

RESIDENTIAL DEVELOPMENT AT
BONHAMMS, FLANSHAM, FELPHAM, WEST
SUSSEX, PO22 8NP

Flood Risk Assessment

for the erection of 4no. 4-bed detached
dwellings, with associated car parking and
landscape enhancements

On behalf of
Victor Coutin

6301/FRA01

November 2021

DOCUMENT CONTROL

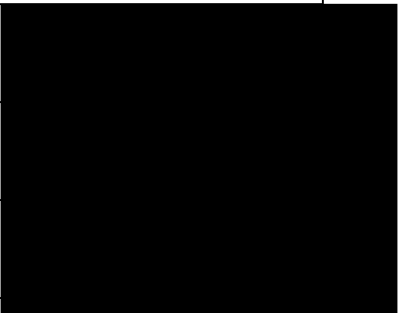
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Document: Flood Risk Assessment

Client: Victor Coutin

Reference: 6301/FRA01

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Status:

Issue	Date	Status	Amendment	Issued by
1.	22.11.2021	FINAL	-	Adam O'Hagan
2.				
3.				
4.				
5.				

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1 INTRODUCTION

- 1.1 RGP has been commissioned by Victor Coutin (the 'Client') to consider the flood risk associated with the proposed development at Bonhams, Flansham, Felpham, West Sussex, PO22 8NP from all potential sources of flooding, as defined by the National Planning Policy Framework (NPPF).
- 1.2 In compiling this Flood Risk Assessment, reference has also been made to the Strategic Flood Risk Assessment (SFRA), produced by JBA Consulting for Arun District Council (ADC), dated August 2016.
- 1.3 The aim of this FRA is to review the potential flooding impact on the proposed development site due to tidal, fluvial (Rivers), pluvial (Overland), sewer, reservoir, canal and other artificial flooding sources. The FRA will also review the potential impact of the development on the flooding in the surrounding area and the measures that could be incorporated as part of the design to mitigate the potential risk.
- 1.4 This FRA has been developed in accordance with the requirements of Chapter 14 of the NPPF, published February 2019, liaison with the Environment Agency (EA), the Lead Local Flood Authority (LLFA) and Southern Water.
- 1.5 Information used in preparing this Flood Risk Assessment was obtained from the following sources and Statutory Consultees:
- (i) Environment Agency Flood Map
 - (ii) Environment Agency Main River Map
 - (iii) Environment Agency Long Term Flooding Map
 - (iv) SFRA produced by JBA Consulting for Arun District Council (2016)
 - (v) Southern Water Asset Maps
 - (vi) Southern Water Sewer Flood Data
 - (vii) West Sussex County Council Local Flood Risk Management Strategy (2014)
 - (viii) South East River Basin District ' River Basin Management Plan (2015)
 - (ix) Arun & Western Streams Catchment Flood Management Plan (Sub-Area 6)
 - (x) River Arun to Pagham Flood and Coastal Erosion Risk Management Strategy (2015)
 - (xi) Topographical Survey
 - (xii) LiDAR Data
 - (xiii) British Geological Survey & Reports

2 PLANNING POLICY

The proposed development will be designed in accordance with the requirements as set out in the National Planning Policy, the ADC Surface Water Management Plan and the Strategic Flood Risk Assessment for ADC.

2.1 National Planning Policy Framework (NPPF)

2.1.1 Section 14 of the NPPF (2019) outlines the requirements for determining if a Flood Risk Assessment is required to be undertaken for new developments. A site-specific FRA should be provided for all sites which are located in Flood Zone 2 and 3.

2.1.2 An FRA should be provided for sites located in Flood Zone 1 where:

- ② The development site area > 1ha;
- ② The site has been identified by the Environment Agency as having critical drainage problems;
- ② The site has been identified in a strategic flood risk assessment as being at increased flood risk in future;
- ② Land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use; or
- ② The site is a small scale major development which where the number of residential units to be constructed is between 10 and 199 and:
 - ⓐ Floorspace to be built is between 1,000 m² and 9,999 m² or
 - ⓑ The site area is between 1ha and 2ha.

2.1.3 The development site is located within Flood Zone 1 in accordance with the EA flood maps. The site, however, may be at risk of surface water flooding and as such, an FRA is to be provided. The overall development area is 11,137m² (1.11ha).

2.1.4 The NPPF sets out the strategy throughout the UK for future development. The key policy provision states that:

- ② Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere.
- ② Strategic policies should be informed by a strategic flood risk assessment, and should manage flood risk from all sources. They should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards.
- ② All plans should apply a sequential, risk-based approach to the location of development 'taking into account the current and future impacts of climate change so as to avoid, where possible, flood risk to people and property.'

2.2 Local Policies

- 2.2.1 ADC have released a Local Flood Risk Management Strategy providing a framework of flood management control & risks within the county, accompanied by a series of technical appendices providing additional information.
- 2.2.2 ADC commissioned JBA Consulting to produce the Surface Water Management Plan (SWMP) (2016) as a strategic tool for the coordinated management of surface water flood risk within the West Sussex area.
- 2.2.3 The Arun and Western Streams Catchment Flood Management Plan (2009) produced by the Environment Agency to assess the inland flood risk within the area, considering all types of flooding including surface water runoff, groundwater, rivers, tidal flooding and coastal flooding from the sea. The site is located approximately 1.60km from the coastline at Felpham.
- 2.2.4 This FRA has been produced in line with the above-mentioned documentation.

2.3 Statutory Authority Consultation

- 2.3.1 The site is located within an area served by Southern Water. Southern Water have been contacted in relation to this site. The foul & surface water run-off is proposed to be discharged through existing connections into the Southern Water system.
- 2.3.2 Copies of Southern Water's Asset Map information has been included within Appendix 3 of this report. As indicated on the mapping, an existing $\varnothing$ 525mm foul sewer is located within Hoe Lane to the north of the site running from east to west, and a $\varnothing$ 600mm foul sewer rising main crossing within the development site from west to east.

3 PLANNING POLICY CONTEXT

A site-specific FRA should be carried out to demonstrate how flood risk will be managed now and over the development's lifetime, taking into account climate change and with regards to the vulnerability of its users.

In order to adequately consider and demonstrate how the flood risk will be managed, we need to identify what the probability is of the site flooding, what the site is going to be used for, the associated flood risk vulnerability, and the compatibility between the flood risk vulnerability and the flood zones.

This section details how the planning policy is applied to this site-specific FRA. Items highlighted in 'Green' in the following tables detail the site specific

3.1 Flood Zones

3.1.1 The flood zones refer to the probability of river and sea flooding, ignoring the presence of defences.

Table 1 - Flood Zones

Flood Zone	Probability	Definition
Flood Zone 1	Low	Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map - all land outside Zones 2 and 3)
Flood Zone 2	Medium	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Flood Zone 2a	High	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding. (Land shown in dark blue on the Flood Map)
Flood Zone 3b	Functional Flood Plain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map)

3.1.2 The particular flood zone(s) for the development are detailed on the Environment Agency's 'Flood Map for Planning', which is available online and is detailed further in Section 6 of this report.

3.2 Flood Risk Vulnerability Classification

3.2.1 The different types of flood risk vulnerability classifications are detailed in Table 2 below:

Table 2 - Flood Risk Vulnerability Classification

Classification	Description
Essential Infrastructure	- Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. - Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. - Wind turbines.

Classification	Description
Highly Vulnerable	- Police and ambulance stations; fire stations and command centres; telecommunications installations required to be operational during flooding. - Emergency dispersal points. - Basement dwellings. - Caravans, mobile homes and park homes intended for permanent residential use. - Installations requiring hazardous substances consent. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as 'Essential Infrastructure').
More Vulnerable	- Hospitals. - Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. - Buildings used for residential houses, student halls of residence, drinking establishments, nightclubs and hotels. - Non-residential uses for health services, nurseries and educational establishments. - Landfill* and sites used for waste management facilities for hazardous waste. - Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	- Police, ambulance and fire stations which are not required to be operational during flooding. - Buildings used for shops; financial, professional and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distribution; non-residential institutions not included in the 'more vulnerable' class; and assembly and leisure. - Land and buildings used for agriculture and forestry. - Waste treatment (except landfill* and hazardous waste facilities). - Minerals working and processing (except for sand and gravel working). - Water treatment works which do not need to remain operational during times of flood. - Sewage treatment works, if adequate measures to control pollution and manage sewage during flooding events are in place.
Water Compatible	- Flood control infrastructure. - Water transmission infrastructure and pumping stations. - Sewage transmission infrastructure and pumping stations. - Sand and gravel working. - Docks, marinas and wharves. - Navigation facilities. - Ministry of Defence installations. - Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. - Water-based recreation (excluding sleeping accommodation). - Lifeguard and coastguard stations. - Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. - Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation

Characteristic	Description
	plan.

3.3 Flood Risk Vulnerability and Flood Zone Compatibility

Table 3 - Flood Risk Vulnerability and Flood Zone Compatibility

Flood Zone	Flood Risk Vulnerability / Compatibility				
	Essential Infra	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Flood Zone 1	V	V	V	V	V
Flood Zone 2	U	V	V	V	V
Flood Zone 3a [†]	Exception Test	U	Exception Test	V	V
Flood Zone 3b [‡]	Exception Test	U	U	U	V [§]

V Development Appropriate

U Development Should not be Permitted

[†] Essential Infrastructure should be designed and constructed to remain operational and safe in times of flood

[‡] In Flood Zone 3b (functional floodplain) essential infrastructure that has to be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to:

- 1. remain operational and safe for users in times of flood;
- 2. result in no net loss of floodplain storage;
- 3. not impede water flows and not increase flood risk elsewhere.

3.3.1 The site is located within Flood Zone 1 in accordance with the EA flood maps. However, the site is at risk of surface water flooding.

3.4 Sequential Test & Exception Test

3.4.1 The proposed development area of the site falls completely within Flood Zone 1, and in accordance with Table 3 above, the development can appropriately proceed without any potential risks to the surrounding areas.

3.4.2 An exception test is not required as the entirety of the site falls within Flood Zone 1.

4 EXISTING SITE INFORMATION

4.1 Site Location

- 4.1.1 The proposed development includes the vacant greenfield land behind Bonhams off Hoe Lane. (Please refer to Figure 1, below) The site is bound to the west by residential properties, and all other sides by greenfield land. The development site is located within Arun District Council, in Flansham.



Figure 1 - Site Location Plan

4.2 Existing Site Description

- 4.2.1 The existing site is a greenfield site, which comprises an overall area of approximately 11,137m² (1.11ha).
- 4.2.2 The approximate OS Grid Location for the development site is E: 496221, N: 101084.
- 4.2.3 A topographical survey of the site has been provided to RGP. Refer to APPENDIX 1.

4.3 Source Protection Zone

- 4.3.1 The site is not located in a Source Protection Zone, as is illustrated in Figure 2, below. The extract of the latest ground water designation maps, obtained from the EA, shows the site (boundary marked in red) is located away from any source protection zones.

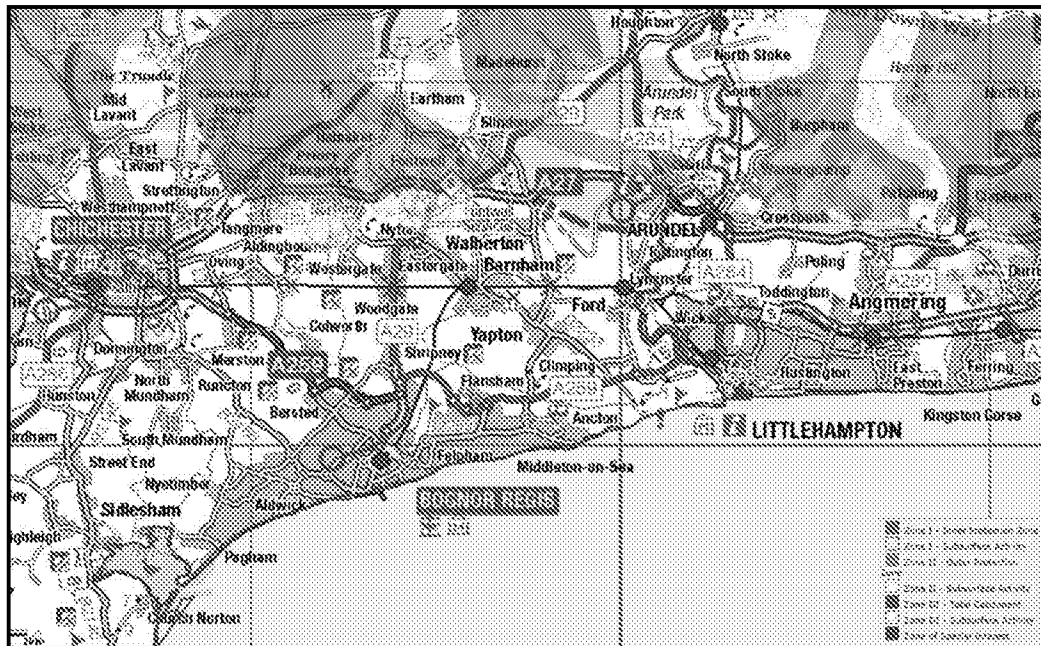


Figure 2 - Source Protection Zone Layout

4.4 Existing Geology and Hydrogeology

- 4.4.1 Having reviewed the existing British Geological Society (BGS) online mapping, the existing site is shown to be located in an area underlain by Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation And Portsdown Chalk Formation (undifferentiated) - (Chalk). Please refer to Figure 3, below, which details the existing bedrock formation and the site location (see red outline in Figure 3 for site location).

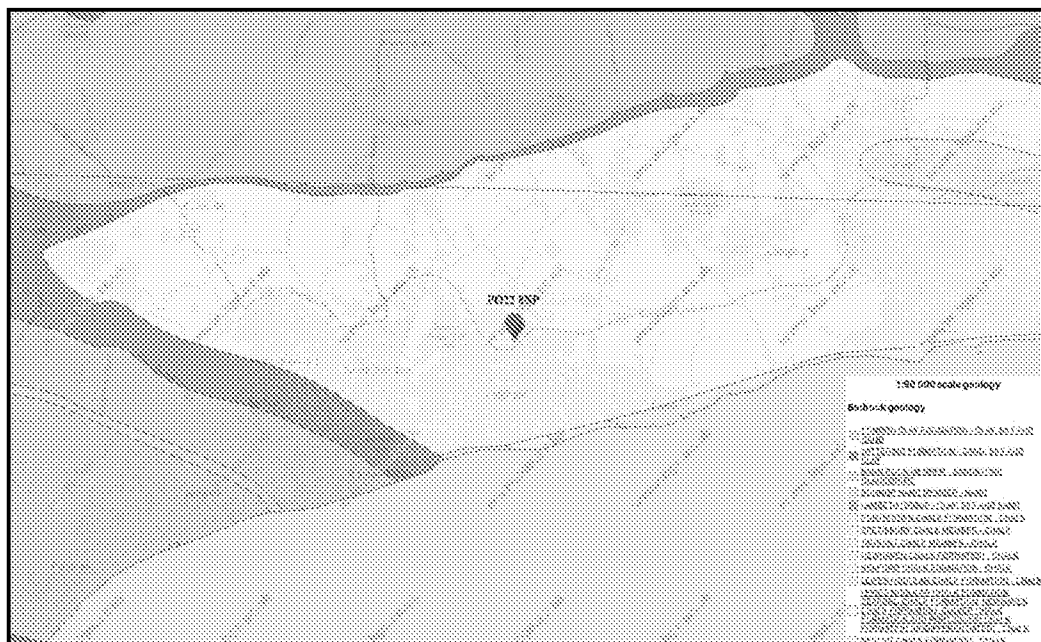
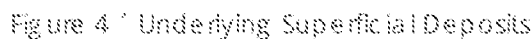


Figure 3 - Underlying Bedrock Formation

- 4.4.2 According to the BGS online mapping, there are superficial deposits of River Terrace Deposits (undifferentiated) - Sand, Silt and Clay comprising of the entire development site, as shown in Figure 4 below.



- ARUN DISTRICT COUNCIL Y/7/22/PL

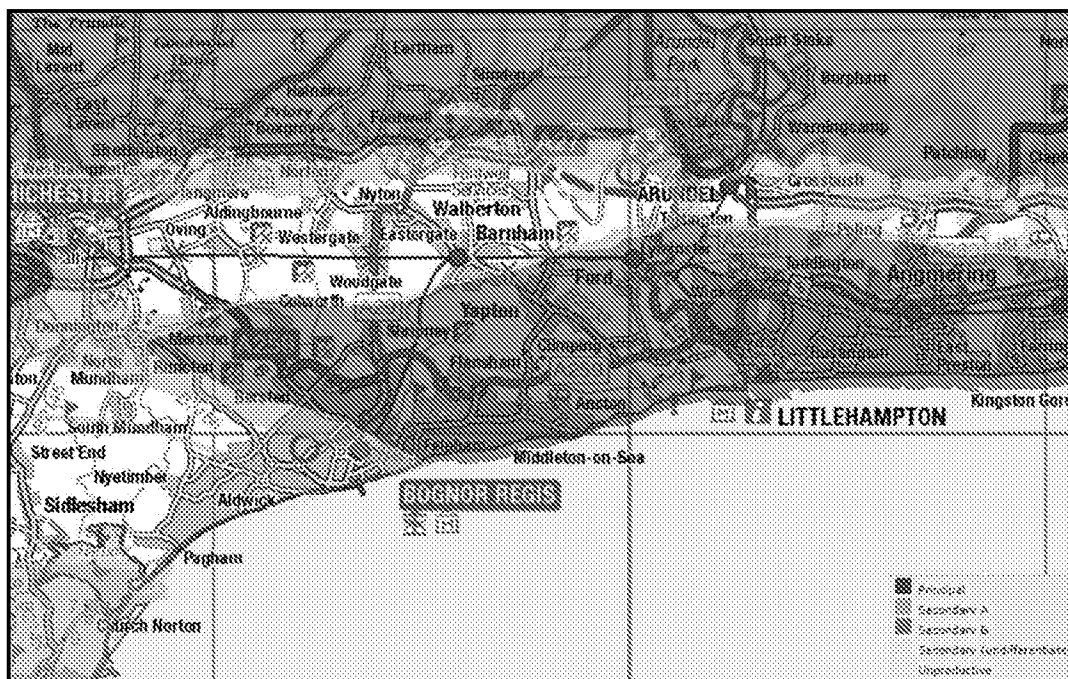


Figure 5 - Aquifer Designation Map

4.5 Surrounding Hydrology

- 4.5.1 There are multiple unnamed watercourses located in the vicinity of the proposed development site, as well as two classified EA Main Rivers. Please refer to Figure 6, below, (red outline at proposed site) which is an extract from the EA online mapping tool.

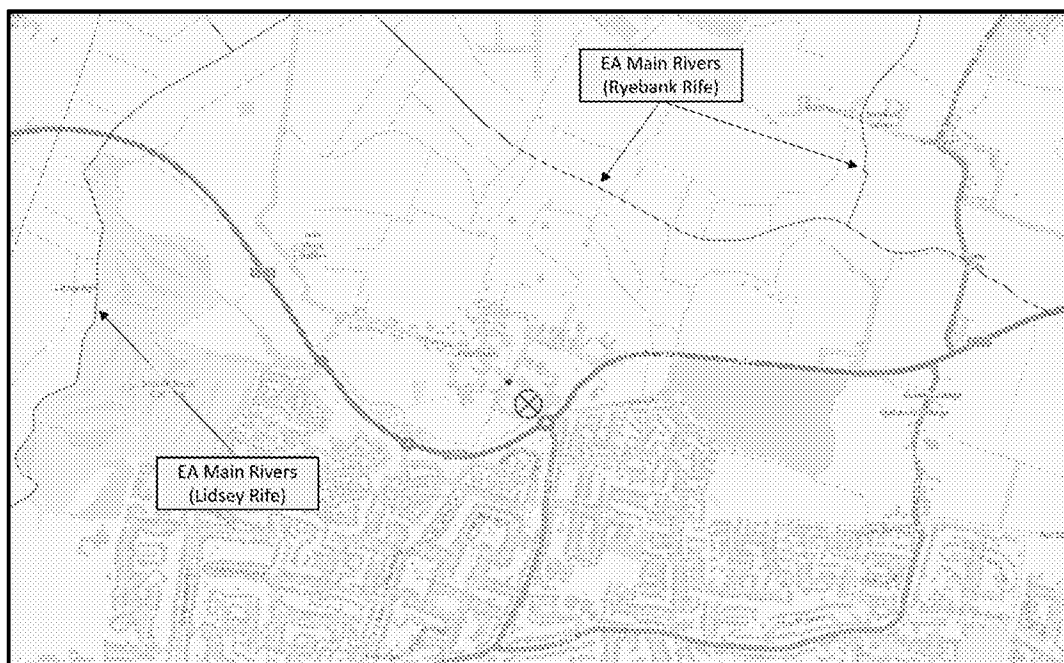


Figure 6 - EA River Map Extract

5 PROPOSED DEVELOPMENT INFORMATION

5.1 Proposed Development Description

- 5.1.1 Please refer to APPENDIX 1 of this report for all site layout plans.
- 5.1.2 The proposed development will include the construction of 4 residential homes.
- 5.1.3 The proposed development will be accessed from the existing private shared access on Hoe Lane.
- 5.1.4 The existing access is constructed of tarmac. The main access will remain tarmac, with the shared access extension to be constructed with permeable block paving.
- 5.1.5 All proposed private shared accesses and parking spaces are proposed to comprise of permeable paving, taking advantage of SuDs on the development. Where surface water storage is not feasible within the permeable paving to accommodate up to the 100 year + 40% climate change flood volumes, below ground soakaways are proposed.
- 5.1.6 The proposed development footprint of permeable paving area and residential building falls completely within Flood Zone 1.
- 5.1.7 The extent of the proposed surfacing to be installed as part of the new development is include in Table 4, below:

Table 4 - Proposed Development Surface Coverage

Item	Description	Area (m ²)
1.	Permeable Paving (Shared Accesses & Parking)	1,560
2.	Residential Homes (Roof Area)	674
3.	Grass/Landscaping	8,903
Total		11,137m ²

- 5.1.8 The proposed permeable and impermeable areas for the development site are summarised below in Table 5:

Table 5 - Proposed Permeable and Impermeable Surface Areas

Item	Description	Area (m ²)
1.	Development Permeable Area	8,903
2.	Development Impermeable Area	2,234
Total		11,137m ²

6 FLOOD RISK

6.1 Flooding from Seas (Tidal)

- 6.1.1 The site is located approximately 1.60km inland from the nearest sea at Felpham and as such, the site is not affected by tidal flooding.
- 6.1.2 The site is not located close to any rivers which are subject to tidal surges and as such, is not affected by these events.
- 6.1.3 Please see Figure 7, which detailed the location of the site in relation to the wider surrounding area.

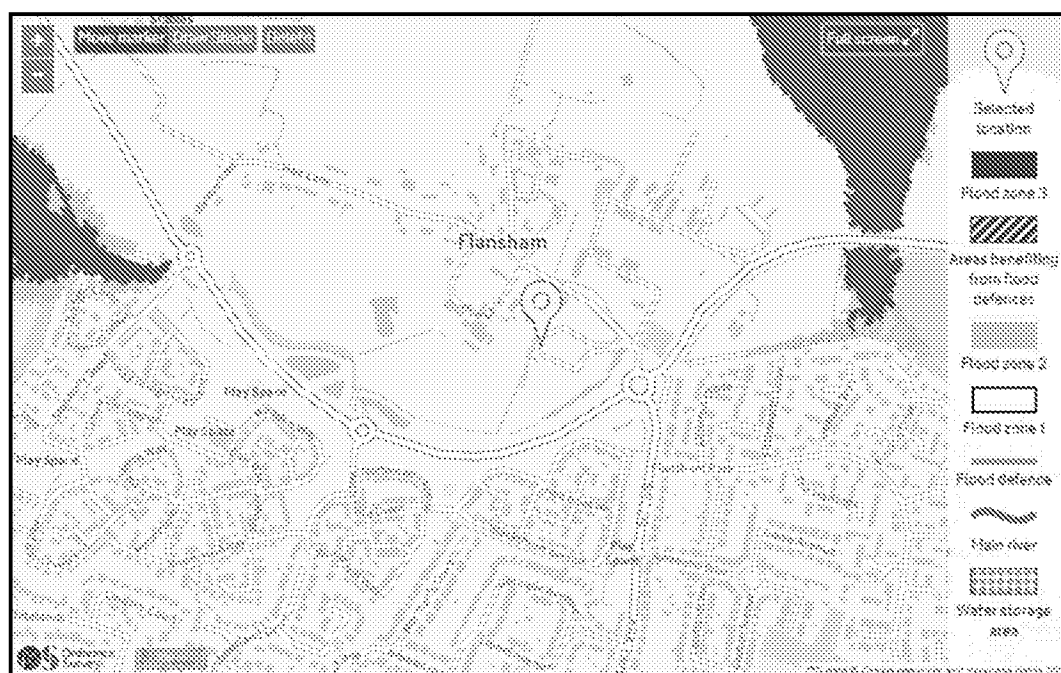


Figure 7 - EA Flood Map - Wider Area

6.2 Flooding from Rivers (Fluvial)

- 6.2.1 There are no other main rivers or ordinary water courses in the vicinity of the works which pose a flood risk to the site.
- 6.2.2 The Environment Agency Flood Map for Planning shows the overall site to be located fully within Flood Zone 1. Please see 6 above, which details the EA flood map zone at the location of the site.
- 6.2.3 The future potential flood risk from rivers and water courses has been assessed as very low.

6.3 Flooding from Surface Water (Pluvial)

- 6.3.1 In the event of excessive rainfall, where the ground has become saturated and rainfall is not able to infiltrate into the ground, the overland flow would typically flow towards the nearest watercourse/ditch. This runoff can cause localised flooding before discharging to the watercourse/ditch.
- 6.3.2 The existing topography of the site indicates that overland flow will be from the north to south across the development site, directing surface water flow towards the English Channel, located to the south of the site.

- 6.3.3 The EA Surface Water Flood Map confirms that the risk from surface water flooding is very low for the majority of the site, included in Figure 8.

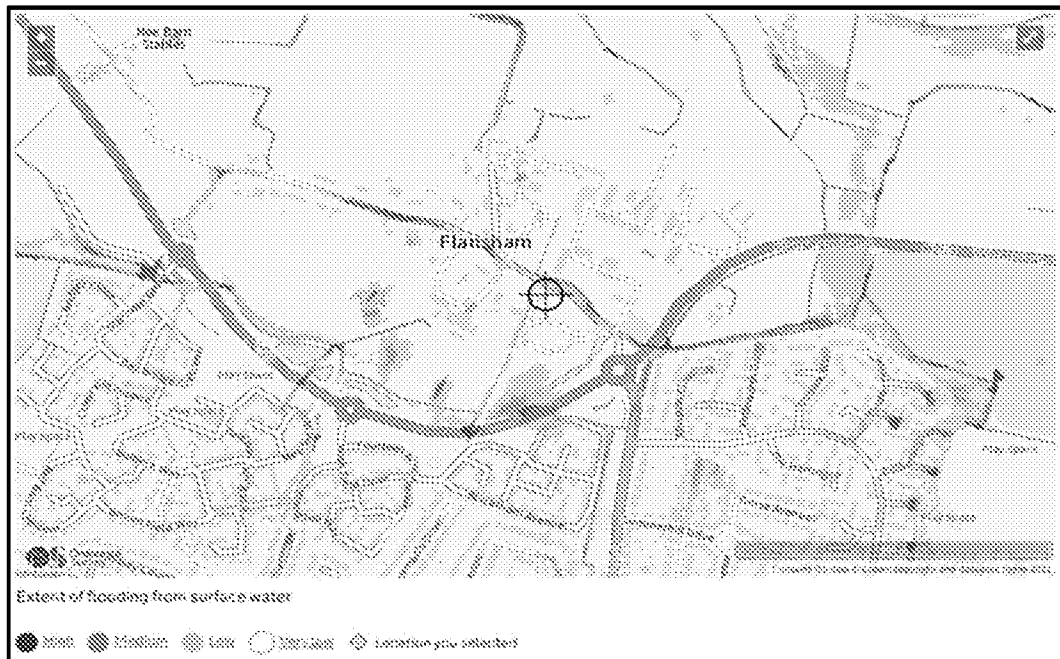


Figure 8 - EA Surface Water Flood Risk Map

- 6.3.4 The risk of overland flooding on the development site is considered low.

6.4 Flooding from Groundwater

- 6.4.1 There are typically seven sources, or mechanisms, of groundwater flooding. These were described by Defra (Jacobs 2007) as:

1. The rise of typically high groundwater levels to extreme levels due to prolonged extreme rainfall;
2. The rise of groundwater levels in aquifers in hydraulic continuity with high in-bank river levels or extreme tidal conditions;
3. The increase in groundwater levels and change of ground water flow paths due to artificial obstructions or pathways, like foundations, and the loss of natural storage and drainage paths;
4. Rising groundwater levels due to a reduction in ground water extraction in Urban areas;
5. Rising groundwater levels due to leaking sewers, drains and water mains;
6. Faulty borehole headworks or casings causing upward leakage of groundwater through confining layers driven by artesian heads;
7. Subsidence of the ground surface below the current groundwater level.

- 6.4.2 Of the abovementioned potential causes of groundwater flooding, only the first two are directly affected as a result of environmental conditions. The remaining five potential causes of groundwater flooding are mainly the result of man-made activities, or the stopping of such activities.

- 6.4.3 There are no works currently being undertaken at the development site, or planned to be undertaken at the development site that would have an impact on the five man-made causes of ground water flooding. As such, this FRA will review the impact on ground water flooding based on the environmental conditions at the site.
- 6.4.4 Groundwater flooding from extreme water level rise at the development site is unlikely.
- 6.4.5 The use of modern construction techniques for the design and installation of the foundations to the proposed new development will also minimise the risk associated with groundwater flooding within the development. These techniques include the design and installation of trench foundations or ground beams to support the new dwelling construction. The installation of raised beam and block floors to accommodate a void underneath the ground floor, which would reduce the risk of ground water flooding.
- 6.4.6 It is not proposed to make use of a raft foundation design for the proposed dwelling as these can be affected by rising and dropping ground water levels.
- 6.5 Flooding from Public Sewers/Highway Drains
- 6.5.1 Sewer flooding can occur when sewer systems become overloaded. Flooding of properties usually happens when either flood water backs up in the pipes and enters directly into low lying properties or where the capacity of the system is exceeded and water discharges from the manholes and runs overland into properties.
- 6.5.2 It has traditionally been thought that in areas where the ground water level is shallow, the risk of groundwater entering the sewer network through pipe joints and cracks is high. As a result, the capacity of the pipe network is reduced. As has been discussed above in Section 6.4, the risk of ground water flooding to the development site area is low and as such, the risk of sewer flooding is also low.
- 6.5.3 Local sewer flooding records have been reviewed from Southern Water. They indicate that there is no historical flooding on the site due to surcharging of public sewers. Please refer to APPENDIX 2 of this report, which includes the Southern Water correspondence.
- 6.5.4 Modern construction techniques and Building Regulations stipulate that the foul water sewer system to be installed watertight to prevent the ingress of ground water to the foul water system.
- 6.5.5 The risk of internal flooding to the proposed new dwelling, from the ingress of ground water to the system, will be unlikely. Further to this, the risk of internal foul water flooding to the development is considered low.
- 6.6 Flooding from Artificial Sources
- 6.6.1 Based on the Environment Agency's 'Long Term Flood Risk' map, the site is not affected by the failure of any reservoir or other man-made infrastructure. Please refer to Figure 9, below, which details that there is no risk of flooding from the failure of reservoirs in the surrounding area.

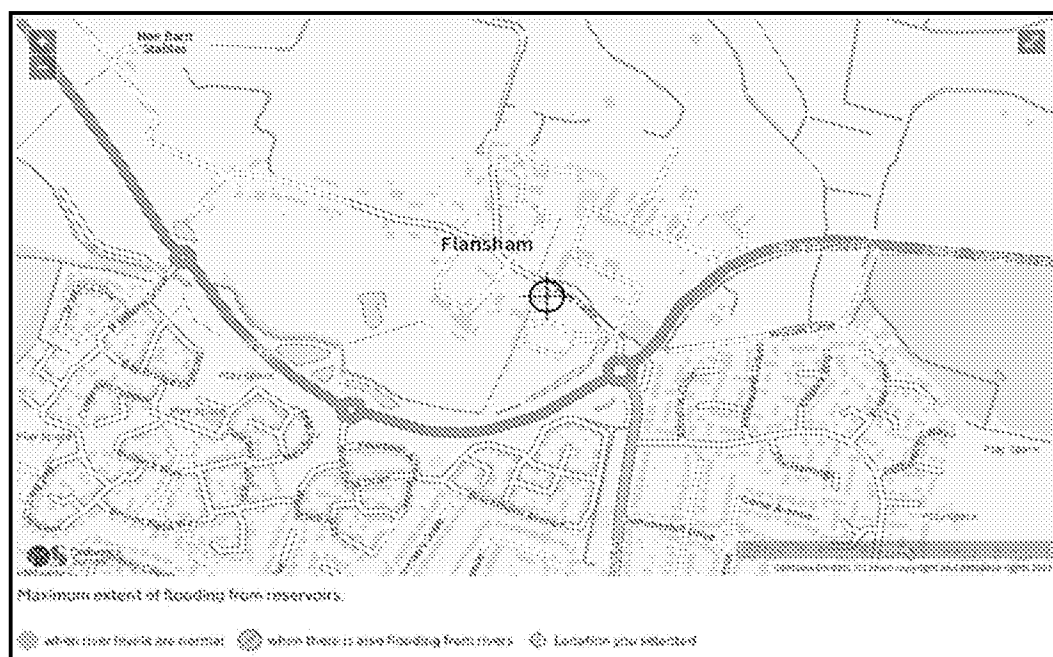


Figure 9 - EA Flood Risk from Reservoirs Map

6.7 Peak River Flow Flood Allowance for Climate Change

6.7.1 The site is not located within the vicinity of an existing watercourse. No provision has been included for in regards to Peak River Flow Flood Allowance.

6.8 High ++ Allowances for Climate Change

6.8.1 The EA defines High ++ Allowances as to 'only apply in assessments for developments that are very sensitive to flood risk, and with lifetimes beyond the end of the century. For example, infrastructure projects or developments that significantly change existing settlement patterns. This includes urban extensions and new settlements.' Although the life expectancy of the proposed development will extend into the next century, we do not believe that the development of a single dwelling meets the requirements for a High ++ Allowance and as such have not included for this allowance.

6.9 Peak Rainfall Intensity Allowance for Climate Change

6.9.1 Having reviewed the EA Table 2 'Peak Rainfall Intensity Allowance in Small and Urban Catchments', we have assumed a climate change allowance of 40% for the proposed onsite surface water drainage design. Please refer to Section 7 for a detailed assessment of the proposed surface water drainage strategy for the development.

7 PROPOSED DRAINAGE STRATEGY AND SUDS

7.1 Existing Surface Water Run-off

7.1.1 The existing site covers an area of approximately 11,137m² (1.11ha). The site is considered greenfield due to the majority of the development comprising of grass fields, with minor tarmac shared accesses. It has been assumed the current site discharges to a nearby watercourse fronting the development on Hoe Lane.

7.1.2 The existing permeable and impermeable areas for the development site are summarised below in Table 6:

Table 6 - Existing Permeable and Impermeable Surface Areas

Item	Description	Area (m ²)
3.	Development Permeable Area	10,201
4.	Development Impermeable Area	936
Total		11,137m ²

7.1.3 The existing site surface water runoff rate has been calculated using the Wallingford Procedure (Design and Analysis of Urban Storm Durations), Volume 4, The Rational Modified Method. Please refer to APPENDIX 3 for the detailed drainage calculations.

Table 7 - Existing Site Surface Water Runoff Rate

Q	Q ₁₀	Rainfall Depth (mm)	Intensity (mm/hr)	Q _{max} (l/s)	Volume (m ³)
M2-60	0.81	16	16.20	4.00	28.96
M30-60	1.54	31	30.87	7.62	55.19
M100-60	2.03	41	40.60	10.03	72.59

7.1.4 It is proposed to discharge all surface water from the roof structures and access road through existing drainage systems connecting to the Southern Water system. Any excess surface water will infiltrate into the ground via the landscaping areas, and permeable paving towards the rear of the site.

Table 8 - Proposed Site Surface Water Runoff Rate

Q	Q ₁₀	Rainfall Depth (mm)	Intensity (mm/hr)	Q _{max} (l/s)	Volume (m ³)
M2-60	0.81	16	16.20	9.55	16.85
M30-60	1.54	31	30.87	18.20	32.11
M100-60	2.03	41	40.60	23.93	42.23

7.2 Development Surface Water Run-off and Storage Estimate

7.2.1 The total proposed impermeable area of the proposed development site comprises approximately 15% of the site.

7.2.2 The proposed runoff rate has been calculated using the Wallingford Procedure (Design and analysis of Urban Storm Durations), Volume 4, The Rational Modified method. Please refer to APPENDIX 3 for the detailed calculations.

- 7.2.3 The proposed surface water runoff rate, discharge volume, estimate permeable paving thickness requirement for the development site have been assessed and are included in APPENDIX 3 of this report.
- 7.2.4 However, in order to reduce the risk of off-site flooding, we have designed the storage tank to accommodate up to the 1:100 yr + 40% for climate change event. In so doing, it is proposed to maintain all potential flooding on site for up to this rainfall event.
- 7.2.5 The details of the estimated storage tank size are included in Table 9, below. It is proposed to include geocellular crates, with a void ratio of 95%, as part of the tank design.

Table 9 – Proposed Storage Tank Sizing (1:100 + 40% for C.C.)

Storage Tank	Storage Tank SDO	Capacity
Storage Tank 1	10m x 10m x 1.2m deep	114m ³

7.3 Sustainable Drainage Systems (SuDS)

- 7.3.1 The SuDS Manual (CIRIA C 753) identifies that ‘Surface water is a valuable resource, and this should be reflected in the way it is managed and used in the built environment. It can add to and enhance biodiversity, beauty, tranquillity and the natural aesthetic of buildings, places and landscapes and it can help make them more resilient to the changing climate:’.
- 7.3.2 Also, ‘The philosophy of sustainable drainage systems is about maximising the benefits and minimising the negative impacts of surface water runoff from developed areas. The SuDS approach involves slowing down and reducing the quantity of surface water runoff from a developed area to manage downstream flood risk, and reducing the risk of that runoff causing pollution. This is achieved by harvesting, infiltrating, slowing, storing, conveying and treating runoff on site and, where possible, on the surface rather than underground:’.
- 7.3.3 The implementation of sustainable water management through sustainable drainage systems and rainwater harvesting is becoming more common in an effort to use and manage water sustainably. The philosophy of SUDS is to mimic as closely as possible the natural drainage from a site before development and to treat runoff to remove pollutants.
- 7.3.4 SUDS provide a flexible approach to drainage, with a wide range of components from soakaways to large-scale basins or ponds. The individual techniques should be used in a management train that reinforces and, where possible, follows the natural pattern of drainage. The management train incorporates a hierarchy of techniques. These are:
- 1 Prevention – the use of good site design and housekeeping measures on individual sites to prevent runoff and pollution (examples include minimising paved areas and the use of sweeping to remove surface dust from car parks),
 - 2 Source control – control of runoff at or very near its source (such as the use of rainwater harvesting, pervious pavements, green roofs or soakaways for individual houses),
 - 3 Site control – management of water from several sub-catchments (including routing water from roofs and car parks to one large soakaway or infiltration basin for the whole site).

- 2 Regional control of management of runoff from several sites, typically in a detention pond or wetland.
- 7.3.5 Adopting a holistic approach towards surface water drainage provides the benefits of combined water quality and quantity control, as well as increased amenity value. This is accomplished by managing the increased flows and pollution from surface water runoff that can arise from development. Ideally, the system should utilise a management train and should achieve equal standing in all three of these areas. However, specific site considerations may mean that a balance of benefits is not always achieved.
- 7.3.6 The priority for the discharge of surface water run-off should be:
- 2 Infiltration;
 - 2 Discharge to surface waters;
 - 2 Discharge to a surface water sewer, highway drain or another drainage system;
 - 2 Discharge to a combined sewer.
- 7.3.7 Discharge of surface water run-off should not be discharged to a foul sewer unless agreed in writing by the statutory authority maintaining the sewer, prior to any construction works commencing.
- 7.3.8 In order to manage surface water sustainably, the use of SuDS is recommended. There are a number of different options available and these are detailed and assessed below in Table 10. The various SuDS systems have been assessed to determine their suitability for the proposed development site.

Table 10 – SuDS Assessment

SuDS Feature	Description	Pros	Cons	Suitable for this
Rainwater harvesting systems	Rainwater collected in an above or below ground tank for reuse on site.	Makes use of surface water run-off as part of the new developments water usage strategy. Provides some detention capacity within the drainage network.	Only provides detention capability within the drainage network until the tank is full. Unless the storage tank can be sized to accommodate all storm events (which is highly unlikely and uneconomical), RWH systems cannot be assumed to contribute to a reduction in peak flow rate on a consistent basis.	U
Green roofs	A planted soil layer is created on the roof to create a living surface. Water is stored in the soil and absorbed by the vegetation.	Mimic predevelopment state of hydraulics and hydrology, good removal capability of atmospherically deposited urban pollutants, ecological, aesthetic and amenity benefits, no additional land take.	Increased Cost (compared to conventional roof), not appropriate for steep roofs, maintenance of roof vegetation, any subsequent damage to waterproof membrane likely to be more critical since water is encouraged to remain on the roof	U
Infiltration systems (soakaways)	Collect and store run-off allowing for infiltration into the existing ground.	Minimal net land take, provides groundwater recharge, good volume reduction and peak flow attenuation, good community acceptability, easy to construct and operate, can be retrofitted.	Not suitable for poor draining soils, field investigations required to confirm infiltration rates, not suitable for locations where infiltration water may put structural foundations at risk, or where infiltrating water may adversely affect existing drainage patterns, not appropriate for draining polluted runoff, increased risk of groundwater pollution, some uncertainty over long-term performance and possible reduced performance during long wet periods, where the property owner is responsible for operation and maintenance, performance difficult to guarantee.	U

SWM Feature	Description	Pros	Cons	Suitable for the
Proprietary treatment systems	Provide treatment of the surface water run-off through the removal of contaminants.			U
Filter Strips	Run-off is allowed to flow over a grassed or otherwise densely vegetated area to promote sedimentation and filtration.	Well suited to implementation adjacent to large impervious areas, encourages evaporation and can promote infiltration, easy to construct and low construction cost, effective pre-treatment option, easily integrated into landscaping and can be designed to provide aesthetic benefits	Not suitable for steep sites, not suitable for draining hotspot runoff or for locations where risk of groundwater contamination, unless infiltration is prevented, no significant attenuation or reduction of extreme event flows	U
Filter Drains	Run-off is temporarily stored below the surface in a gravel filled trench which provides attenuation, conveyance and treatment.	Important hydraulic benefits are achieved, can be incorporated easily into site landscaping and fits well beside roads.	High clogging potential without effective pre-treatment, not for sites with fine particled soils (clay/silts) in upstream catchment, build-up of pollution/ blockages difficult to see, high historic failure rate due to poor maintenance, wrong siting or high debris input, limited to relatively small catchments, high cost of replacing filter material should blockage occur.	V
Swales	A vegetated channel that conveys surface water run-off. Can be 'wet' or 'dry', lined or unlined to allow infiltration.	Easy to incorporate into landscaping, good removal of urban pollutants, reduces runoff rates and volumes, low capital cost, maintenance can be incorporated into general landscape management, pollution and blockages are visible and easily dealt with.	Not suitable for steep areas or areas with roadside parking, limits opportunities to use trees for landscaping, risks of blockages in connecting pipe work	V
Bioretention Systems	Shallow land depression used to allow surface water run-off to pond temporarily, before filtering through vegetation and underlying soils prior to being collected or infiltrated into the existing ground.	Can be planned as landscaping features, very effective in removing urban pollutants, can reduce volume and rate of runoff, flexible layout to fit into landscape, well-suited for installation in highly impervious areas, provided the system is well-engineered and adequate	Requires landscaping and management, susceptible to clogging if surrounding landscape is not managed, not suitable for areas with steep slope	U

SuDS Feature	Description	Pros	Cons	Suitable for the
		space is made available.		
Trees	Tree can be used to improve the performance of a number of SuDS features as root growth and decomposition increase infiltration capacity. They can also be used as standalone features within tree pits, collecting and storing run-off and providing treatment.			U
Pervious Pavements	Surface Water run-off is allowed to flow through the structural paving (block paving, block work or porous asphalt paving). Water can be stored in the sub-base of the construction make-up and often permitted to infiltrate into the underlying ground.	Reduced peak flows to watercourses reducing the risk of flooding downstream, reduced effects of pollution in runoff on the environment, can be used in high density developments with a range of surface finishes that accept surface waters over their area of use, reduced need for deep excavations for drainage, which can have significant cost benefits.	Cannot be used where large sediment loads may be washed/carried onto the surface, in the UK, current practice is to use on highways with low traffic volumes, low axle loads and speeds of less than 30 mph, risk of long-term clogging and weed growth if poorly maintained.	V
Attenuation Storage (geocellular storage systems)	Storage is typically provided in large underground storage features that are used to temporarily store the surface water run-off before being infiltrated, discharged under controlled conditions or re-used on site. Typically constructed from geo-cellular storage systems, concrete tanks or oversized pipes. They can be lined to make them impermeable or enclosed in a geotextile which allows for infiltration into the surround soil.	Modular and flexible, dual usage (i.e. infiltration and/or storage), high void ratios, lightweight and easy to install and robust, capable of managing high flow events, can be installed beneath trafficked or non-trafficked areas, long-term physical and chemical stability, can be installed beneath public open spaces, e.g. play areas.	No water quality treatment or amenity provision, performance can be difficult to monitor, can be difficult to maintain.	V
Detention Basins	During a rainfall event, run-off accumulates in a landscape depression with a restricted outlet. This allows the run-off to fill the detention basin and provides attenuation. Basins are generally dry, except during and immediately after the storm event. Vegetated detention basins allow for treatment of the conveyed run-off across the length of the basin.	Can cater for a wide range of rainfall events, can be used where groundwater is vulnerable, if lined, simple to design and construct, potential for dual land use, easy to maintain, safe and visible capture of accidental spillages.	Little reduction in runoff volume, detention depths may be constrained by system inlet and outlet levels.	U

SuDS Feature	Description	Pros	Cons	Suitable for this
Ponds and Wetlands	Ponds and wetlands typically have a 'wet' bottom which means the bottom of the feature holds water during the year. These features have a restricted outlet which allows water levels to rise within the pond or wetland during the storm event, before being discharged. They can support both emergent and submerged vegetation which enhance the treatment process and biodiversity.	Good removal capability of urban pollutants, if lined, can be used where groundwater is vulnerable, good community acceptability, high potential ecological, aesthetic and amenity benefits, may add value to local property.	Land take is high, requires baseflow, limited depth range for flow attenuation, may release nutrients during non-growing season, little reduction in run volume, not suitable for steep sites, colonisation by invasive species would increase maintenance, performance vulnerable to high sediment inflows.	U

7.3.9 Based on the above assessment, the outline drainage strategy for the development could include some of the following SuDS features into the design (subject to detail design and agreement with the local authority, LLFA and the EA):

- £ Filter Drains
- £ Swales
- £ Pervious Pavements
- £ Attenuation Storage (geocellular storage systems)

7.3.10 Other SuDS features detailed above in Table 10 were not suitable for inclusion into the drainage strategy due to site constraints, land limitations and the general size of the development.

7.4 Surface Water Discharge Quality

7.4.1 The quality of surface water collected and discharged to the surrounding environment, by direct discharge to watercourses or by infiltration into the ground water, should be managed such that the receiving bodies are protected from pollution. The implementation and installation of suitable SuDS features within the overall surface water drainage network can improve water quality through the removal of pollutants.

7.4.2 Where roof and road drainage cannot be discharged via the landscaped gardens surrounding the building and car parks, it is proposed to discharge via proposed surface water connections into the watercourse fronting Hoe Lane to the north.

7.4.3 The proposed surface water drainage system is considered suitable and sufficient to allow for the discharge to the environment.

7.5 Proposed Foul Drainage Strategy

7.5.1 There is an existing ϕ 600mm foul water pumped rising main crossing the centre of the development site, running from west to east. There is also an existing ϕ 525mm foul water main within Hoe Lane to the north of the development site, running from east to west. Please refer to the Southern Water Asset Maps in Appendix 3.

7.5.2 It is proposed to utilize existing manhole (MH2101) within Hoe Lane directly north of the existing site access to discharge all proposed foul water. A CCTV drainage survey will be required to determine the condition of all existing pipes, their locations and their connection points prior to any construction works starting. The proposed development will be subject to a Section 106 Direct Connection agreement with Southern Water due to the increase in flows.

- (i) The existing ϕ 525mm foul water main within Hoe Lane is made of Bonded Asbestos Cement. Consultation with Southern Water during the detailed design stage will be required to determine how a connection will be undertaken, including specialist construction crews trained in handling and working around asbestos materials.

7.5.3 The proposed development will include 4 new residential homes.

- (i) The proposed new foul drainage requirements for the residential development have been assessed and calculated using the Design and Construction Guidelines: (the DGC). The peak design flow rate for dwellings has been designed based on 4000 l/dwelling/day.

- (ii) The proposed new foul discharge has been calculated as 0.19 l/s.

7.5.4 A Section 106 application to Southern Water for the new direct foul sewer connection to the existing public sewer network would be submitted at the detail design stage in order to accommodate the proposed new residential development. This application would be progressed once planning consent had been granted and the detail design of the foul water drainage system to the development has been completed.

7.6 Maintenance and Management of the Drainage Systems and SuDS Features

7.6.1 All drainage, site accesses (pervious pavements) on site will remain private, under the management of a management company.

7.6.2 A Surface Water Management and Maintenance Strategy is included with this report in APPENDIX 5, which details the requirements for maintenance and also the responsibility for the management and maintenance for the drainage system.

8 SAFE ACCESS

- 8.1.1 The development site is not at risk of flooding from rivers, seas, surface water, groundwater or reservoirs. As such, the need to assess safe access and egress has not been undertaken.
- 8.1.2 This FRA demonstrates that the risk to human life associated with access and egress at the development site is very low.

9 CONCLUSION

- 9.1.1 This FRA has been undertaken in accordance with the requirements of the NPPF and Arun District Council Strategic Flood Risk Assessment. The FRA has considered the potential risk of flooding from all sources, including the specific requirements to review the risk from ground water flooding and fluvial flooding associated with the existing watercourse.
- 9.1.2 The development site is located within Flood Zones 1.
- 9.1.3 The site is currently occupied by greenfield spaces, with a tarmac access road running to Flints.
- 9.1.4 The proposed foul discharge will connect into the Southern Water foul network utilizing proposed connections (4 dwellings at 0.19 l/s).
- 9.1.5 Based on the information collated as part of this FRA, the proposed development flood risk from all sources has been assessed as low. The area of the site being developed upon is located within Flood Zone 1 and the assessment of the potential future flooding of the site illustrates that this will be maintained in the future.
- 9.1.6 The development proposed for this site should not be precluded based on flood risk grounds.