

# The Flood Risk Implications of Strategic Development at Barnham / Eastergate / Westergate

## *The Hydrological and Hydrogeological Aspects of 2000 new houses at BEW*



Tidal sluice and pumping station on the Aldingbourne Rife at Felpham



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### **Executive Summary**

The report has been prepared at the request of the “Villages Action Group” to draw to the attention of the decision makers at Arun District Council the technological challenges and the increased flood risks arising from the allocation of a site in the Barnham, Eastergate & Westergate area for the construction of 2,000+ houses.

The report has examined the hydrology, hydrogeology and topography of the area as well as the current sewage and drainage system status alongside the following studies and reports in relation to recent flooding incidents in the area:-

- Arun District Strategic Flood Risk Assessment (2008),
- Arun Infrastructure and Funding Study (2009),
- Arun and Western Streams CFMP (2009),
- West Sussex SFRA (2010),
- West Sussex County Council Report on June 2012 Flood Event (2012),
- Arun District Council Infrastructure Delivery Plan (2013),
- West Sussex Local Flood Risk Management Strategy (LFRMS) (2013).

We consider that the 2008 SFRA was based on very little data and failed to take adequate account of the complexities of the hydrogeology, the risks of groundwater flooding or the adverse effect which the groundwater has on SuDS drainage systems.

There are 2 further studies under preparation that will provide information crucial to any decision regarding strategic development at Barnham, Eastergate and Westergate, these are:-

- The Lidsey Surface Water Management Plan (*being undertaken by WSCC and Southern Water*)
- The Aldingbourne Rife Strategy (*being undertaken by the Environment Agency*).

This is part 1 of the study. Part 2 will include a hydrological and hydrogeological comparison of BEW against other potential strategic housing locations.

The conclusions from Part 1 are:-

- 1) It is premature for this site to be allocated for housing before the SWMP and the Aldingbourne Rife Strategy studies are complete. Both of these are vitally important in quantifying the flooding risk and most importantly to identify whether the technological challenges of developing this site can ever be overcome.
- 2) The 2008 SFRA is not an adequate document upon which to base a decision for housing allocation. The reasons for this are the better understanding of surface water and groundwater flooding risks which have been gained subsequent to the 2008 report. Both of these are key aspects of the flooding risk to this site.
- 3) There is insufficient knowledge available at the present time to know whether allocation of this site for housing would be consistent with the West Sussex Flood Risk Management Strategy. The current, ongoing studies will be able to inform this.
- 4) It is essential that this development (if allocated) should be drained by means of SuDS as conventional surface water drainage systems will seriously increase flooding risk in many areas. There are very limited types of SuDS features which can be implemented at this site and inevitably

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they will be expensive and require a large land take; these factors may make the development non-viable.

- 5) If this site is allocated for housing development ahead of adequate legislation and regulatory provision it is probable that WSCC (as the SuDS Adopting Body) will be unable to enforce the implementation of a SuDS drainage system. This would have inevitable consequences in significantly increasing the flood risk to existing properties in Westergate, Eastergate, Barnham, Felpham and Bognor Regis.
- 6) There is no doubt that a smaller central portion of the site could be developed with adequate measures to mitigate the flood risk but it is unlikely that 2000 houses could be accommodated within this site.

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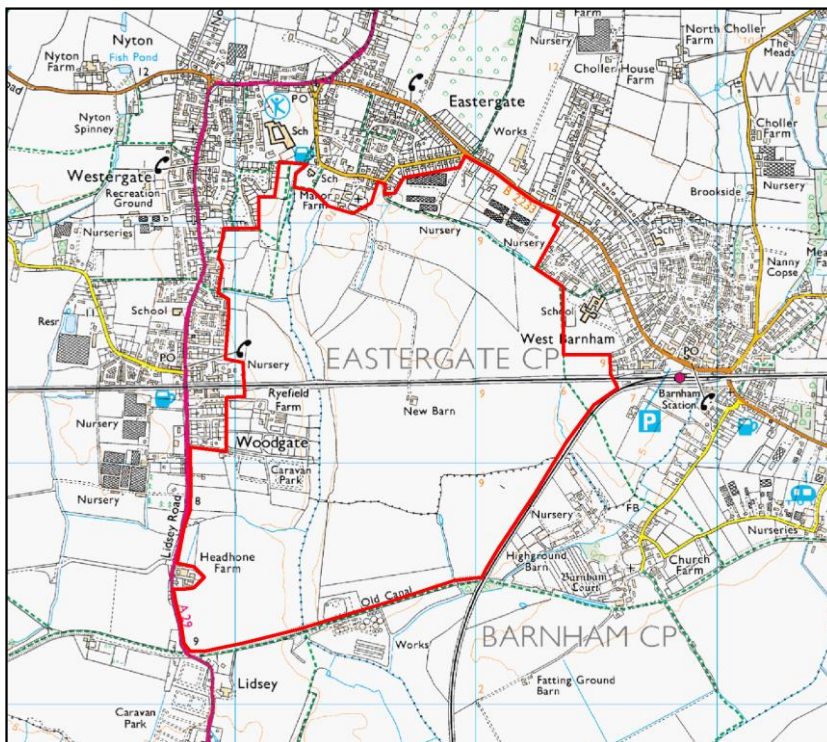
### **Introduction**

The report has been prepared at the request of the “Villages Action Group” to draw to the attention of the decision makers at Arun District Council the technological challenges and the increased flood risks arising from the allocation of a site in the Barnham / Eastergate / Westergate (BEW) area for the construction of 2,000+ houses.

This report is Part 1 of a two part study. Part 2 will include a hydrological and hydrogeological comparison of the BEW area with other potential strategic housing locations.

The allocation of this site within the context of the National Planning Policy Framework is examined as part of this report.

The site proposed for development is outlined in Figure 1 below.



**Figure 1: Site Location**

The local area is a Coastal Plain extending from the foot of the South Downs to the current sea coast. Historically the coast lay further inland and in effect the whole Coastal Plain is a series of ancient beaches and alluvial flats.

The consequence of this is that the land is flat, is close to sea level and is only drained by means of a series of drainage channels known as “rifes”.

The soil conditions comprise a highly complex and highly variable series of superficial deposits laid down as a series of ancient beaches. As a consequence of this the groundwater levels are frequently at a very shallow depth with widespread groundwater emergence across the region. This report will examine these aspects in more detail.

This report will also provide a snapshot of what studies have previously been undertaken and the current status of a multitude of current ongoing studies. This report will also examine the feasible options for the surface water drainage of any development in the area.

### **National Planning Policy Framework**

The National Planning Policy Framework<sup>1</sup> sets out the framework for planning which amongst other factors should consider flooding risk. Local Plans should be supported by Strategic Flood Risk Assessments (SFRA)

<sup>1</sup> National Planning Policy Framework, March 2012, Department for Communities and Local Government

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and should develop policies to manage flood risk taking advice from the Environment Agency (EA), Lead Local Flood Authority (LLFA) [*in this case West Sussex County Council*] and other flood risk management bodies. Local Plans are required to apply a sequential, risk-based approach to the location of development to avoid flood risk to people and property.

The “Technical Guidance to the National Planning Policy Framework<sup>2</sup>” defines flood risk and areas at risk of flooding as follows:-

*“Flood Risk” means risk from all sources of flooding – including from rivers and the sea, directly from rainfall on the ground surface and rising groundwater, overwhelmed sewers and drainage systems, and from reservoirs, canals and lakes and other artificial sources.*

*“Areas at Risk of Flooding” means land within Flood Zones 2 and 3; or land within Flood Zone 1 which has critical drainage problems and which has been notified to the local planning authority by the Environment Agency.*

The underlining above has been added by the author to emphasise key aspects which are relevant to this site. It is recognised that large parts of the proposed development site are within Flood Zone 1 but all of the site is affected by “critical drainage problems”.

The primary concerns of the “Villages Action Group” are that firstly the SFRA under-estimated the risks associated with groundwater emergence, secondly that a number of important studies which should be used to inform the Local Plan are not yet complete and thirdly that the technological difficulties of providing adequate surface water drainage for the development have been under-predicted and may be insurmountable at reasonable cost.

**We consider the Hydrological and Hydrogeological complexities of the BEW site are such that the Environment Agency should class the site as having “Critical Drainage Problems” and should notify Arun DC accordingly.**

## ***Previous Studies and Reports***

Previous studies and reports in relation to flooding in the local area include:-

### ***Arun District Strategic Flood Risk Assessment (2008)***

The Arun District SFRA<sup>3</sup> was prepared by Capita Symonds as Consultants to Arun District Council and comprises 4 volumes and 31 plans. Volume 2 is the Technical Guide and the plans for appendices to this report. Volume 4 is an assessment of sites of search (ie alternative development sites). The currently proposed site is contained within the two areas of Westergate and Barnham which were considered in this report.

There are many aspects of this SFRA which have been superseded with better information and the SFRA is due to be updated. Of particular relevance to the potential development site are the surface water flooding risk which has now been determined in far more detail by the Environment Agency and the risk of groundwater flooding which has now benefited from a far more rigorous assessment by the British Geological Survey and Consultants.

<sup>2</sup> Technical Guidance to the National Planning Policy Framework, March 2012, Communities and Local Government

<sup>3</sup> Arun District Council Strategic Flood Risk Assessment, February 2008, Arun District Council

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**We therefore consider that reliance on the SFRA report in respect of the risk of flooding from surface water or from groundwater would be misguided.**

### **Arun Infrastructure and Funding Study (2009)**

The Arun Infrastructure and Funding Study<sup>4</sup> was prepared by a team drawn from EDAW, Faber Maunsell and King Sturge as Consultants to Arun District Council. This study assessed 3 options to meet the housing demand; extension of coastal towns, a new settlement at Ford and expansion of inland settlements. The factors included in the assessment in this study included Education, Healthcare, Emergency Services, Community Facilities, Open Space, Transport and Infrastructure. This report did not consider flood risk and was primarily aimed at determining the infrastructure needs and costs for each option. The most expensive option was the creation of a new settlement at Ford.

**We are concerned that the absence of any consideration of flooding risk from this report may have resulted in an unbalanced assessment.**

### **Arun and Western Streams CFMP (2009)**

The Arun and Western Stream CFMP<sup>5</sup> is a formal planning document which sets out the Environment Agency's preferred plan for sustainable flood risk management for the next 50 to 100 years.

This report is based on a series of sub-areas with Sub-Area 6 comprising the Coastal Plains and East Wittering. The key messages for this area are:-

*Climate change, sea level rise and urban growth are likely to increase future levels of risk. Sea level rise will increase the duration of tide-locking in the area, which combined with increased rainfall will also increase flood risk within the area.*

**The preferred policy (by the EA) for this area is to manage the flood risk and keep pace with climate change.**

### **West Sussex SFRA (2010)**

The West Sussex Strategic Flood Risk Assessment<sup>6</sup> was prepared by Capita Symonds as Consultants to West Sussex County Council. This report was a county wide strategic flood risk assessment in support of their Minerals and Waste Development Framework rather than to support development of the housing allocation aspects of the Local Plan.

### **West Sussex County Council Report on June 2012 Flood Event (2012)**

The report<sup>7</sup> on the June 2012 flood event was an in-house report on the flooding which occurred as a result of the rainfall which in parts of West Sussex exceeded 100mm of rain in just 16 hours. A series of 11 flooding clusters were reported on including Barnham, Felpham and Central Bognor Regis / Bersted which are all relevant to the proposed development site. There was also some flooding recorded at properties in Westergate but were not reported on as a 'flooding cluster'.

**This report highlights the flooding risk in the local area due to heavy rainfall.**

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<sup>4</sup> Arun Infrastructure and Funding Study, Final Report, August 2009, Arun District Council

<sup>5</sup> Arun and Western Streams Catchment Flood Management Plan, December 2009, Environment Agency

<sup>6</sup> West Sussex Strategic Flood Risk Assessment, January 2010, West Sussex County Council

<sup>7</sup> Report on June 2012 Flood Event, November 2012, West Sussex County Council

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### **Arun District Council Infrastructure Delivery Plan (2013)**

The Arun District Council Infrastructure Delivery Plan<sup>8</sup> was prepared by Parsons Brinckerhoff as Consultants on behalf of Arun District Council. This report includes a consideration of flood defence requirements with a particular section of the report devoted to the Barnham, Eastergate, Westergate area. This section of the report states:-

*The suitability of this area for 2000 dwellings should be informed by any findings of the Surface Water Management Plan (SWMP) which is being undertaken by Southern Water and WSCC. This project is at an early stage, but will look at the existing problem and suggest ways of managing the existing risk.*

Worryingly, this section of the report also states that the landowners have produced a Surface Water & Waste Water Drainage Strategy and have shared this with WSCC and ADC though it is not publically available for scrutiny. It appears illogical for interested parties to have developed an adequate strategy in advance of both the SWMP and the Aldingbourne Rife Strategy.

**This report clearly states that it would be premature to allocate this site in advance of the SWMP being completed.**

### **West Sussex Local Flood Risk Management Strategy (LFRMS) (2013)**

The West Sussex Local Flood Risk Management Strategy<sup>9</sup> was prepared by an in-house team at West Sussex County Council. This report sets out the strategy for how WSCC will meet their obligations under the Flood and Water Management Act 2010 as the Lead Local Flood Authority. The report identifies a series of "Wet Spots" throughout the county. Appended to this report are two plans from the WSCC Strategy Report; these are for the "Aldingbourne, Westergate & Eastergate Wet Spot" and the "Bognor Regis and Felpham Wet Spot". Both plans show areas at risk of flooding from river or sea (in blue) or from surface water flooding (in purple) as determined by the Environment Agency. For the Aldingbourne, Westergate and Eastergate Wet Spot a total of 300 properties were identified at risk of surface water flooding (the majority in Westergate) with 110 properties at risk of flooding from rivers or the sea.

This report identified that the area around this site comprises:-

*Low lying topography with poorly drained and often waterlogged soils....The characteristics of the district mean that surface water ponding and water logging due to high groundwater or extreme rainfall can cause flooding.*

**It is important that all planning decisions are fully consistent with this Flood Risk Management Strategy.**

## **Ongoing Current Studies**

There are two particularly important studies which are ongoing at the present time which we consider to be highly relevant to the decision on whether or not to allocate the Westergate/Eastergate/Barnham site for housing development:-

<sup>8</sup> Arun District Council Infrastructure Delivery Plan, April 2013, Arun District Council

<sup>9</sup> West Sussex Local Flood Risk Management Strategy, June 2013, West Sussex County Council

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### Lidsey Surface Water Management Plan

This plan is being prepared jointly by Southern Water and West Sussex County Council. This started as a SWMP for just Barnham but because of the complexities of the area it was subsequently expanded to include all of the Lidsey Sewage Treatment Works catchment and also the areas of Middleton, Elmer and Slindon as well as Westergate. This report is due mid 2014.

### Aldingbourne Rife Strategy

The Aldingbourne Rife Strategy is being undertaken by the Environment Agency and will include an improved hydraulic model of the network of drainage systems including rifes, ditches and sewers. There will be an improved hydrological assessment which will take account of the recent improvements available in respect of the hydrogeological linkage between rainfall on the South Downs and the emergence of groundwater on the coastal plains. The strategy will also assess the adequacy of the sluice and pumping station arrangement at Felpham (see frontpiece photograph), the sea defences and the adequacy of the various watercourse channels.

The Aldingbourne Rife which flows southwards through the potential development site is classed as “Main River” and is therefore the responsibility of the Environment Agency. It is inevitable that the proposed development would have a significant impact on the Aldingbourne Rife and also other Main River watercourses in the area. It is highly unlikely that the Environment Agency will be able to obtain any public funding for any watercourse or pumping station / sluice improvements when the main beneficiary would be the property developers; it is therefore inevitable that the developers will need to finance all of the necessary upgrading works but the cost of this cannot be determined until the Strategy is complete.

## **Proposed Development**

An indicative layout of the potential development is shown in Figure 2 to the right.

This layout appears to have generally positioned the housing on the slightly higher ground and kept the areas within Flood Zones 2 and 3 as a Country Park, as Green Parks or as Open Space.

It is most notable however that there are no areas included in the layout for open flow attenuation (flow balancing) ponds. There is also some development clearly shown on the western side of the development within known surface water flooding risk areas.



Figure 2: Potential Development Layout



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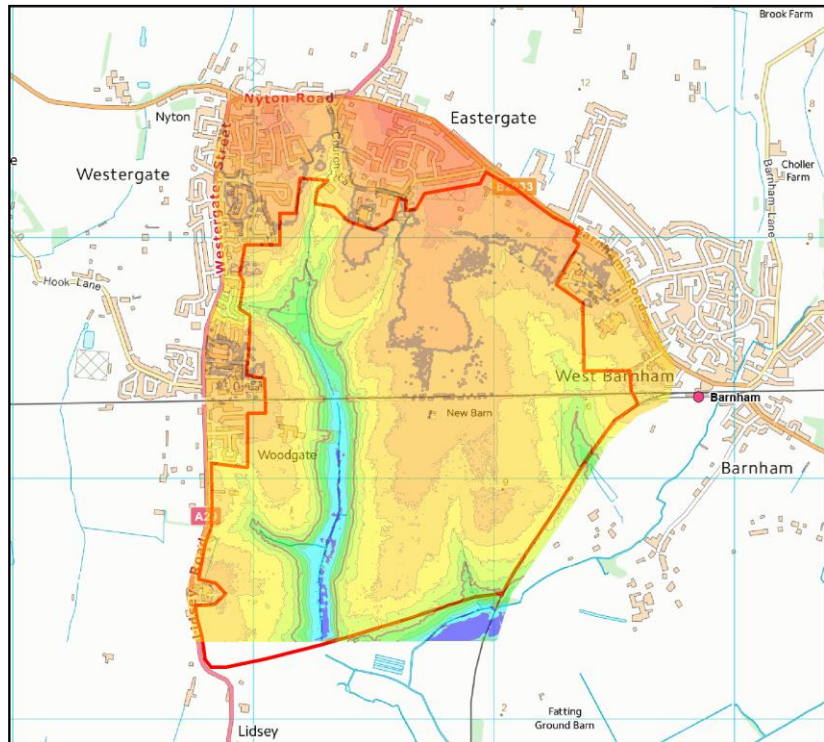
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### **Topography**

The topography of the potential development site is shown in Figure 3 to the right. The shallow valley of the Aldingbourne Rife can clearly be seen with ground levels down to +1m AOD (Above Ordnance Datum). The central part of the site rises up to approximately +10m AOD with some areas in Eastergate and Westergate as high as +13m AOD.

It can be appreciated that Barnham is slightly lower than Eastergate which is why there is a higher flooding risk in Barnham. It is important to recognise that much of the potential development site is at a similar level to Barnham.

Taken solely on the topography of the site, as the fluvial and tidal flood mapping has done in the EA's flood zone areas, it would appear that the central part of the site would be free from flooding. However, that most certainly is not the case due to the complexities of the ground conditions and the hydrogeological linkage with the South Downs.



**Figure 3: Site Topography**

### **Ground Conditions and Groundwater Levels**

The geology and hydrogeology of the area is complex and is dominated by the South Downs. The coastal plains consist of an impermeable layer of London Clay which separates the Chalk beneath and what are termed 'superficial' deposits above. The Chalk is the same Chalk which forms the South Downs. The superficial deposits can be complex and highly variable ranging from alluvium and silts which are also impermeable through to highly permeable ancient beach deposits.

Both the Chalk and the Superficial Deposits are aquifers which are generally not linked together except when the groundwater levels in the Chalk are high in which case water from the Chalk can pass into the Superficial Deposits. The Chalk aquifer is generally fed from rainfall occurring on the South Downs and the Superficial Deposits aquifer is fed by rainfall on the coastal plain. The linkage between the Chalk and the Superficial Deposits is not widespread but is at a number of discrete locations where the underlying Reading Beds constrict the Chalk; not all of these linkage locations are known. Groundwater flooding at Northfields Lane, Westergate in spring 2013 and 2014 is one location where there was flooding from the Chalk with between 50 and 100 megalitres per day emerging.

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The problems which arise from this complexity are that the groundwater levels in the Superficial Deposits cannot be reliably predicted even with extensive periods of groundwater monitoring. Monitoring of the groundwater in the Superficial Deposits may give an indication of the variations without any influence from the Chalk but as soon as the groundwater level in the Chalk rises high enough for the linkage to occur it is a completely different set of circumstances which only occur intermittently. An example of this is a current development at Brooks Nursery on Barnham Road which had to abandon groundwater monitoring and change their drainage proposals to include a pumped balancing pond system.

Under most conditions the groundwater in the Superficial Deposits feeds the watercourses and this is what makes the situation so deceptive as a simple assessment will not identify the complex relationship with the Chalk aquifer.

**We consider that the 2008 SFRA was based on very little data and failed to take adequate account of the complexities of the hydrogeology and the risks of groundwater flooding or the adverse effect which the groundwater has on SuDS drainage systems.**

### ***Foul Sewage Drainage System***

Southern Water are responsible for the sewerage network in the area and the sewage treatment at Lidsey STW. The sewer network comprises a mixture of foul sewers, some combined sewers (ie those which take both foul sewage and rainwater runoff) and some surface water sewers.

The sewer network in Westergate, Eastergate, Barnham and other areas draining to Lidsey STW become very severely overloaded by inundation from groundwater and surface water. This has led to multiple periods, though most recently during December 2013 to March 2014, when extensive tankering operations were needed in order to keep the sewerage system functioning. Additionally when the sewers are already in an overloaded condition due to groundwater infiltration there is a diminished capacity to deal with storm flows and flooding incidents occur with relatively minor storms. The foul sewer network was constructed piecemeal and as a result is a mixture of a variety of different materials laid at different times with different standards of workmanship. It is inevitable that some of this network is in a poor condition and is therefore more prone to groundwater inundation.

Southern Water in their response to the housing allocations have stressed the need for adequate infrastructure to be constructed to prevent inundation of the foul sewer network with groundwater or rainfall runoff. It will be essential not only for adequate surface water and groundwater provision at the outset but there must also be adequate provision and enforcement to ensure that the phenomenon known as 'urban creep' does not occur in the future.

### ***Sustainable Drainage Systems (SuDS)***

West Sussex County Council will shortly become the SuDS Approval Body (SAB) and they will become responsible for the approval and then the maintenance of all SuDS facilities constructed by the developers.

It had been the intention of the current and previous government to introduce legislation to make it compulsory for all new development to be drained via SuDS facilities. However, the latest drafts of this legislation give the house builders a 'get out' if SuDS are too difficult or too expensive to implement.

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Implementation of any SuDS at this site will be both extremely difficult and expensive to construct and the only feasible measures will require a large land take. All of these aspects added together will probably make the development non-viable.

Unless there are very strict planning conditions requiring the house builders to implement SuDS it is unlikely that adequate surface water drainage systems will be implemented with potentially major increases in the flooding risk to residents in Westergate, Eastergate, Barnham, Felpham, Bognor Regis and other areas. The Arun District Council Infrastructure Delivery Plan emphasised the need for the SWMP to inform the decisions about any housing allocations in this area. The same also applies to the Aldingbourne Rife Strategy.

There are a range of SuDS features which can be implemented on a national scale and these are commented on below in relation to this site:-

**Rainwater Harvesting** – if implemented correctly so that water is used regularly this measure can be effective but it is generally limited to small storms and adequate measures still need to be provided for larger storms.

**Green Roofs** – if implemented correctly this measure can be effective but it is restricted to storms with no more than 5mm of rain and it relies on a subsequent warmer period for evaporation to occur to empty the storage within the roof structure. Additional adequate measures are still needed for larger storms.

**Permeable Pavements** – this is not feasible at this site due to high groundwater levels.

**Below Paving Storage** – this is not feasible at this site due to high groundwater levels.

**Infiltration Trenches** – this is not feasible at this site due to high groundwater levels.

**Soakaways** – this is not feasible at this site due to high groundwater levels.

**Infiltration Basins** – this is not feasible at this site due to high groundwater levels.

**Swales** – these are shallow, grass lined linear depressions and if implemented correctly these could be effective for drainage of roads, hardstandings and roofs. It is likely these would need to be augmented with larger detention basins in order to deal with larger storms.

**Attenuation Tanks** – these are unlikely to be cost effective as they would be very large, shallow structures with a significant risk of the structures floating due to high groundwater levels. They can be anchored down but that is very expensive.

**Balancing Ponds** – if implemented correctly these could be effective if used in conjunction with swales. They would however need to be kept shallow so that they are able to drain by gravity and also so that they are not too badly affected by groundwater. There would be a very large land take associated with implementation of this technique which alone may make the development non-viable.

**Pumped Storage Systems** – pumped storage systems are not classed as Sustainable because of the high energy and carbon costs.

**Exceedance Routing** – this technique can be used in some circumstances in order to protect particular sensitive properties but their use here would significantly increase the flood risk in Westergate, Eastergate,

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Barnham, Felpham, Bognor Regis and other areas. The tidal sluices and pumping station at Felpham would be seriously affected.

In April 2014 WSCC along with 8 other Lead Local Flood Authorities in the South-East of England launched a new report entitled **“Water. People. Places. A guide for master planning drainage into developments”**. This publication gives examples of SuDS features and also explains the design principles behind them and in relation to sites with shallow groundwater it states:- *“In this instance, SuDS should be selected and designed to be on the surface or shallow in depth and to avoid infiltration.”* That is exactly the same as the comments made above. This guide is what WSCC as the SAB will use to determine the acceptability of the SuDS design.

### **Conclusions**

The conclusions reached in this report can be summarised as follows:-

- 1) It is premature for this site to be allocated for housing before the SWMP and the Aldingbourne Rife Strategy studies are complete. Both of these are vitally important in quantifying the flooding risk and most importantly to identify whether the technological challenges of developing this site can ever be overcome.
- 2) The 2008 SFRA is not an adequate document upon which to base a decision for housing allocation. The reasons for this are the better understanding of surface water and groundwater flooding risks which have been gained subsequent to the 2008 report. Both of these are key aspects of the flooding risk to this site.
- 3) There is insufficient knowledge available at the present time to know whether allocation of this site for housing would be consistent with the West Sussex Flood Risk Management Strategy. The current, ongoing studies will be able to inform this.
- 4) It is essential that this development (if allocated) should be drained by means of SuDS as conventional surface water drainage systems will seriously increase flooding risk in many areas. There are very limited types of SuDS features which can be implemented at this site and inevitably they will be expensive and require a large land take; these factors may make the development non-viable.
- 5) If this site is allocated for housing development ahead of adequate legislation and regulatory provision it is probable that WSCC (as the SuDS Adopting Body) will be unable to enforce the implementation of a SuDS drainage system. This would have inevitable consequences in significantly increasing the flood risk to existing properties in Westergate, Eastergate, Barnham, Felpham and Bognor Regis.
- 6) There is no doubt that a smaller central portion of the site could be developed with adequate measures to mitigate the flood risk but it is unlikely that 2000 houses could be accommodated within this site.