

REPORT N^o 50600666

ANGEL'S NURSERY, BARNHAM

FLOOD RISK ASSESSMENT AND
DRAINAGE STRATEGY

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WEST SUSSEX COUNTY COUNCIL

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EXECUTIVE SUMMARY

WSP | Parsons Brinckerhoff (WSP | PB) has undertaken this Flood Risk Assessment (FRA) and Drainage Strategy to support a detailed planning application for the development of a site at Angel's Nursery in Barnham, West Sussex.

The FRA investigates flood risk in the area and outlines the mitigation measures proposed to ensure the sustainable and safe development of the site in line with the requirements of the National Planning Policy Framework (NPPF). The FRA and associated drainage strategy build on the information previously collected and consultation undertaken by WSP | PB since we started our involvement in the project back in 2013; this planning application is in fact supporting a further iteration of a scheme for which a planning application was initially submitted back in 2010 and has been developed since. The proposed drainage strategy reflects the comments received from the various stakeholders over the last three years.

The site is located within EA Flood Zone 1, comprising land assessed as having a low probability of fluvial and tidal flooding, less than 0.1% annual probability.

Other sources of flooding have been investigated and mitigated as appropriate. The sustainable management of surface water runoff will be ensured through the proposed outline surface water drainage strategy.

The FRA has been produced in consultation with the Environmental Agency (EA), Southern Water (SW) and Arun District Council (ADC). Relevant correspondence is discussed in the sections below. West Sussex County Council (WSCC) has also been approached, however at the time of writing this report, no formal response had been received.

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PROJECT BACKGROUND

2.1 APPOINTMENT AND BRIEF

- 2.1.1 Under an Appointment between WSP | Parsons Brinckerhoff (WSP|PB) and West Sussex County Council, WSP|PB were employed as Consultant to provide a FRA and Drainage Strategy to support a planning application for a development of a site at Angel's Nursery, Barnham.
- 2.1.2 This Report is intended for the sole benefit of the parties named above and shall not be capable of assignment. WSP|PB shall not be liable for any use of the report for any reasons other than that for which the report was originally prepared and provided.
- 2.1.3 Although this Report was prepared using the degree of skill and care ordinarily exercised by engineers practicing under similar circumstances; please note that WSP|PB cannot take responsibility for errors in the information provided by third parties.

2.2 OBJECTIVE OF THE STUDY

- 2.2.1 This FRA investigates flood risk in the vicinity of the site and establishes the mitigation measures required to ensure the sustainability and safety of the scheme over its lifetime.
- 2.2.2 The FRA has been produced in line with the requirements of the NPPF and the EA's Standing Advice, and in consultation with the SW, WSCC and ADC.
- 2.2.3 As mentioned above this planning application is supporting a further iteration of a scheme for which a planning application was initially submitted back in 2010 and has been developed since.
- 2.2.4 In October 2015 a FRA and drainage strategy was prepared by WSP|PB to support a new layout for the development prepared by Huw Thomas Architects under a section 73 submission. The layout was originally prepared for 86 units, however the FRA additionally included an estimate for the additional 9 units. This was to ensure future proofing to the drainage design and ensure there is a sufficient capacity within the attenuation pond and no increased risk of downstream flooding.
- 2.2.5 In March 2016 a new layout has been prepared by Huw Thomas Architects reflecting the exact location of the existing Southern Water rising main. There is an intention for the rising main to remain unmoved and a 3m easement is being proposed. The new masterplan incorporates 95 units, and a new location for the retention basin /pond as discussed in the following pages.
- 2.2.6 This FRA and the drainage strategy have been produced to support a new planning application for the new layout. Refer to Appendix A for the latest masterplan.

2.3 STUDY METHODOLOGY

- 2.3.1 The appraisal process consisted of a desk study, data research and a review of the following reports and previous studies undertaken by WSP | PB for the site:
- Flood Risk assessment and Drainage Strategy report, undertaken by WSP/PB in October 2015 for the Section 73 Application.
 - Ground Investigation Report (GI) undertaken by Geo-Environmental Services Limited in September 2015
 - Angel's Nursery Redevelopment Groundwater Assessment undertaken by WSP in July 2014
 - Infiltration Drainage Feasibility Assessment report prepared by WSP in October 2013

- ⇒ Preliminary Flood Risk and Drainage Assessment report prepared by WSP in September 2013

2.3.2 The study also uses the information contained within the following strategic studies:

- ⇒ Arun District Council Strategic Flood Risk Assessment (SFRA, 2008)
- ⇒ West Sussex County Council Strategic Flood Risk Assessment (WSCC SFRA, 2010)

2.3.3 The Flood Investigation Report (produced by West Sussex County Council, June 2012) has also been reviewed as part of this FRA although no significant information has been identified within that study.

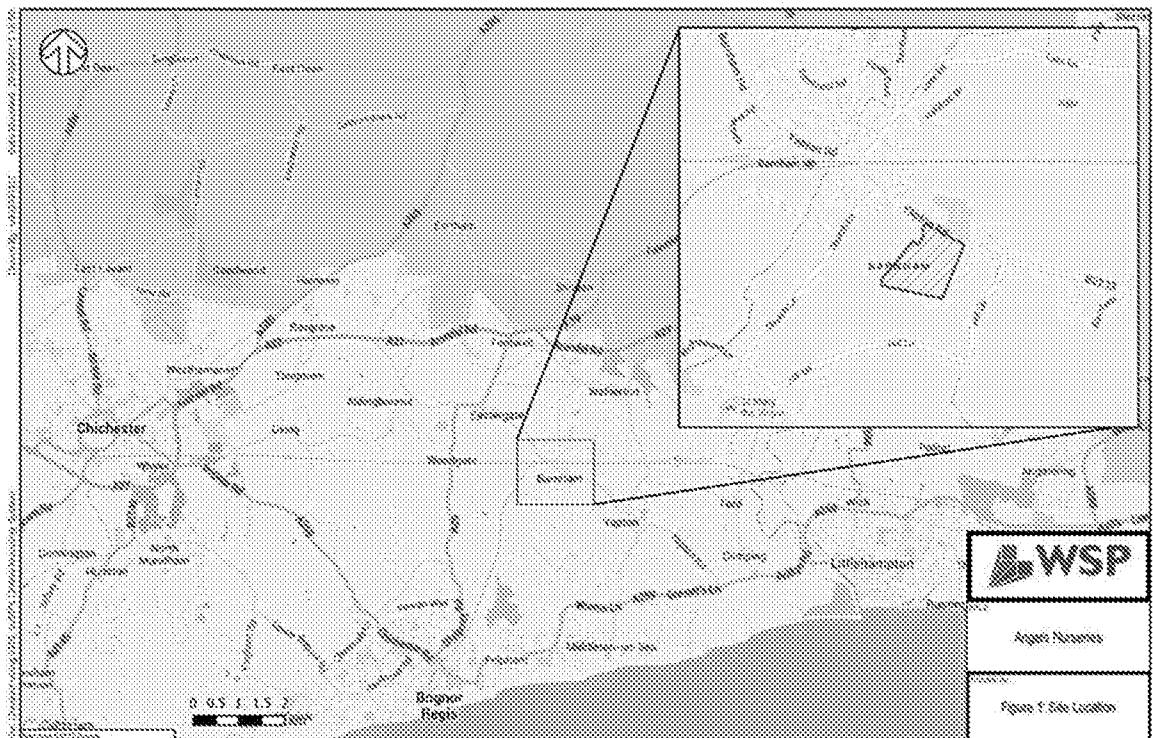
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EXISTING SITE

3.1 SITE LOCATION

- 3.1.1 The site is located approximately 0.5 km southeast of the centre of the village of Barnham. The Site is bounded by open fields and a community centre to the west, nurseries to the south, a holiday caravan park to the east and Yapton Road (the B2233) to the north with residential properties and another former nursery site beyond.

Figure 1 – Location plan



- 3.1.2 Refer to Figure 1 above and to the location plan and to in Appendix B for location and an indication of the extent of the planning application site.

3.2 SITE DESCRIPTION

- 3.2.1 The site covers an area of 3.51ha and is relatively undeveloped and unoccupied; however there are areas of temporary hard standing and a derelict residential unit to the northern boundary. The site is owned by Sussex County Council.
- 3.2.2 Site levels generally fall in a south easterly direction with levels varying from 9.2m AOD to 8.4m AOD, though there are areas to the north of the site which are predominately flat or even falling towards Yapton Road. Refer to Appendix C for the Topographical survey produced by BHP in July 2013.

- 3.2.3 The ground cover predominantly is long grass with bushes and thickets of thistles and brambles. Mature trees are present along the boundaries and in the southwest and centre north part of the Site. A single building (a brick built former residential property) is present in the northeast of the Site. Several areas of gravel pathway and concrete pads (likely foundations for former outbuildings/greenhouses) are present mainly in the north and central portions of the Site. A former pedestrian entrance and a former vehicular entrance are located to the east and west of the building respectively on Yapton Road and are blocked by concrete security barriers.
- 3.2.4 There are several drainage ditches along the boundary and within the site, these have been picked up by the topographical survey and confirmed from an onsite visit.

3.3 GEOLOGY AND HYDROGEOLOGY

- 3.3.1 Based on British Geological Society (BGS) mapping, the site's underlying bedrock geology is at the border between London and Lambeth Clay, consisting predominantly from Clay, Silt and Sand. A summary of the findings is presented in Table 1.

Table 1 - Summary of Mapped Geology

GEOLOGICAL UNIT	GENERAL DESCRIPTION	AQUIFER DESIGNATION*
River Terrace Deposits (Langley Silt Member) [formerly known as 'Brickearth']	Varies from silt to clay, commonly yellow-brown and massively bedded.	No designation
Raised Beach Deposits	Shingle, sand, silt and clay; may be bedded or chaotic; beach deposits may be in the form of dunes, sheets or banks – (generic description); now above the level of the present shoreline as a result of earth movement or a general fall in sea level.	Secondary (A) Aquifer
London Clay Formation	Typically stiff clay and weak mudstone	Unproductive Strata
Lambeth Group	Clay, silt and sand	Secondary (A) Aquifer
Upper Chalk	Fractured calcareous rock	Principal Aquifer

- 3.3.2 The Geo-Environmental Ground Investigation Report states that the ground conditions Comprised a limited thickness of Topsoil and/or Made Ground overlying the River Terrace Deposits. The underlying London Clay was not proved in any of the trial pits.
- 3.3.3 The site is indicated to be outside of any Source Protection Zone (SPZ).
- 3.3.4 The Groundwater Assessment carried out by WSP in July 2014 and attached in Appendix L states that the Ground Investigation revealed that the site is underlain (in chronological order from younger to older) with Made Ground, Langley Silt, Raised Beach Deposits and London Clay.
- 3.3.5 The Groundwater Assessment report also explains that the groundwater levels at the proposed Angels Nurseries development site are responsive to rainfall events. Majority of groundwater levels within the site rise to within at least 0.8 metres from ground surface. The groundwater monitoring data suggests that based on the locally calculated infiltration rate test permeabilities the drainage conditions would be described as poor.

3.4 EXISTING WATERCOURSES

- 3.4.1 The investigative work carried out to date, suggests strongly that the vast majority of the existing site drains via means of a series of existing onsite ditches. These ditches convey water from the site to a main ditch which runs from west to east along the southern boundary of the site and continues off site towards Hill Lane. There the ditch discharges into another stream (as proven by a drainage survey) running north-south along the road which eventually connects onto an EA main river downstream.
- 3.4.2 The ditches within the site fall under the Lead Local Flood Authority's (LLFA) responsibility (West Sussex County Council), and therefore works within or affecting the flow within these ditches require ordinary watercourses consent from the LLFA. West Sussex CC passes these consent requests to Arun DC, who are working as the agents for WSCC. As some of the existing ditches crossing the site will need to be removed as a consequence of the development early consultation with the LLFA is recommended to confirm that this would be acceptable.
- 3.4.3 As confirmed by ADC the ditches around the site need maintenance and re-grading.
- 3.4.4 Refer to the correspondence with ADC in Appendix D.

3.5 EXISTING FLOOD DEFENCES AND OTHER STRUCTURES

- 3.5.1 The online EA maps confirm that the site is not within an area benefiting from flood defences owned or managed by the EA. However this is not relevant as the site is located away from any fluvial and tidal floodplain as discussed in the following pages.

3.6 EXISTING SURFACE AND FOUL WATER DRAINAGE

- 3.6.1 No public surface water drainage network is present in proximity to the site based on SW Asset Records.
- 3.6.2 SW records indicate the presence of a public foul rising main, crossing the lower half of the site from east to west. (Refer to Appendix G for the SW Records). Southern water has confirmed that the rising main is in place and that an easement of 3m either side is required if the rising main is to be left as it is.
- 3.6.3 The public sewer records also show a 225mm foul sewer crossing the northern section of the site (manhole references 3001, 3101, 2101); Southern Water have confirmed that this existing foul pipe would require a 3m easement either side. (Refer to Appendix H for SW Correspondence).
- 3.6.4 Easements are needed by SW to maintain their associated assets, no permanent structures are permitted within these areas, though low level landscaping (in line with Sewers of Adoption 7), car parking and access road are permitted within the easement as these would not prohibit access if required by SW.
- 3.6.5 Huw Thomas Architects have been informed regarding these associated easement requirements, and these have been reflected in the current layout. It is however recommended that Southern Water review the plans early in the process to ensure they have no formal objections to the layout.

- 3.6.6 A Level 2 Capacity Check was carried out by SW back in August 2014, which confirmed that there is not sufficient capacity within the existing sewer to receive the proposed foul flows, and that reinforcement work is required. Refer to Appendix H and section 9 for details. Please note that the Level 2 enquiry in 2014 was carried out assuming that development of the site and of the correspondent site to the north of Yapton Road would progress in parallel; further discussion with Southern Water is therefore recommended to confirm the availability of capacity within the public drainage network.
- 3.6.7 Based on SW Asset Records there is no existing surface water sewer in the vicinity of the site, however there is a highway drainage system, which serves Yapton Road and discharge into the watercourse further east.

4

PROPOSED DEVELOPMENT

4.1 DEVELOPMENT PROPOSALS

4.1.1 The proposed development comprises the following:

Demolition of all existing structures and redevelopment with 95 dwellings together with associated open space, landscaping and access improvements.

4.1.2 A proposed site layout, produced by Huw Thomas Architects, drawing 2037/02, is attached at Appendix A.

4.2 VULNERABILITY CLASSIFICATION

4.2.1 Based on Table 2 in the Planning Practical Guidance (PPG) to the NPPF, the proposed use will be classified as 'more vulnerable' due to its residential element.

4.3 SEQUENTIAL TEST AND EXCEPTION TESTS

4.3.1 As stated in the NPPF, a sequential risk-based approach to determine the suitability of land for development in flood risk areas should be applied at all stages of the planning process giving precedence to low flood risk areas wherever possible.

4.3.2 Due to the site's location within Flood Zone 1 and to the fact that no other significant sources of flooding have been identified as affecting the site (refer to following sections), the proposed development is fully compliant with the requirements of the Sequential Test and the principles of the NPPF and the PPG which aim to steer development towards areas at low probability of flooding. Accordingly, there is no requirement to carry out an 'Exception Test'.

5

DEFINITION OF THE FLOOD HAZARD

- 5.1.1 Relevant maps from the SFRA are attached in Appendix I and relevant correspondence is attached in Appendix D, E and F. Maps from the WSCC SFRA are not attached as larger scale than those of the SFRA and generally consistent with them.

5.2 FLUVIAL FLOODING AND TIDAL FLOODING

- 5.2.1 The closest floodplain is the fluvial floodplain associated with a main watercourse located 500m to the North West from the site, towards Barnham.
- 5.2.2 As shown in the EA's online flood map and as confirmed by them in their correspondence, the site is located in Flood Zone 1 and therefore not at risk from any fluvial or tidal source of flooding. The EA have confirmed back in 2013 that the site has not been subject to fluvial flooding in the past which is consistent with its location within Flood Zone 1.
- 5.2.3 The above is consistent with Map A1-F and A1-T of the SFRA which shows the site as located in Flood Zone 1. Map C1-F and C1-T confirm that the site would remain well outside of the floodplain even in a climate change scenario although it is worth flagging up that the climate change guidance and potential allowances to be considered have evolved since the issue of the SFRA.
- 5.2.4 The maps of the WSCC SFRA confirm the above points.
- 5.2.5 Based on the above the probability of fluvial and tidal flooding at the site has been assessed as low.

5.3 SURFACE WATER FLOODING

- 5.3.1 Based on the EA online flood maps, the vast majority of the site is predicted to have a 'Very Low' probability of surface water flooding. This is land assessed as having a less than 0.1% chance of surface water flooding. Only localised, small spots are shown as having some potential for surface water flooding likely linked to local topography and the water potentially ponding there.
- 5.3.2 At the various stages of consultation with Arun DC they have flagged up the existing flooding issues further east, in Hill Lane and they have recently stated that the possible solution would be to lay a new 300mm diameter pipe parallel to the existing 225mm pipe. Please refer to appendix D for details.
- 5.3.3 The above is consistent with Map H of the SFRA which shows historic flooding at the junction between Yapton Road and Hill Lane.
- 5.3.4 The EA have raised back in 2013 the fact that Yapton Road flooded in 1987 from surface water along the northern boundary of the site. Refer to Appendix E for details.
- 5.3.5 Based on the above, the probability of surface water flooding at the site is assessed as low although surface water flooding might affect the surroundings of the site. Despite the low probability, the management of surface water at the site will be discussed further in Section 7 of this report.
- 5.3.6 Based on the above the probability of surface water flooding at the site can be classified as low although surface water flooding cannot be excluded in the surrounding areas.

5.4 GROUNDWATER FLOODING

- 5.4.1 Based on Map G1 'Indicative Risk of Groundwater Flooding' of the SFRA the site is shown to be on the boundary between an area of Groundwater Emergence and of High risk of Groundwater flooding. This is consistent with the expected high groundwater level at the site (Refer to Section 2.3).
- 5.4.2 Based on the above the probability of groundwater flooding at the site can be classified as medium to high although any risk is mitigated by the absence of any proposed basements.

5.5 SEWER FLOODING

- 5.5.1 We have contacted SW asking for about history of sewer flooding and any specific concerns that they have however they have advised that they do not provide data related to flood risk. Refer to the correspondence within Appendix H.
- 5.5.2 No history of sewer flooding is shown in Map S of the SFRA.
- 5.5.3 Based on the above the probability of sewer flooding at the site can be classified as low.

5.6 ARTIFICIAL SOURCES OF FLOODING

- 5.6.1 The nearest artificial reservoir is the Bilsham Farm Reservoir located approximately 1.5km south of the site; however the site is shown as located outside the maximum extent area of any potential flooding linked to that reservoir.
- 5.6.2 Based on the above, the probability of flooding from artificial sources at the site is considered to be negligible.

6

CLIMATE CHANGE

6.1 BACKGROUND INFORMATION

- 6.1.1 As explained in the Climate Change Adaptation Sub-Committee Progress Report 2014, increased flood risk is the greatest threat to the UK from climate change. Models of the climate system suggest floods of the type experienced in England and Wales in autumn 2000, and between December 2013 and February 2014, have become more likely as a consequence of increased concentrations of greenhouse gases in the atmosphere.
- 6.1.2 More frequent short-duration, high intensity rainfall and more frequent periods of long-duration rainfall could be expected. Sea levels are also expected to continue to rise.
- 6.1.3 New EA guidance “Flood risk assessments: climate change allowances” issued on the 19th February 2016 (and subsequent updates) provides up to date information on expected changes in rainfall, river flows and sea level rise as a consequence of climate change. Refer to Appendix J for details.
- 6.1.4 A key change from the previous guidance is that the climate change allowances for peak river flows now are shown as variable on a regional basis; allowance are also now based on percentiles, whereby a percentile is a measure used in statistics to describe the proportion of possible scenarios that fall below an allowance level (e.g. a 50% percentile means that the allowance has 50% chances of not being exceeded). However fluvial flooding is not relevant for the site due to its location in Flood Zone 1 and the distance from the floodplain.
- 6.1.5 For peak rainfall the EA Guidance provides an upper end and central allowance depending on epoch; the guidance recommends assessing both the central and upper end allowances to understand the range of impact. These allowances are detailed in Table 2 (Peak rainfall intensity allowance in small and urban catchments) of the EA guidance
- 6.1.6 Sea levels allowances reflect the previous guidance and vary on a regional basis and for each epoch as shown in Table 3 of the EA guidance. As above tidal flooding is not relevant for the site based on its location away from any tidal floodplain.

6.2 DEVELOPMENT LIFESPAN AND APPLICABLE ALLOWANCES

- 6.2.1 A typical lifespan for residential developments is 100 years; based on this, the contingency allowances for climate change that are potentially applicable to this Site are:

Peak Rainfall;

→ Upper End – 40% by 2115

→ Central – 20% by 2115

- 6.2.2 River and sea level allowances are not relevant due to the location of the site away from any fluvial and tidal floodplain.

6.3 IMPACT OF CLIMATE CHANGE ON THE DEVELOPMENT

- 6.3.1 Due to the location of the site away from any fluvial and tidal floodplain climate change is not expected to have a significant impact on the probability of fluvial and tidal flooding at the site and for the proposed development.

- 6.3.2 The EA guidance indicates that developers should assess both the central and upper end allowances for rainfall to understand the possible range of impacts that climate change might have on surface water runoff generated at a development. The drainage strategy discussed in the following pages therefore considers both potentials scenarios in compliance with NPPF and the latest EA climate change recommendations.

7

FLOOD RISK MITIGATION MEASURES

- 7.1.1 The site is located within Flood Zone 1 and no significant sources of flooding which might affect the development have been identified.
- 7.1.2 The only potential significant source of flooding identified which might affect the site is groundwater flooding; however the related risk is minimised by the absence of any proposed basement at the site.
- 7.1.3 Therefore no mitigation measures are expected to be required to ensure the safety of the development against flood risk apart from the development of a surface water drainage strategy to ensure the sustainable and safe management of surface water runoff (refer to the following pages).
- 7.1.4 Even in the case of an extreme flooding event that may affect the site, the impact would be limited by the following mitigation measures which minimise any residual risk:

7.2 RAISED THRESHOLDS

- 7.2.1 It is recommended that the ground floor level thresholds are raised compared to the adjacent carriageways of the site so that any potential runoff from the adjacent carriageways would be prevented from entering the buildings. The use of slopes on the paving surfaces surrounding the site would also ensure that any overland flow generated offsite would naturally fall away from the building envelope.

8

OUTLINE SUDS/SURFACE WATER DRAINAGE STRATEGY

8.1 OVERVIEW

- 8.1.1 The proposed drainage solutions reflect the strategy developed to support the previous iterations of the scheme; however they take into account the additional information now available on the location of the existing raising main crossing the site which has imposed some changes in the development layout and in the location of the attenuation basin/pond.
- 8.1.2 From a sustainable drainage perspective, the Building Regulations (H3) and relevant SuDS policy and best practice state that the priority for discharging surface water runoff from a development is as follows:
- Infiltration into the ground;
 - Discharge into a watercourse;
 - Discharge into a sewer.
- 8.1.3 Though the EA in their 2013 correspondence stated that soakaways are not considered to be an appropriate solution for discharging surface water runoff from the site, Arun DC back in 2014 made clear that they would want to see winter groundwater monitoring (October – March) and infiltration testing in accordance with BRE 365, CIRIA R156 or a similar proved method be undertaken to determine soakage potential on site in order to ascertain how much infiltration could be achieved before relying on a controlled discharge of surface water to a watercourse.
- 8.1.4 As such WSP undertook infiltration testing and groundwater monitoring in 2014 (Appendix L) which confirmed the following:
- *Based on these locally calculated infiltration rate test permeabilities the drainage conditions would be described as poor by Carter & Bentley*
 - *Current best practice suggests that there should be a minimum of 1m (unsaturated zone) between the base of the soakaway and the groundwater. During wet winter conditions this condition will not be met at the Angels Nursery site*
 - *The groundwater levels at the proposed Angels Nurseries development site are responsive to rainfall events. All recorded groundwater levels within the site rise to within at least 0.8 metres from ground surface, excluding borehole WS1 where artesian conditions were recorded. The period of time over which the seasonally influenced groundwater levels have remained high is in the order of 2 to 3 months. The implications of seasonally influenced groundwater levels at or close to ground surface are that the proposed current invert of 1m below land surface for a storm water attenuation pond or an invert of <1m below ground level would be compromised by the presence of seasonally influenced groundwater.*
- 8.1.5 Infiltration has therefore been assessed as not being an appropriate solution for surface water management at the site.
- 8.1.6 Arun DC previously agreed that if infiltration was completely unviable from the onsite testing, then the proposed drainage strategy would solely utilise the existing connection to the wider ditch network, with the appropriate SuDS attenuation features as required on site.

- 8.1.7 The proposed drainage philosophy therefore reflect that previously discussed and agreed with Arun DC i.e. the surface water runoff generated by the development will be conveyed via lined permeable paving situated within the private driveways and car parks to gravity sewers located within the adopted highway. The sewers require oversizing to provide required fall across the site. The sewers will outfall into an attenuation basin/pond which has been sized to attenuate flows up to and including the 100 year event plus 20% for climate change. A hydrobrake has been proposed downstream of the pond to restrict flows to Q_{bar} (7.3l/s). To keep the consistency with the previous FRAs, the drainage calculations have been carried out using FSR rainfall method. Calculations have been carried out using MicroDrainage incorporating 1 in 1, 1 in 30 and 1 in 100 year event with 20% climate change. The impact of 40% climate change has also been assessed. The results show no flooding.
- 8.1.8 The proposed solutions eliminate the risk of any downstream flood risk through the management of both peak and volumetric runoff in line with best practice.
- 8.1.9 The restricted flow will be discharged into the southern ditch which flows towards east and offsite. Refer to the drainage strategy drawing 50600666-D-01 within appendix M and Microdrainage calculations within appendix N.
- 8.1.10 The ditch located along the eastern extent of the site will require partial abandonment and infilling, the two central ditches will require full abandonment and infilling in order to allow the development to take shape. In order to negate any habitat loss through the abandonment of the ditches, there is a potential option to lower the base of the pond to provide a permanent wet feature; this would provide ecological benefits such as vegetation and wildlife.
- 8.1.11 Although the outline surface water drainage strategy identifies the principles of surface water management at the site, the details of the proposed strategy, including storage requirements and solutions, will need to be confirmed and further refined at the detailed design stage following additional investigations and discussions with relevant stakeholders (e.g. A DC, SW and WSCC). At this outline stage the basin/pond has been designed assuming 1 in 3 bank slopes for safety reasons. This will need to be re-assessed at the detailed design stage and health and safety requirements will need to be fully assessed to ensure that the proposed solutions do not cause a risk to people, especially children.
- 8.1.12 It is proposed to install permeable paving on shared access roads and parking bays prior to discharging to the site wide network and attenuation basin/pond.
- 8.1.13 The paving system, where proposed, will provide a treatment sequence where sediment and oil are trapped at the surface, in the laying course and upper geotextile, and any remaining oil will biodegrade within the pavement sub base. Where permeable pavements are not proposed trapped gullies will provide the first level of treatment.
- 8.1.14 Additional treatment will be provided within the retention basin/pond. The retention time promotes pollutant removal through sedimentation.

9 DRAINAGE MAINTENANCE STRATEGY

9.1.1

The following drainage maintenance and management strategy (Table 10) has been produced and will need to be further developed and confirmed at detailed design stage; it is expected that the maintenance for the entire scheme will be managed by West Sussex County Council, SW or a private management company; this will be confirmed post planning and a suitably qualified maintenance specialist will undertake the work.

Table 10 – Maintenance Strategy

Drainage Feature	Regular Maintenance	Occasional/Remedial Maintenance	Monitoring
Drainage channels/Gullies	- Inspections will include gratings; covers including their locking bolts; sumps and sump buckets; exposed concrete surround and adjacent surfacing. - Check for accumulation of debris and silt and cleaned as necessary - Gratings, frames and all associated locking parts to be checked for damage. - Exposed concrete and adjacent surfacing to be checked for cracking and general damage. - Check condition of inlet and outlet pipes, flow controls, baffles and isolation structures	- Channel cleaning will be by flushing with water or high pressure jetting (no boiling water or cleaning agent will be used). All silt buckets and sumps will be cleaned out replaced back into the units ensuring they are correctly fitted. - All channel surfaces and joints will be checked and repaired as necessary. - Repair/rehabilitation of inlets, outlet, overflows and vents, as required.	- Inspect every 4 months or after large storm.

Catchpit Manholes/Inspection Chambers	- Check for accumulation of debris and silt and cleaned as necessary. - Covers and frames to be checked for damage. - Exposed concrete and adjacent surfacing to be checked for cracking and general damage. - Check condition of inlet and outlet pipes, flow controls, baffles and isolation structures	- Clean as necessary. - All manhole and inspection chamber covers and frames to be replaced as necessary. - Repair exposed concrete and surfacing as necessary - Repair/rehabilitation of inlets, outlet, overflows and vents, as required.	- Inspect every 6 months or after large storm.
Permeable Paving	- Brushing and vacuuming three times/year at end of winter, mid-summer, after autumn leaf fall, or as required on Site-specific observations of clogging or manufacturer' recommendations	Stabilise and mow contributing and adjacent areas, as required - Removal of weed, as required	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving, as required. Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, as required. - Rehabilitation of surface and upper sub-structure, as required.

Petrol/Oil Interceptor	- Check for accumulation of debris and silt and cleaned as necessary. - Covers and frames to be checked for damage. - Exposed concrete and adjacent surfacing to be checked for cracking and general damage. - Check for any hydrocarbon build-up within the interceptor chambers and clear/remove as necessary - Check condition of inlet and outlet pipes of flow controls, baffles and isolation structures - Check condition and test alarm probe.	- Clean as necessary. - All manhole and inspection chamber covers and frames to be replaced as necessary. - Repair exposed concrete and surfacing as necessary. - Repair/rehabilitation of inlets, outlet, overflows and vents, as required.	- Inspect every 6 months or after large storm.
Attenuation Ponds/basins	Litter Removal, as required. Grass cutting (public areas), monthly (during growing season). Grass Cutting (meadow grass), Half yearly (spring before nesting season, and autumn). Inspect vegetation to pond edge and remove nuisance plants (for the first 3 years), monthly (as start, then as required).	Remove sediment from the main body of big ponds when pool volume is reduced by 20%. 25 years or as required.	Repair of erosion or other damage, as required. Aerate pond when signs of eutrophication are detected, as required. Realignment of rip-rap or other damage, as required. Repair/rehabilitation of inlets, outlets and overflows, as required.

	Hand cut submerged and emergent aquatic plants (at minimum of 0.1m above pond base). Include max 25% of pond surface, annually. Remove 25% of bank vegetation from water edge to a minimum of 1m above water level, annually. Tidy all dead growth before start of growing season, annually. Remove sediment from one quadrant of the main body of pond every 5 years.		
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10 FOUL WATER DRAINAGE

10.1 OVERVIEW

- 10.1.1 With reference to the Southern Water Sewer records (Refer to Appendix H), the proposed point of foul discharge would be the existing 225mm diameter foul drain towards the northern boundary of the site. As discussed in Section 2 a Level 2 Capacity Check has been undertaken by Southern Water back in 2014 for this site and the one to the north of Yapton Road, refer to Appendix I. Southern Water back then confirmed that there was not sufficient capacity within the existing sewer to receive the proposed flows, and that reinforcement work would be required.
- 10.1.2 In recent discussions Southern Water has recommended that a section 98 application would be the next step forward to provide the necessary infrastructure to the proposed development site.
- 10.1.3 Due to the topography of the site, it has been determined that a pumping station will be required to serve the development. The pumping station would receive flows via gravity powered sewers, and pumped via a rising main to discharge into the existing foul sewer located along the northern boundary of the site in Yapton Road. Location of the pumping station to be confirmed.

11 OFF-SITE IMPACT

- 11.1.1 The development will not cause impacts elsewhere in terms of fluvial and tidal flood risk due to its location within Flood Zone 1, where probability of fluvial/tidal flooding is lowest.
- 11.1.2 Surface Water will be discharged into an existing ordinary watercourse crossing the southern end of the site at Qbar in line with best practice and avoiding negative impact on flood risk downstream.
- 11.1.3 In terms of foul water discharge, there is an available network to the north of the site (along Yapton Road), a response from Southern Water outlined that reinforcements works are required to accept the additional flows from the proposed site.

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RESIDUAL RISK

- 12.1.1 The residual risk linked to fluvial and tidal flooding is negligible due to the location of the site away from any fluvial and tidal floodplain
- 12.1.2 The residual risk linked to surface water flooding around the area can be further mitigated by the incorporation of slopes on external pavements. This would ensure surface water would naturally fall away from the buildings' development.
- 12.1.3 The surface water drainage strategy takes into account the potential impact of a climate change even assuming a 40% increase of rainfall intensity in a 1 in 100 year return period scenario
- 12.1.4 Suitable designed overland flow routes will be provided at the detailed design stage to direct surface water flows away from buildings and towards the proposed SuDS features within the site.

13 CONCLUSIONS

- 13.1.1 The site is located within Flood Zone 1 and no significant potential sources of flooding have been identified.
- 13.1.2 The focus of this FRA is therefore the development of a surface water drainage strategy demonstrating the sustainable management of surface water runoff at the site.
- 13.1.3 The surface water strategy has been designed in accordance with best practising the use of SuDS at the site. Discharge rates have been restricted to the Qbar rate to ensure there is no risk of downstream flooding.
- 13.1.4 The risk of pollution from the site has been managed through the use of SuDS features such as a detention basin/pond and permeable paving.
- 13.1.5 There are several key constraints/requirements highlighted within this report, namely:
- 13.1.6 Existing foul rising main crossing the development site in the lower south area (with 3m easement required).
- 13.1.7 Existing foul sewer crossing the development site towards the North (with 3m easement required).
- 13.1.8 LLFA are responsible of the existing ditches within the development site, Arun DC (agents of the LLFA) have confirmed that they would require a 3m easement to the ditches in order for them to maintain the ditches. Ordinary watercourses consent will be required for any works in proximity of the ditches. As some of the ditches crossing the site will need to go as a consequence of the development early consultation with the LLFA and ADC is recommended to confirm that this is acceptable.
- 13.1.9 Equally ADC/LLFA do not favour culverting due to the loss of habitat and potential to increase flood risk. The proposed development proposal should aim to limit the amount of culverting of ditches to a minimum. As above it is highly recommended that the LLFA and ADC are engaged