook. Hydraulic modelling software such as ISIS should be applied to achieve this.

One further concern of the FRA is a discussion on the flood risk during the construction phase, which could affect both the local drainage and impact on the wider area (Ginge Brook). The compaction of soils by heavy machinery would significantly reduce infiltration capacity leading to greater surface runoff during heavy rainfall. The excavation of the site would expose more bare earth and therefore pose a greater risk of erosion. The eroded material would degrade water quality and could also have an effect on the flood risk by causing blockages in the existing ditches.

Redrow Homes Development Site

The FRA for the Redrow Homes development site was undertaken by MEC Consulting Development Engineers in February 2013. This report was more detailed than the Pye Homes FRA including 34 pages of text and 48 pages of appendices. The correspondence with the EA is also included in the appendices but in this case the EA did not ask for a proforma to be completed as with the Pye Homes site. It is not clear whether the EA has changed its policy in 2013 with regard to this matter or perhaps a further request for such a completed proforma will be made. For consistency the evaluation of the Redrow Homes FRA is divided into the same sections as used for the Pye Homes FRA evaluation.

Hydrology

As with the Pye Homes FRA, little detail is given on the overall hydrology of the site in terms of its catchment setting although more details are given about the local water courses and drainage of the site. The topographic survey is shown to extent to the north of the site which gives a better idea of the site levels in relation to the surrounding land and a better assessment is made of the overall slope of the land from Milton Road towards the site. The report would benefit from having a better visualisation of the topography through generating a DTM. The report included a fuller description of the site in relation to the soils and drainage, including the locations of trial pits, descriptions of soil profiles and the results of infiltration tests. All the infiltration tests however could not be completed due to ground water, and the soils/groundwater conditions along the northern edges of the side, close to the photo location in Figure 5 supported the observations in section 1 of the area being underlain by clay soils. The overall conclusion was that a subsurface drainage scheme with soakaways was not feasible for the site, which contrasts with the Pye Homes drainage strategy.

Historical Flooding

The information on historical flooding is sparse, with just reference to an event in 2003, but no further evidence to support this (such as newspaper reports or rainfall records). The River Thames experienced the worst floods since 1947 in January 2003, so there is plenty of information relating to flooding at this time. The report does however document surface water from site observations in February 2013 which support the observations presented in Part 1 and provide further evidence against the use of soakaways. The importance of historical flooding data is given in the corresponding section of the Pye Homes FRA evaluation.

Methods Used for the Drainage Design

More detail is given on the calculations used for the drainage desing but rather less detail is presented about the design itself. The only drawing of the layout, shown in Appendix K does not include any of the new development showing the extent of impermeable surfaces or any infrastructure to demonstrate how excess surface water will be conveyed from these surfaces. The strategy just shows a large detention pond to the north of the site with a controlled outflow conveying water into the Ginge Brook. Although some flow values are presented in the text the calculation method for estimating the storage volume is wrong. The IH 124 method (Marshall and Bayliss, 1994) for estimating flows from small catchments is used. This is the standard EA approved method for estimating greenfield flows from development sites but its application has raised much concern since it is not a conceptually appropriate method to use (Rodda and Hawkins, 2012). One of the problems is that it just estimates a peak flow and does not have any associated time component, therefore the user must assume a time for which the flow would be maintained (e.g. 1 hour) to estimate the volume.

In the Redrow Homes FRA values of the greenfield flow for various return periods are listed in Table 2 on page 22 of the report. It is normal practice to then compare the greenfield flows from the site with the estimated flows from the developed site. The developed site flows would be based on a combination of design rainfall of particular duration obtained from the FEH, (e.g. 1 in 100 year 1 hour rainfall depth including a +30% increase to account for climate change), the impermeable area and a runoff coefficient – a factor to define the proportion of the rainfall which will reach the drainage system. For a worst case scenario it is common to assume a coefficient of 1, meaning 100% of the rainfall will form surface runoff. The outflow from the site would be restricted to the greenfield flow rate so the remaining excess water from the developed site must be temporarily stored. The greenfield and developed site volumes are then calculated as the product of the flow (usually l/s) by the time (e.g. 3600, the number of second in 1 hour). The storage volume is calculated as the difference between the greenfield volume and the developed site volume. From the text it appears that the Redrow FRA calculates a difference in volume between the 1 in 2 year greenfield flow and the 100 year + 30% greenfield flow. The actual calculations and time intervals are not given so it is difficult to see how the storage volume has been derived.

As with the Pye Homes FRA the Micro-Drainage software has been used and output from this is included in the appendix but no description is included in the text giving any details on exactly how the software has been applied. The result sheets shown in Appendix J are of poor resolution but like the Pye Homes FRA rainfall has been taken from the outdated Flood Studies Report.

The drainage scheme gives no details about the control of pollutants from the developed site. One advantage of using soakaways is that the gravel/sand sub-base can filter out sediment and also contaminants such as hydrocarbons from oil and petrol spills. The outflow from the pond is proposed to be conveyed to the Ginge Brook along a Swale, a broad shallow ditch which the FRA claims can also remove pollutants. The problem is though that any pollutants would have already drained to the pond which would not create a particularly favourable environmental for wildlife. If this is the only element of pollution control then more details should be included on how pollutants could be removed from the water prior to it reaching the pond.

Impact on the Wider Area

The Redrow FRA also gives no details on what the impact of the development would be on the wider area. The proposed limited oulet flow into the Ginge Brook is very low and would have little impact to overall flows in the Brook during flood conditions but because few details have been given on the drainage design for the whole site and the storage volume calculations it is uncertain as to whether all of the excess surface water will be stored in the pond or if water will find its way into the Brook through other channels or mechanisms. More detail is required on the overall drainage design and a proper assessment of the impact on flows in Ginge Brook should be made using hydraulic modelling.

The FRA does not give any information on the impacts during the construction phase, as raised in the evaluation of the Pye Homes FRA.

Summary

This report has documented the current conditions of two development sites in Sutton Courtenay in terms of the overall catchment hydrology, topography, soils, drainage conditions and flood risk. Incidents of historical flooding in the area have also been presented. Specific attention has been given to assessing the risk of flooding at Lower Mill, Ginge Brook, a property where the stream flows through the garden and is culverted under the building. Finally a critical assessment has been presented of the flood risk assessment and drainage design accompanying the planning application for one of the development sites. The FRAs for both development sites have been undertaken by civil engineering consultancies and show a lack of hydrological expertise. This has led to little detail being presented about the hydrology and incidents of historical flooding, incorrect assessments of flood risk, incorrect and poorly explained calculations and inappropriate drainage desings. The main findings are as follows:

Site characteristics:

1. The proposed development sites are within the catchment of the Ginge Brook, a tributary of the River Thames which drains an area of 39 km^2 about half of which is underlain by permeable Chalk and the remainder is impermeable clay bedrock with areas of superficial permeable gravels.
2. The sites are on low lying floodplain areas, 1m below the existing Milton Road properties with poorly drained water logged soils, or saturated soils experiencing high groundwater.
3. The natural drainage pathway is from Milton Road and the Milton road properties to the development sites and then into the Ginge Brook.
4. Observations in February 2013 noted standing water on both sites and ditches along one site to be flooding.
5. Sutton Coutenay has experienced flooding from Ginge Brook in the past, notably in July 2007 when properties in the village were flooded.

Lower Mill Flood Risk:

1. The property at Lower Mill is at particular risk of flooding due to the Brook being culverted under the house, causing a constriction in the channel and the potential for flood water to back-up and spill out of bank.
2. Environment Agency data showed the Ginge Brook to be at bank full state about 2-3 times a year on average.
3. Out of bank flooding was likely on average every 3-4 years.
4. The 2007 flooding in the vicinity was estimated as a 1 in 200 year event.
5. The frequency of extreme events will increase due to the effect of climate change so an event of similar magnitude to the 2007 floods may have a return period of 1in 20 years in the future.

Pye Homes FRA evaluation:

1. The content of the Pye Homes FRA is rather brief with less than 12 pages of text from a 48 page report describing the site conditions, flood risk and remedial measures.
2. The report is particularly weak describing the overall hydrology of the site, incidents of historical flooding, the methods used to design a drainage strategy and the impacts of the new development on the wider area.
3. The FRA makes an incorrect assessment of the risk of surface water and groundwater flooding at the site.

4. The drainage design relies on conveying excess surface water into soakaways which will then percolate into shallow groundwater, but ignores the effects of limited groundwater storage and periodic high water table levels.
5. Calculations of the drainage system storage volumes are poorly explained and the method appears to use values from old sources which have since been replaced
6. No attempt is made to quantify the impacts of the development on the flows in Ginge Brook.
7. No consideration is given to the impacts on flood risk and hydrology during the construction phase.

Redrow Homes FRA Evaluation

1. The Redrow Homes FRA is more detailed with around 30 pages of text and details of field soil surveys and infiltration measurements.
2. The report is still brief on the overall catchment hydrology and information on historical flooding in the area.
3. The FRA recommends not using soakaways due to the soil conditions but having a single detention pond to temporarily store the excess surface water from the developed site.
4. The calculations of the storage volume appear to have used an incorrect method and the drainage design does not show details of the development.
5. Other drainage calculations using computer software are poorly explained and use rainfall values from old sources which have since been replaced.
6. No attempt is made to quantify the impacts of the development on the flows in Ginge Brook.
7. No consideration is given to the impacts on flood risk and hydrology during the construction phase.

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