

Flood Risk Assessment Roseland

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PROJECT:

Roseland
Station Approach,
The Causeway, Arundel
BN18 9JL

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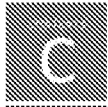
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Executive Summary

Birchside Management Ltd has commissioned Hilson Moran Partnership Ltd (Hilson Moran) to prepare a National Planning Policy Framework (NPPF) compliant Flood Risk Assessment (FRA) for its residential development located on land at Roseland, Station Approach, The Causeway, Arundel, BN18 9JL, National Grid Reference TQ 02402 06417.

This document constitutes a formal FRA to NPPF guidelines, appropriate to the scale and nature of the development and risks involved.

The proposed development site comprises a total area of 0.03 ha, occupied by a one storey building and garages, currently used as a commercial workshop and living accommodation. The Planning Application for the site seeks to construct 4 dwellings (flats) in approximately the same location as the pre-existing building. According to NPPF Technical Guidance, such residential use is considered **“More Vulnerable”** to flood risk.

The Arun District Council (ADC) Strategic Flood Risk Assessment (SFRA) provides a detailed account of the risk of flooding across the borough and, as such, supplements the Environment Agency (EA) Flood Mapping. These indicate that the proposed development is located in the EA's Flood Zone 3. Referring to NPPF Technical Guidance, the location of the proposed development would be categorised as “High Flood Probability” - *i.e.* the annual exceedance probability (AEP) of flooding from riverine sources is greater than 1 % or from tidal sources is greater than 0.5%. However, the site benefits from flood defences, which when modelled remove the site from the current flood zone. Consequently, there is no requirement to provide compensatory fluvial flood storage and the residual risk of fluvial/coastal flooding is deemed to be of **minor/adverse significance**.

The site does lie within the 0.5% AEP for tidal sources when climate change (CC) is taken into account for the year 2110. However, within their Lower Tidal River Arun Strategy Environmental Report, the EA has stated their commitment to sustain a 1 in 75 year Standard of Protection (SoP) for the local flood defences for at least the next 100 years. Consequently, if this commitment is upheld then it is unlikely that overtopping of the local defences would ever occur within the lifetime of the development for the 1 in 100-year+CC event. Nevertheless, it is proposed that the ground floor level of the dwellings is raised to above the current undefended 1 in 100 year flood levels and a demountable flood barrier provided for the shared front door along with flood resilient design of the building to confer protection against future residual risk.

A review of EA, ADC and British Geological Society (BGS) information demonstrates that the site is unlikely to be at risk of groundwater flooding due to the impermeable surface geology. The risk of groundwater flooding to the proposed development is therefore considered of **low significance**.

EA and LDC resources demonstrate that the site has low susceptibility to surface water flooding. The risk of flooding of the proposed development from surface water flooding is therefore considered **negligible/neutral significance**.



There are no records of surface water sewer problems or flooding incidents from highway drainage within the vicinity of the site. Consequently, the risk of flooding of the site from sewers is therefore considered **negligible/neutral significance**.

Neither the LDC SFRA nor the EA identify any potential flooding from reservoirs, canals and/or other artificial sources specifically within the application site. The risk of flooding of the site from artificial drainage bodies is therefore considered **negligible/neutral significance**.

It is anticipated that the proposed redevelopment will lead to an increase in foul water discharges from the site. The developer will augment the existing sewer infrastructure accordingly. In accordance with Building Regulations Part G, it is also anticipated that low water consumption appliances (low-flow taps and white goods) will be introduced throughout the proposed redevelopment, which will minimise foul water discharges. Following the introduction of these measures, the residual impact of the proposed redevelopment on the local sewerage infrastructure is deemed to be of **neutral/negligible significance**.

In light of the above, the principle of the proposed redevelopment is deemed acceptable on flood risk grounds.

A summary of the flood risks associated with the redevelopment is presented as Table 1.1.

Table 1.1: Summary of Flood Risks associated with the Proposed Development

Effect	Impact	Mitigation	Residual Impact
Displacement of floodwater	Negligible/neutral (Flood Zone 3 with defences and also the footprint of the buildings is not expected to increase substantially)	None required.	Negligible/neutral
Flooding from tidal sources	Minor adverse (protected by defences, however at risk by 2110)	Raised ground floor levels Demountable Flood Barriers Raised electrical sockets and window levels. No air bricks below flood level	Minor adverse
Groundwater emergence	Low	None required.	Negligible/neutral
Flooding from artificial drainage bodies	Negligible/neutral	None required.	Negligible/neutral
Surface water flooding	Negligible/neutral	None required.	Negligible/neutral
Increased surface runoff generation	Negligible/neutral	None required.	Negligible/neutral



Effect	Impact	Mitigation	Residual Impact
Performance of existing surface water sewage system	Negligible/neutral	None required.	Negligible/neutral
Performance of existing foul water sewage systems	Minor adverse	Augment sewer infrastructure & introduce low flow appliances.	Negligible/neutral



1. Introduction

1.1. Background

Hilson Moran Partnership Ltd (Hilson Moran) was appointed by Birchside Management Ltd to undertake a FRA and prepare recommendations for the proposed residential development on the 0.03 ha plot of land at Roseland, Station Approach, The Causeway, Arundel, BN18 9JL.

1.2. Purpose

This FRA accords with the NPPF, the Flood and Water Management Act (2010) and Building Regulations, Part H (Drainage and Waste Disposal). This report will accompany the planning application and is produced in accordance with guidance contained within the NPPF relating to the necessary requirements of FRAs for the evaluation of risks associated with development.

1.3. Structure

The following sections of the report appraise the pre-existing baseline conditions on the application site, describe the proposed development, flood issues relating to the development, flood risk posed by the development on the surrounding area, scope for mitigation and conclusions of the assessment.

Relevant appendices are included at the end of the report with document control information included at the front.

1.4. Scope of the Assessment

This document comprises a FRA with respect to the proposed redevelopment of the 0.03 ha site for the replacement of the existing single storey building with a new residential building comprising of 4 flats over 2 storeys. The site is centred approximately on National Grid Reference TQ 02402 06417.

1.5. Limitation and Copyright

This report has been prepared on behalf of and for the exclusive use of Birchside Management Ltd, and is subject to and issued in connection with the provisions of the agreement set out by Hilson Moran. Hilson Moran accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this report by any third party.

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2. Policy Framework and Legislative Regulation

2.1. Planning Policy

2.1.1. National

The NPPF¹ sets out policies which apply to the preparation of local plans, and to development management decisions. This framework sets out the Government's economic, environmental and social planning policies for England. Taken together, these policies articulate the Government's vision of sustainable development, which should be interpreted and applied locally to meet local aspirations. The NPPF states that flood risk and surface water disposal are material considerations for Local Planning Authorities (LPAs) when determining individual land-use planning proposals. The NPPF supersedes the previous Planning Policy Statement 25 on the consideration of flood risk in the planning process.

The NPPF reinforces the importance that the Government attaches to the management and reduction of flood risk in the land-use planning process, whilst also adopting a precautionary approach and fully accounting for the effects of climate change. The NPPF states how flood risk should be considered at all stages of planning and development, in an attempt to reduce future loss of life and damage to property.

The NPPF also states that surface water disposal is a material consideration for LPAs when determining individual land-use planning proposals and that SuDS should be incorporated into a development wherever practical.

In particular, Paragraph 103 of the NPPF states that:

'When determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific flood risk assessment following the Sequential Test, and if required the Exception Test, it can be demonstrated that:

- *within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location; and,*
- *development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning, and it gives priority to the use of sustainable drainage systems'.*

The NPPF is supported by Planning Practice Guidance², which provides further information on key issues in the implementation of policies identified in the NPPF. The overall aim of the NPPF guidance is to steer development into areas of low flood risk (Flood Zone 1). The NPPF requires LPAs to demonstrate application of the Sequential Test, which aims to steer development into areas of low flood risk where all development types are considered to be appropriate. Sites in Flood Zone 3 should only be considered where opportunities in Flood Zones 1 or 2 are not reasonably available with the flood risk vulnerability of land uses taken into account and the application of the Exception Test if required.

It should be noted that From 6th April 2015, new national planning guidance came into force for the implementation of sustainable drainage systems within all "major" new housing developments (*i.e.* developments of 10 dwellings or more) in the form of a House of Commons: Written Statement.³ The guidance states that "*we expect local planning policies and decisions on planning*



applications relating to major development - developments of 10 dwellings or more; or equivalent non-residential or mixed development (as set out in Article 2(1) of the Town and Country Planning (Development Management Procedure) (England) Order 2010) - to ensure that sustainable drainage systems for the management of run-off are put in place, unless demonstrated to be inappropriate."

In consultation with Karen Garner, Technical Support Unit Assistant within the Planning Department at Arun District Council (ADC) it was agreed by email on the 14th October 2016 that as the proposed development comprises only four residential dwellings on previously developed land there is no requirement for a SuDS Strategy for the scheme and that the application can be made valid without a Drainage Statement in this case. ADC will add a drainage condition to any approval made, to be discharged at a later date (refer to Appendix A).

2.1.2. Local

Local planning policy is provided through the ADC Local Plan⁴, which sets out the strategic vision for the Arun Local Planning Authority Area (LPA) up to 2029 and beyond. Finer scale details for the issues identified in the Local Plan are also taken forward in the Neighbourhood Development Plans. The Local Plan and Neighbourhood Development Plans⁵ together form the statutory development plan for the district.

Policy ECC SP1 - Adapting to climate change states that:

"The Council will support development which is located and appropriately designed to adapt to impacts arising from climate change such as the increased probability of tidal and fluvial flooding; water stress; health impacts as a result of extreme temperatures and a decline in the quality of habitats and richness of biodiversity.

In order to achieve this, development must be designed to take account of the following issues:

- a. Location (in relation to flood risk and vulnerability to coastal erosion);*
- b. Water efficiency;*
- c. Shade, cooling, ventilation, solar gain;*
- d. Connectivity to the green infrastructure network;*
- e. Layout and massing;*
- f. Resilience of buildings and building materials to extreme weather events; and*
- g. Capacity of drainage systems and incorporation of Sustainable urban Drainage Systems (SuDS)"*

Policy W DM2 – Flood Risk states that:

"Development in areas at risk from flooding, identified on the latest Environment Agency flood risk maps and the Council's Strategic Flood Risk Assessment (SFRA), will only be permitted where all of the following criteria have been satisfied:

- a. The sequential test in accordance with the National Planning Policy Framework Technical Guidance has been met.*
- b. A site specific Flood Risk Assessment demonstrates that the development will be safe, including access and egress, without increasing flood risk elsewhere and reduce flood risk overall.*



- c. *The scheme identifies adaptation and mitigation measures.*
- d. *Appropriate flood warning and evacuation plans are in place; and*
- e. *New site drainage systems are designed to take account of events which exceed the normal design standard i.e. consideration of flood flow routing and utilising temporary storage areas.*

The reports prepared as part of the criteria above must take into account contingency allowances, taking climate change into account as set out in the NPPF Technical Guidance.

In locations where strategic flood defence or resilient and resistant construction measures are necessary within the site itself, proposals will be required to demonstrate how measures have been incorporated as an intrinsic part of the scheme in a manner which is compatible with the Strategic Flood Risk Assessment.

All development proposals must take account of relevant Surface Water Management Plans, Catchment Flood Management Plans and related Flood Defence Plans and strategies such as the Lower Tidal River Arun Strategy. The council may require financial contributions from development on sites where measures to address flood risk or to improve the environmental quality of watercourses have been identified by these Plans and Strategies.

Developments shall also be consistent with all other Local Plan policies.”

2.2. Legislative Regulation

2.2.1. Building Regulations Part H: Drainage and Disposal (2010)

Building Regulations Approved Document Part H⁶ states that, where feasible, the first choice for surface water removal should be to discharge such waters to an adequate soakaway or infiltration system. If this is not reasonably practicable then discharge should be to a watercourse, the least favoured option being to an existing sewer.

2.2.2. Environmental Protection Act (1990)

The Environmental Protection Act (1990)⁷ states that ‘Contaminated land is any land which appears to be in such a condition, by reason of substances in, on or under the land, that:

- *Significant harm is being caused or there is a significant possibility of such harm being caused, or*
- *Pollution of controlled waters is being or is likely to be caused’.*

2.2.3. Flood and Water Management Act (2010)

The Flood and Water Management Act (FWMA 2010)⁸ makes specific provision for the management of risks associated with flooding and coastal erosion.

The Act states that construction work which has drainage implications may not be commenced unless a drainage system for the work has been approved by an approving body (unitary authority/county council).

In determining an application for approval the approving body must:

- *‘grant it, if satisfied that the drainage system, if constructed as proposed, will comply with national standards for sustainable drainage’; or,*



- *'refuse it, if not satisfied'*.

The Act therefore removes the automatic right to connect to the public sewer if the proposed drainage strategy does not fully consider the feasibility of sustainable drainage techniques.

2.3. Designation of the Development for Flood Risk Assessment Purposes

With regards to the proposed development, the application site has a footprint of approximately 0.03 ha and according to the ADC SFRA and EA Flood Maps the entire application site is located within Flood Zone 3. With reference to the EA and Department for Environment, Food & Rural Affairs (DEFRA)'s guidance for flood risk assessment for planning applications, the developer is therefore required to consult with the EA and provide a FRA for the proposed development.

3. Proposed Development

3.1. Location

The application site is located to the south east of the town of Arundel, adjacent to the town's railway station, just off of the 'The Causeway'. The site lies near the entrance to the station's car park, with the Back Arun Fishery car park to the immediate north of the site. The site is located close to the River Arun and the South Downs National Park.

The site is centred approximately on National Grid Reference TQ 02402 06417 (refer to Figure 3-1) and occupies an area of approximately 277 m² (0.03 ha).

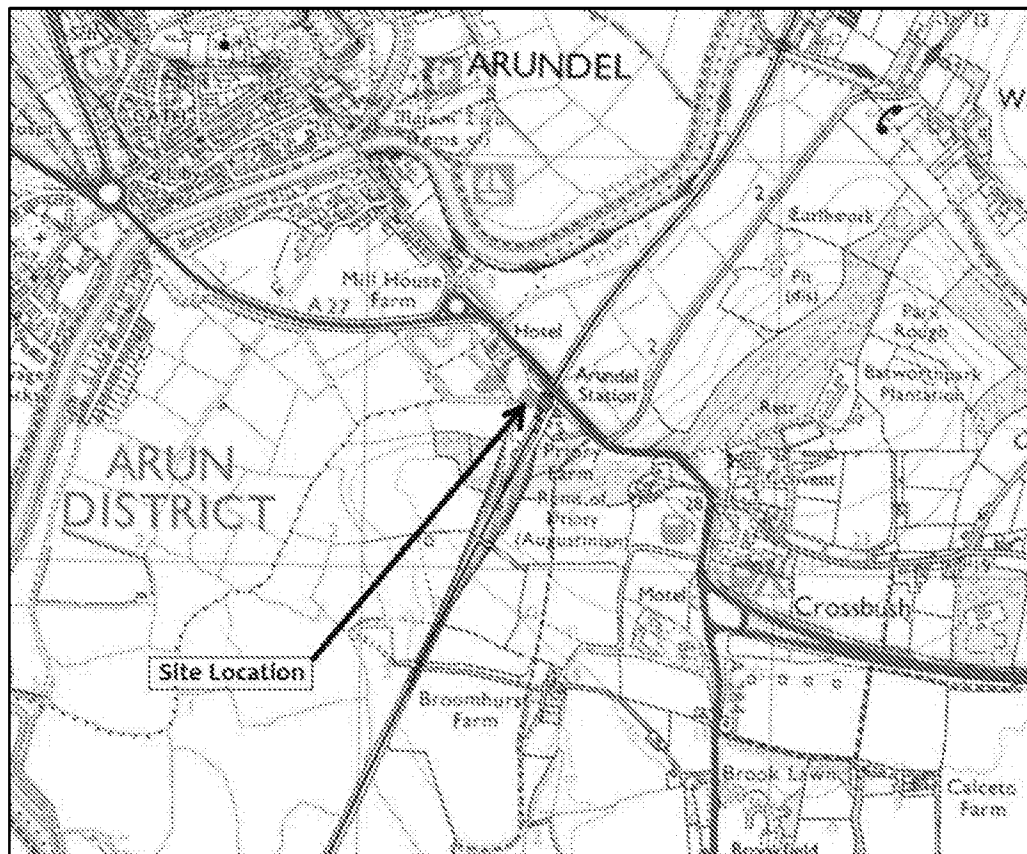


Figure 3-1 - Approximate Location of the Proposed Development

3.2. Proposal

The proposed development comprises the demolition of the current buildings and the construction of a new residential building comprising 4 flats over 2 storeys in approximately the same location as the pre-existing building. The proposed layout of the site is provided in Figure 3-2.

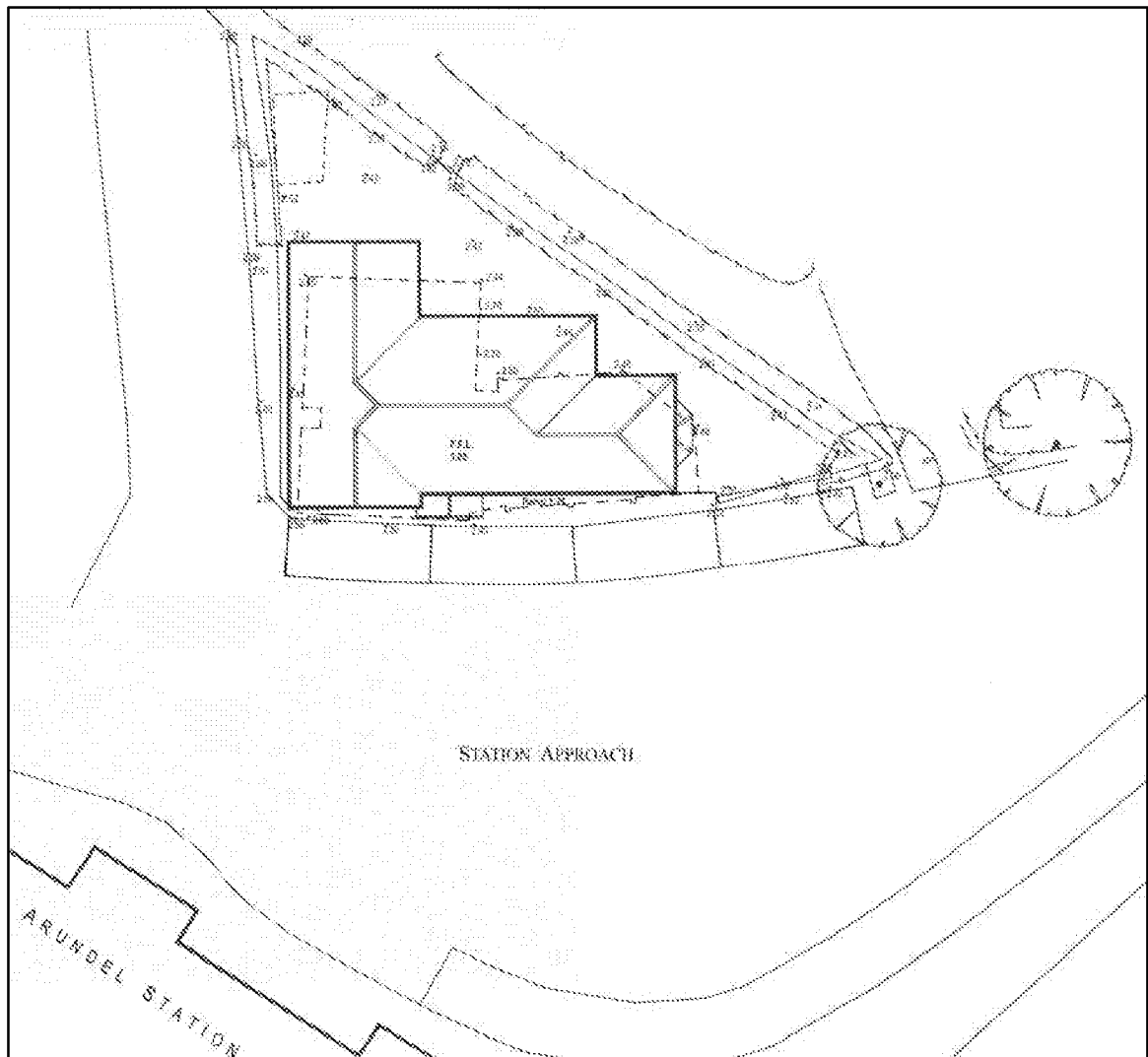


Figure 3-2 - Proposed Development Layout

4. Baseline Conditions

4.1. Existing Site

The application site is occupied by a one storey building and garages, currently used as a commercial workshop and living accommodation with a low hedge bounding the site on the north western and southern sides and the access road to the station car park bounding the eastern side of the site.

The existing site can be seen in Figure 4-1.



Figure 4-1 - Existing site aerial photo

4.2. Topography

The site is generally flat, although with a slight slope towards the north west, with a gradient of about 2 %. The highest point on site is in the centre of the site at 2.70 mAOD, whilst the lowest point is located at the north western edge of the site, adjacent to Back Arun Fishery land, at an elevation of 2.29 mAOD as shown in Figure 4-2, however the majority of the site is between 2.42 and 2.50 mAOD.

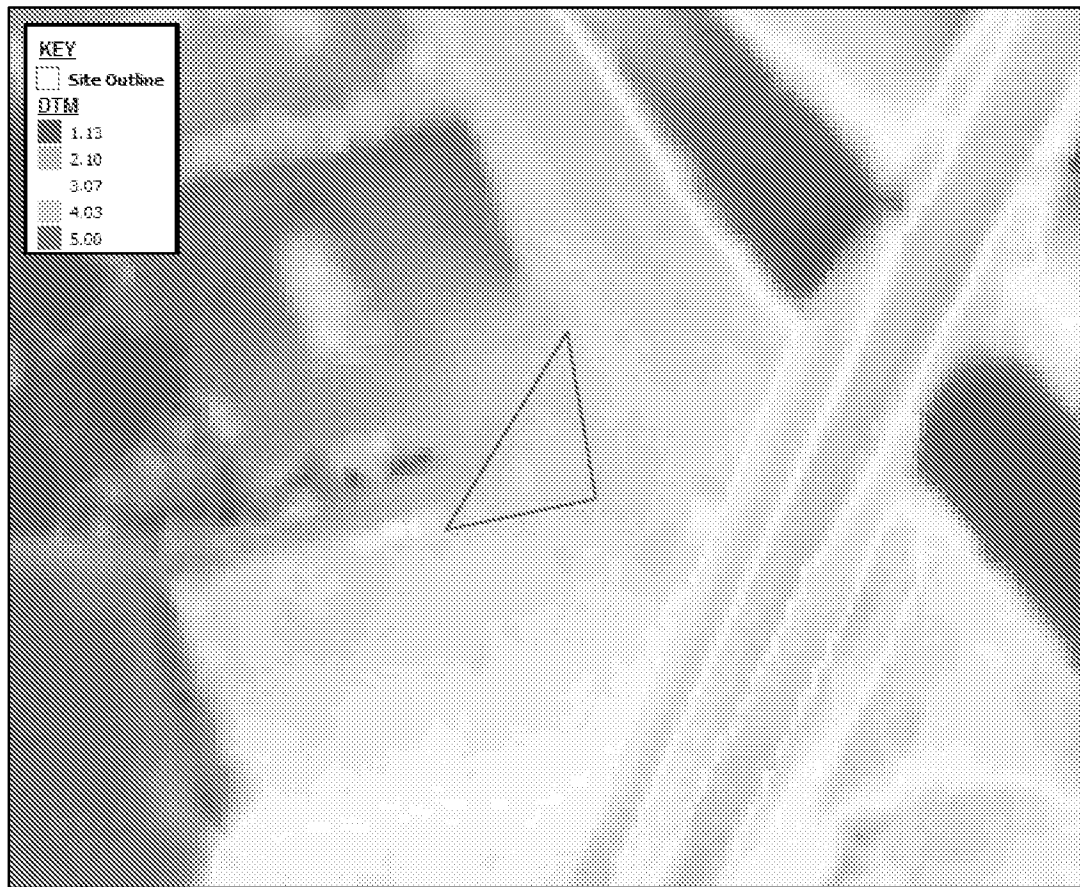


Figure 4-2 - Topographic Plan of the Site

4.3. Geology and Soils

The British Geological Survey's (BGS) Geology of Britain viewer⁹ provides an understanding of the geological formations throughout Great Britain. Review of the information at the 1:50,000 scale mapping identifies that the site is underlain by Lambeth Group (clay, silt and sand), with Raised Marine Deposits (clay, silt, sand and gravel) superficial deposits.

There are no known boreholes on site, however there are number of boreholes in the vicinity of the site (BGS reference TQ00NW33, TQ00NW32, TQ00NW35, TQ00NW41 and TQ00NW42), along The Causeway and Station Road approximately 50-100 m to the east of the site, which was characterised by soft clay with varying amounts of sand, silt and gravel (Marine Deposits overlaying Lambeth Group) down to approximately 31.75 m and Chalk below this.

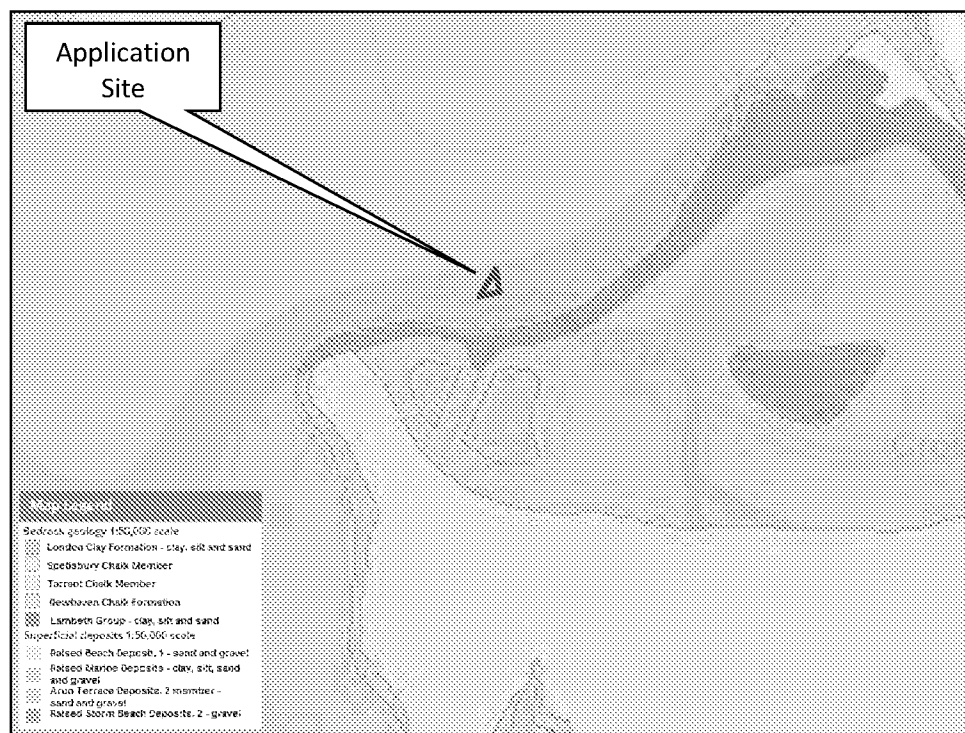


Figure 4-3 - Bedrock Geology in and around the Site (BGS, 2017)

The National Soil Resources Institute (NSRI) Soilscape¹⁰ database identifies the soil types across England and Wales. The database identifies that the land on which the development site stands are “*slightly acid loamy soils*”. The drainage aspect of the soils is identified as “*freely draining*”. However, the site is close to an area identified as having naturally high groundwater to the north of the site, associated with the floodplain of the River Arun.

4.4. Hydrology

4.4.1. Information Sources

In determining hydrological conditions across the proposed site, reference has been made to a number of sources. In particular, information has been brought together from:

- The EA’s Flood Mapping resource¹¹ (see appendix A);
- The ADC Strategic Flood Risk Assessment (SFRA), Level 1¹²;
- SFRA Level 2¹³;
- 2008 SFRA Volume II Technical Report¹⁴;
- West Sussex Local Flood Risk Management Strategy (LFRMS)¹⁵
- The Arun and Western Streams Catchment Flood Management Plan (CFMP)¹⁶; and
- The EA’s Lower Tidal River Arun Strategy Environmental Report.¹⁷

4.4.2. Surface Waters

The main catchment in the ADC area is for the River Arun, which flows south through the centre of the district. The development site falls within the lower catchment of the River Arun.

The SFRA Level 1 identifies that the catchment of the River Arun is predominantly rural with the exception of the towns of Arundel and Littlehampton, with much of the flow originating in the South Downs. River levels downstream of Arundel are heavily influenced by tide levels. The River Arun flows from the South Downs National Park to the north of Arundel, passing the site approximately 500 m to the north before flowing westwards through Arundel. The River Arun then continues southwards through Tortington, past Ford and to the west of Littlehampton before flowing into the English Channel. It should also be noted that there are flood defences in place along the River Arun in Arundel and in Littlehampton which act to reduce flooding.

In addition to the waterbodies described above, there are a number of minor drainage routes for surface water near to the site. These generally follow field boundaries, roads and the railway line. There is also the Back Arun Fishery located immediately north west of the site. These drainage paths are indicated on the SFRA “Flood Map for Surface Water (uFMfSW)” (refer to Figure 4-4).

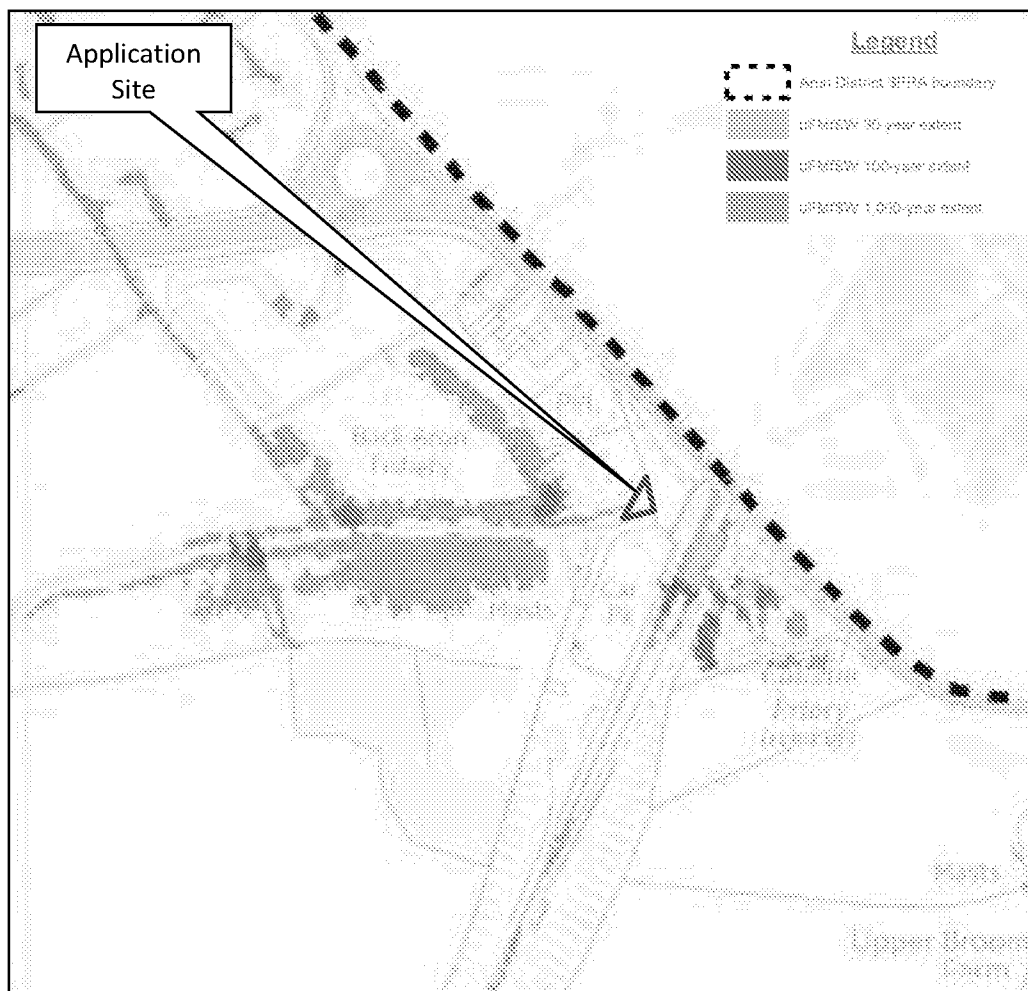


Figure 4-4 – Extract from the SFRA Flood Map for Surface Water (uFMfSW) (not to scale)

4.4.3. Flood Mapping

4.4.3.1. EA Flood Map

The EA Flood Zone Mapping, provided in Figure 4-5, identifies that the application site is located entirely within Flood Zone 3 (High Risk, *i.e.* greater than 1 in 100 annual probability of river or sea flooding, >1%). The closest source of flooding, is the River Arun, approximately 300 m to the north of the site

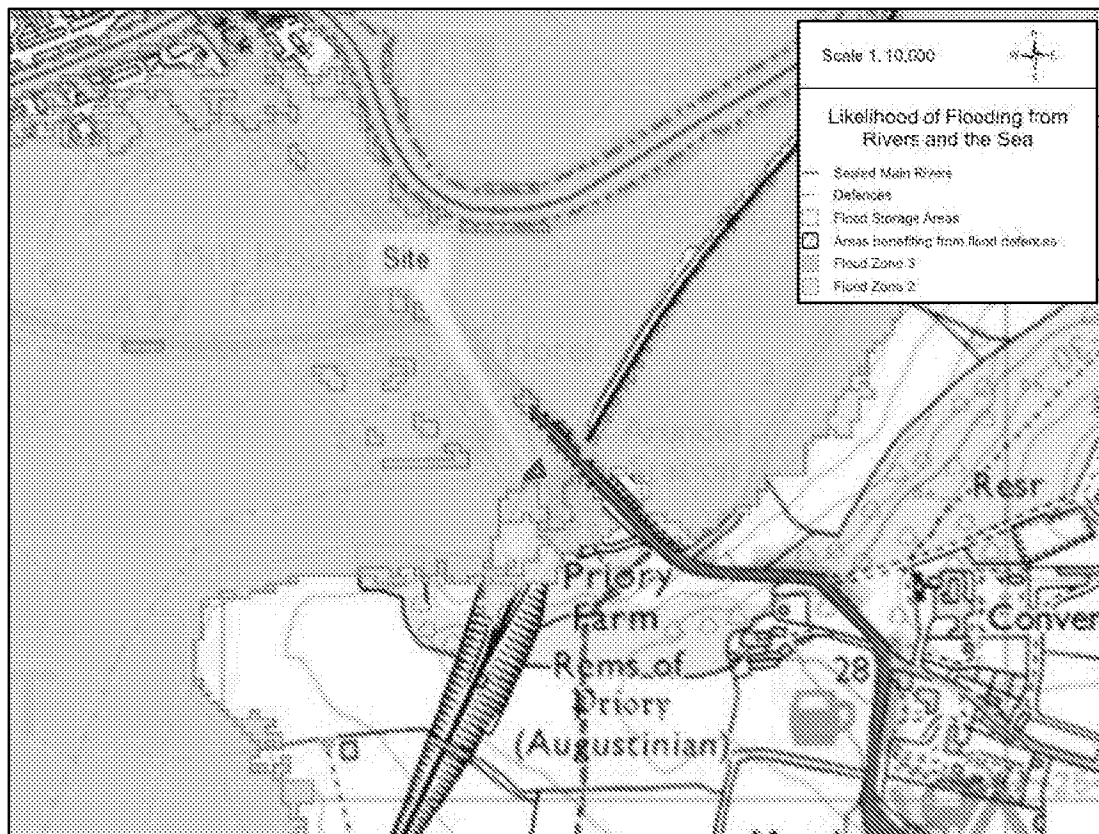


Figure 4-5 - EA Flood Map (not to scale)

To put the flood zone mapping into context, Flood Zone 3 comprises areas categorised as subject to 1% annual probability of flooding from rivers (*i.e.* the 1 in 100-year event) or 0.5% from the sea (*i.e.* the 1 in 200-year event) and Flood Zone 2 comprises areas categorised as subject to 0.1% annual probability of flooding from rivers or sea (*i.e.* the 1 in 1000-year event). Cumulatively, these areas provide the best estimate of the indicative floodplain of the identified watercourses **if there were no flood defences or other man-made structures and channel modifications in place.**

The EA also provided, through Product 4, further maps for flood risk in the area. These give the results from the Lower Tidal River Arun Strategy Study (2010), including the impact of climate change (CC). Node levels were provided for the site, giving the predicted depth of flood water on site during the 5 % Annual Exceedance Probability event (AEP), 0.5 % AEP, 0.1 % AEP and 0.5 % AEP for 2070 and 2115 for the tidal levels (defended and undefended) and also the 5 %, 1 %, 1 % (+CC) and 0.1 % AEP for the fluvial flood risk (defended and undefended). According to this modelling work, the site currently lies within the 5 % AEP flood zone for tidal flood risk (undefended) and the 1 % AEP for fluvial flood risk (undefended), however site survey levels

indicate that the fluvial flood risk would not impact the main part of the site as the majority of the site levels are above the 1 % flood level of 2.41 m AOD. These flood outlines are shown below in Figure 4-6 and the flood levels on site are given in Table 4-1

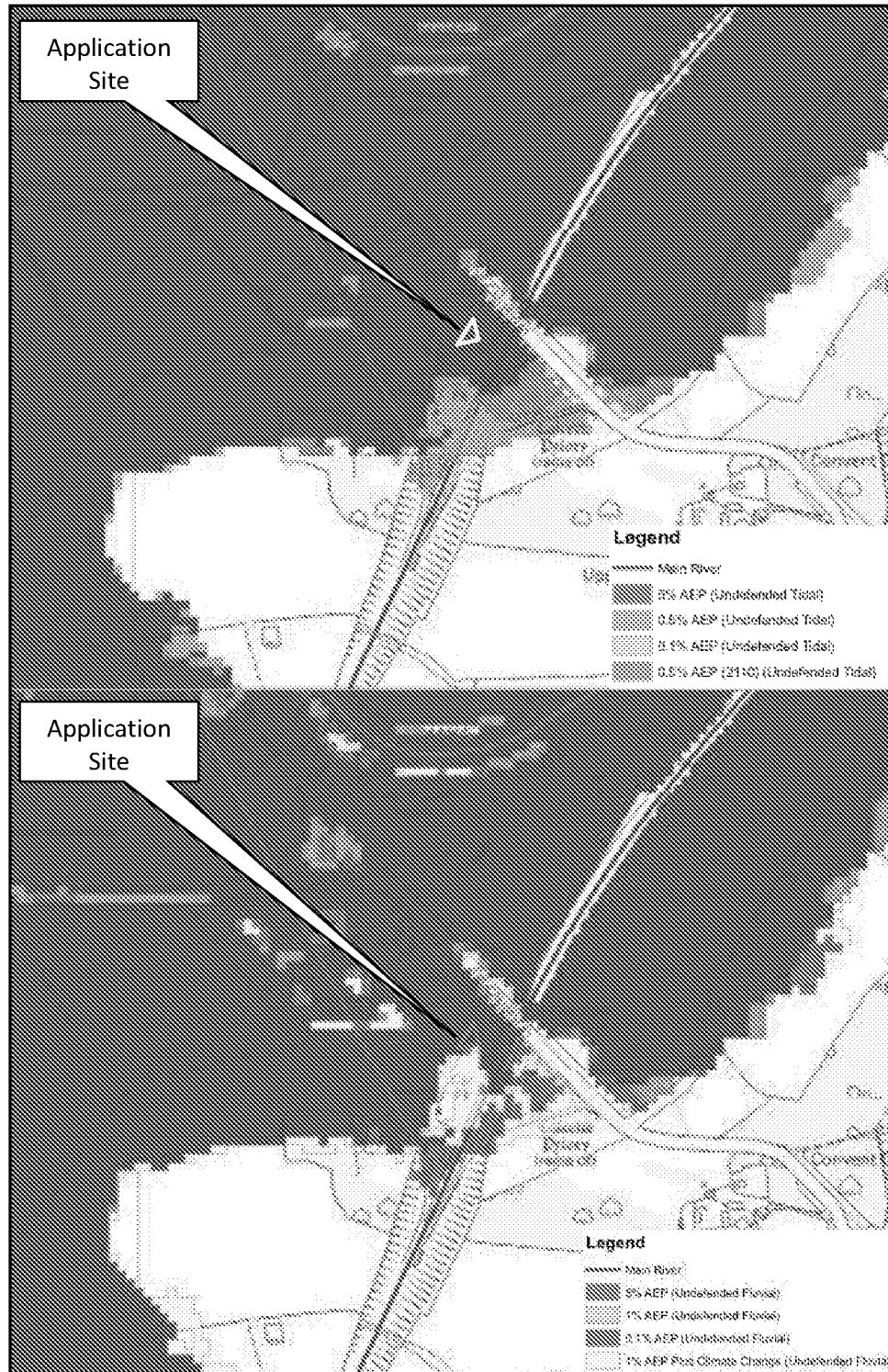


Figure 4-6 - Extract of the outputs from the Lower Tidal River Arun Strategy Study (upper map – Undefended Tidal, lower map - Undefended fluvial)



Table 4-1 - Water Depths (m) for Lower Tidal River Arun Strategy Study (2010)

Scenario	Node Reference	Tidal Modelled Flood Levels (mAOD)				Fluvial Modelled Flood Levels (mAOD)			
		5%	0.5%	0.5% (2070)	0.5% (2110)	5%	1%	1% + CC	0.1%
Undefended AEP	1	2.76	2.99	3.59	3.05		2.41	3.33	2.72
	2	2.76	2.99	3.59	3.05		-	3.33	2.72
	3	2.76	2.99	3.59	3.05	2.32	2.41	3.33	2.72
Defended AEP	1	-	-	3.50	-	-	-	-	-
	2	-	-	3.50	-	-	-	-	-
	3	-	-	3.50	-	-	-	-	-

The Product 4 data includes the outputs of the same model with Defended scenarios, including the impact of the currently maintained flood defences for the River Arun on the flood extents. The impact of flood defences removes the site entirely from the predicted flood extent for fluvial flooding, however the site remains in the flood zone for tidal flooding in the 2110 scenario (*i.e.* including climate change), as shown in Figure 4-7 (please note that these figures are reproduced at a greater scale in Appendix C).

However, within their Lower Tidal River Arun Strategy Environmental Report, the EA has stated their commitment to sustain a 1 in 75 year Standard of Protection (SoP) for the local flood defences (*i.e.* Strategy Unit 5: Arundel) for at least the next 100 years. Consequently, if this commitment is upheld then it is unlikely that overtopping of the local defences would ever occur within the lifetime of the development for the 1 in 100-year+CC event.

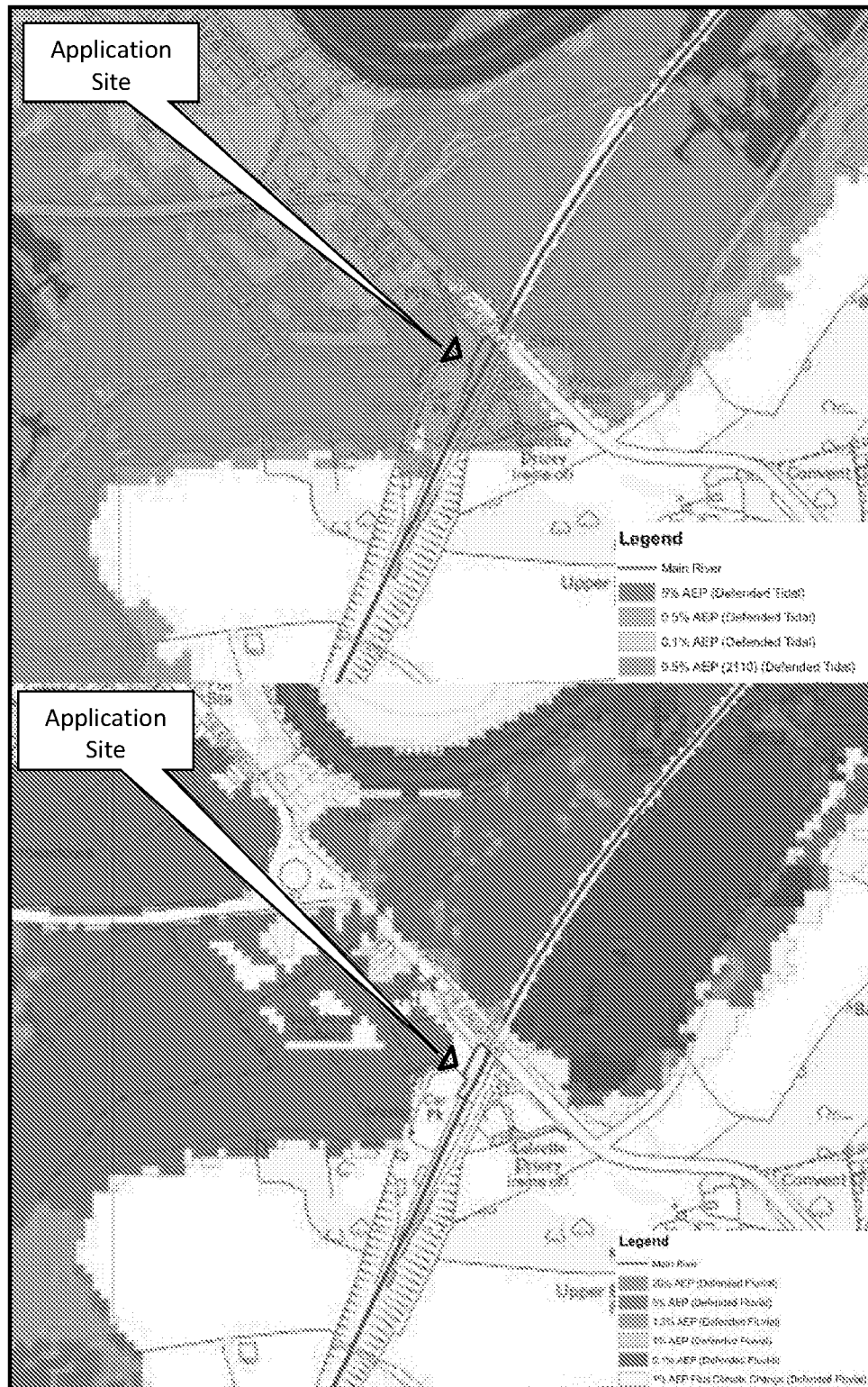


Figure 4-7 - Extract of the outputs from the Lower Tidal River Arun Strategy Study (upper map – Defended Tidal, lower map - Defended fluvial)



4.4.3.1. LDC SFRA Flood Map – Rivers and Sea Flooding

The extent of the flood zones depicted in the ADC SFRA are based on the EA's Flood Mapping. Within the SFRA, the Flood Zone outlines were estimated without consideration to the presence of flood defences. This puts the site within flood Zone 3a, the area assessed as having a greater than 1 % AEP of flooding from rivers or greater than 0.5 % AEP of flooding from the sea. The Level 1 SFRA also includes the potential impacts of climate change upon flood risk for 2031, 2061 and 2110 within vicinity of the site, not including the impact of flood defences. The future flood outlines indicate little impact in the vicinity of the site in terms of extent of the flood.

4.4.4. Groundwater

There are very few records of flooding events recorded as attributable to groundwater flooding, with most records not providing detailed information on groundwater flooding events. The SFRA provides a map of areas susceptible to groundwater flooding on a 1 km grid square scale. This data shows the proportion of each 1km grid square, where geological and hydrogeological conditions indicate that groundwater might emerge. It does not show the likelihood of groundwater flooding occurring, nor does it take account of the chance of flooding from groundwater rebound (rising groundwater levels resulting from a reduction in abstraction rates from groundwater). This dataset covers a large area of land, and only isolated locations within the overall susceptible area are actually likely to suffer the consequences of groundwater flooding. This mapping technique puts the site within an area with between 50-75 % susceptibility to groundwater flooding.

The 2008 SFRA states that the most extensive areas of groundwater flooding across Sussex in the historical records have occurred in the upper reaches of Chalk catchments. The 2008 SFRA attributes a medium risk of groundwater flooding across the Arundel area, with areas close to the River Arun locations where groundwater emergence has been identified. The geology around the area is predominantly clay, silt and sand layers, with the boreholes as described in section 4.3 indicating that the surface layers are composed mostly of clays with varying proportions of silt and sand. Only two of the boreholes encountered groundwater, at a level 3m below the ground level. It is therefore considered that the site is relatively low risk of flooding from groundwater sources.

The EA's groundwater protection map identifies that the entire application site falls outside of any Groundwater Source Protection Zones (SPZ) (refer to Appendix E for definitions of SPZs), the closest SPZ is Zone 1 (inner zone), approximately 1.3 km to the north of the site.

The BGS Aquifer maps indicate that the bedrock and superficial deposits underlying the site are classified as Secondary A aquifers.

Given that the site is not located within a SPZ/potable water abstraction points, the potential risk of contaminant mobilisation and migration to groundwater resources is considered to be of low significance and therefore special measures or restrictions are not anticipated to be required when designing the drainage systems for the scheme.

4.4.5. Surface Water Flooding

Surface water flooding occurs when intense, often short duration, precipitation events are unable to enter a drainage system due to blockages, breakages in water pipes or where the drainage capacity has been exceeded. This type of flooding is usually short-lived, associated with heavy precipitation events and highly localised. Surface run-off will tend to flow towards low spots where



it collects. Flooding can occur both to land or property which lies in the flow path of the water or to property situated in the low spot where the water finally collects. The effects of climate change are predicted to increase the frequency of heavy downpours, therefore increasing the number of events that exceed the capacity of the sewer system.

The combination of surface water flooding and urban drainage issues can cause some localised areas of combined fluvial and urban flooding. The risk of surface water flooding associated with the application site is identified in the SFRA uFMfSW (see Figure 4-4). However, according to the SFRA there have been no flood incidents attributed to surface water within Arundel or the vicinity.

Figure 4-4 and the EA Flood maps demonstrate that the site is considered to have a very low risk of surface water flooding below 0.1 % probability of occurrence in any given year, however there are a couple of areas close to the site which are identified as being at low risk (0.1% - 1% probability) of surface water flooding, within the Back Arun Fishery site whilst the Arundel railway station has a medium to high risk of flooding from surface water (3.3 % probability).

The EA and the ADC LFRMS have not identified any critical drainage areas (CDA) in the vicinity or immediately downstream of the site. CDAs are areas in which new development is likely to overload the capacity of the existing drainage system, with areas upstream having potential to put further pressure on the capacity of the downstream drainage system.

4.4.6. Sewer Flooding

During heavy rainfall, flooding from the sewer system may occur if: the rainfall event exceeds the capacity of the sewer system/drainage system; the system becomes blocked (by debris or sediment); or the system surcharges due to high water levels in receiving watercourses.

Eight incidents of sewer flooding events have been recorded within the wider postcode area of BN18 9, which the site falls within, however further details of where these events were or the cause (overloading or blockage) are unknown for confidentiality reasons. Much of this postcode area covers the main Arundel town and extends down to the causeway. In the 2008 SFRA, sewer flooding records have been mapped, with more than eight incidents located within the Arundel town which would relate to the BN18 9 postcode and none in the vicinity of the site. It is therefore considered that the risk of sewer flooding is low.

According to Southern Water the closest adopted sewer and sewer manhole (4401) is a foul sewer which starts just south east of the site and runs along the Station Approach northwards towards The Causeway where it continues northwards into Arundel. All the sewers described are indicated on Figure 4-8.

The site is located at the end of a gravity sewer line and therefore it is unlikely to overflow onto the site given the very small sewer catchment area. In addition, in the event of a sewer flooding, it is expected that any potential sewer flooding would follow the path of the highways towards low ground, which in the case of the closest sewer would be along Station Approach towards the Back Arun Fishery or along the highways towards Arundel, away from the site.

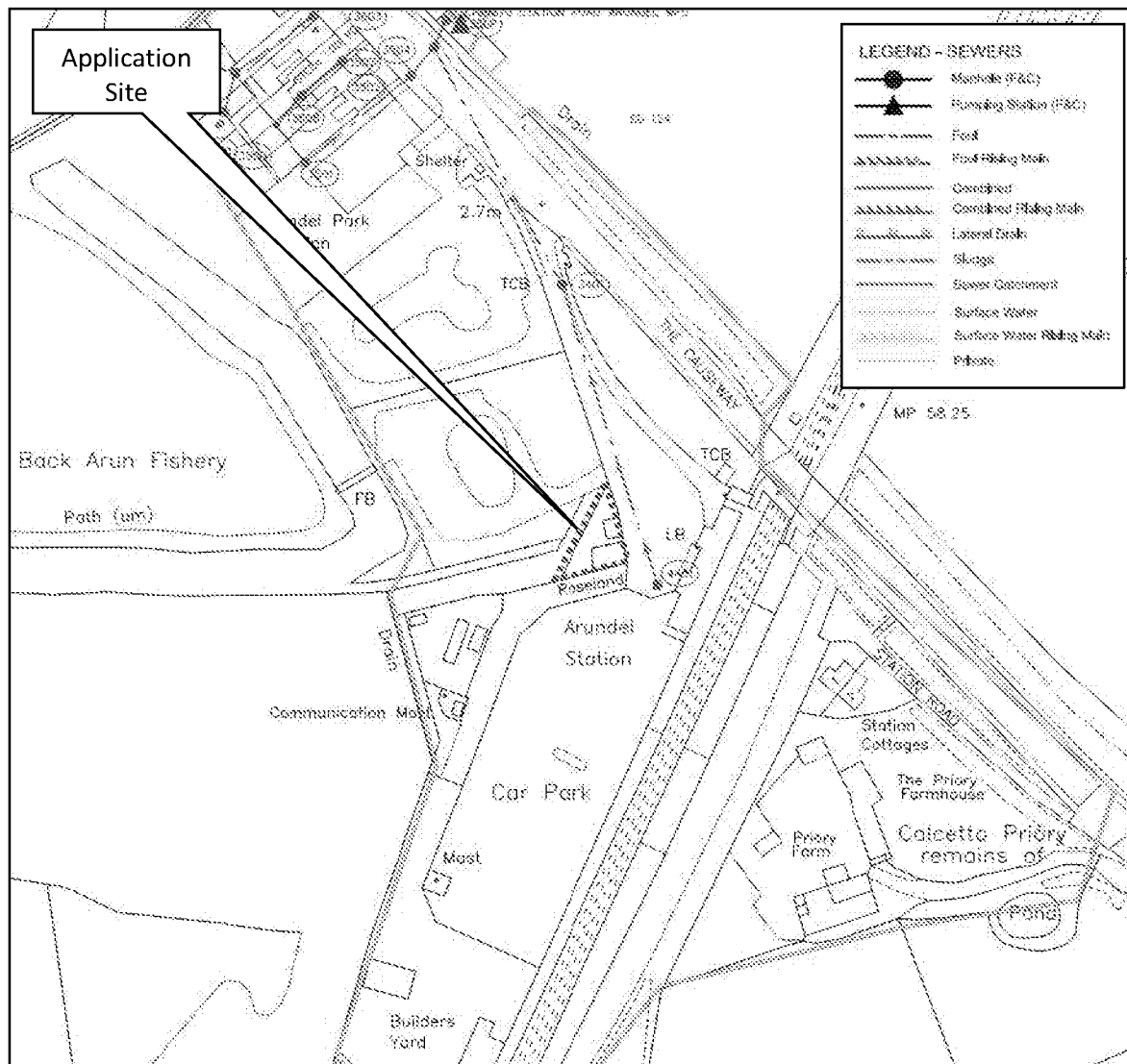


Figure 4-8- Sewer Records (Southern Water, 2016)

4.4.7. Artificial Waterbodies

Neither the SFRA nor EA identify any potential flooding of the application site or the nearby area from reservoirs, canals and/or other artificial sources.

4.4.8. Records of Historical Flooding

The SFRA Level 1 states that the Arun District has a long history of flood events, from multiple sources. The three most notable events in the last 60 years were in 1974, 2000 and 2012 which were associated with heavy rainfall over an extensive period. The SFRA summarises the most notable floods to the area of Arundel as below:

- *“November 1974: Heavy rainfall resulted in significant surface water and fluvial flooding throughout the district. Tidal flooding also occurred in Arundel when heavy rainfall*

coincided with a high tide. This caused the river to overtop defences and flood several properties and roads.

- Significant groundwater flooding has been observed across Sussex in 1993/94, 2000/01 and 2002/03. The areas subjected to this flooding were mainly the upper reaches of Chalk catchments, in areas of localised low topography, and in areas of drift cover absence.
- May 2009: District wide flooding reported, but particularly at Yapton, Felpham, Walberton and Bersted. This is reported to have been primarily a surface water flooding issue brought about by intense rainfall, although fluvial flooding issues were also reported.
- June 2012: The West Sussex County Council June 2012 Flood Event report has identified that on the 10th, 11th and 12th June 2012, an extreme rainfall event led to widespread flooding across parts of West Sussex. Approximately 780 properties were affected by flooding from a variety of sources. The worst affected areas in the Arun District were Bognor Regis and Littlehampton. West Sussex County Council (WSCC) recorded that rainfall in June 2012 was 430% higher than the average rainfall for June in the Bognor Regis to Chichester area. The probability of the rainfall event for this incident was estimated to be 1 in 200 (0.5% AEP)."

The SFRA gives a map of the historical flood records, an extract for the area surrounding the site is shown in Figure 4-9, indicating that the site does not have a historical record of flooding from any sources.

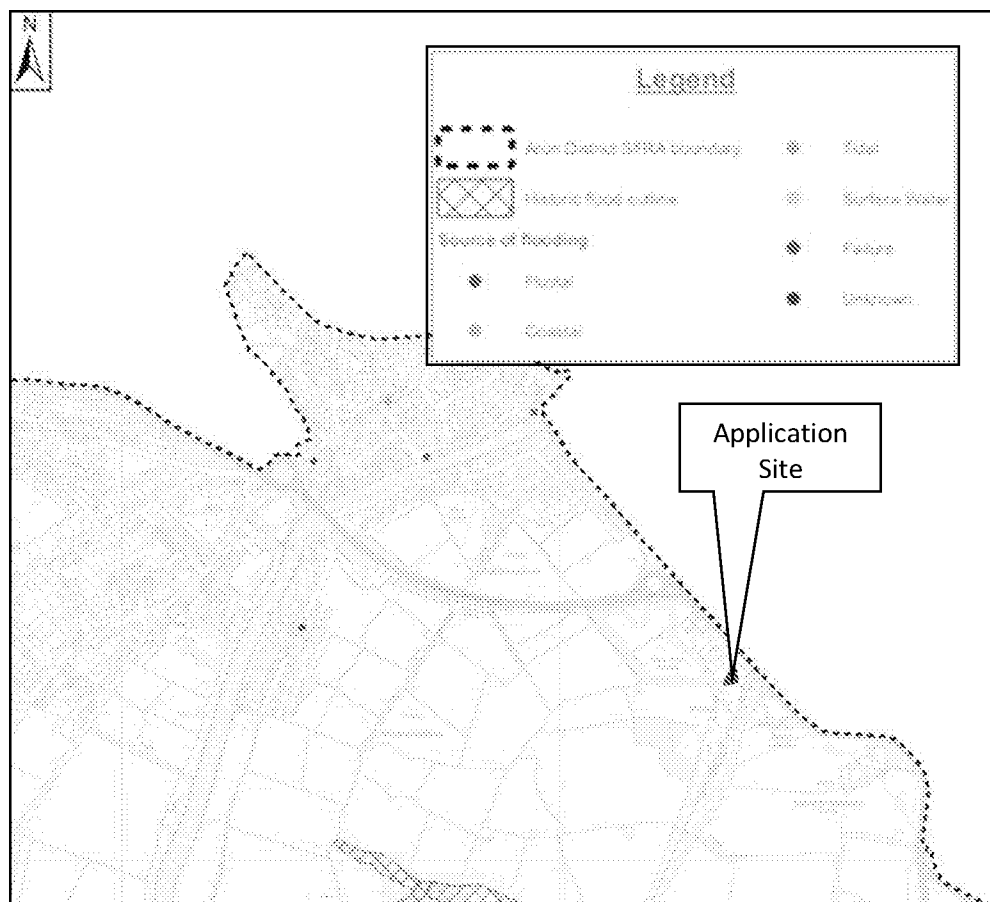


Figure 4-9 - Extract from SFRA Level 1 - Historical Flooding Records



5. Flood Risk Effects of the Proposed Development

5.1. Assessment of On-Site Flood Risk

The ADC SFRA and EA Flood Map indicate that the proposed development is wholly located in the EA's Flood Zone 3. Referring to NPPF Technical Guidance, the location of the proposed development would be categorised as "*High Flood Probability*" - i.e. the annual probability of flooding from riverine sources is greater than 1 % or 0.5% from tidal sources. However, the site currently benefits from flood defences which when modelled indicate that the site is not within the flood risk zone. Consequently, there is no requirement to provide compensatory fluvial flood storage and the residual risk of fluvial/coastal flooding is deemed to be of **low significance**. However, the site is at risk of flooding from the tidal 0.5% AEP (2110) event when climate change is taken into account (although it is unlikely that overtopping of the local defences would ever occur within the lifetime of the development for the 1 in 100-year+CC event as the EA are committed to sustaining a 1 in 75 year SoP for Arundel Strategy Unit for at least the next 100 years. Nevertheless, it is recommended that flood resilience measures are implemented within the development to protect against any residual risk to the site.

A review of EA, ADC SFRA information demonstrates that the site lies within an area with 50-75 % susceptibility to groundwater flooding, however the geology of the site and borehole records indicate that groundwater incursion would be unlikely due to low permeability surface geology. The risk of groundwater flooding to the proposed development is therefore considered of **low significance**.

The EA and LDC resources demonstrate that the site has a low risk of localised surface water flooding. Consequently the risk of surface water flooding to the proposed development is therefore considered of **negligible/neutral significance**.

There are no records of surface water sewer problems or flooding incidents from highway drainage within the vicinity of the site, the risk of flooding of the site from sewers is therefore considered **negligible/neutral significance**.

Neither the LDC SFRA nor the EA identify any potential flooding from reservoirs, canals and/or other artificial sources specifically within the application site. The risk of flooding of the site from artificial drainage bodies is therefore considered **negligible/neutral significance**.

5.2. Proposed Mitigation

The site is considered to be of high risk of flooding from fluvial/tidal sources in the undefended models, upon which the flood zones are based (the risk for fluvial/tidal flooding is reduced from high risk due to the presence of flood defences), therefore it is considered prudent that mitigation and/or flood resilience measures are considered. The impact of climate change also poses a risk of flooding to the site from tidal sources in the defended model scenarios. However, the EA are committed to maintaining the SoP conferred by their local defences for at least the next 100 years.

With reference to Figure 3-2 above the ground levels in the vicinity of the proposed building average around 2.50 mAOD. With reference to EA Product 4 data (refer to Appendix B) a flood level of 2.41 mAOD is predicted for undefended fluvial flooding for the 1 % AEP event, which would result in only marginal flooding of the north western boundary of the site. This, coupled



with the protection conferred by local defences means that the site is currently considered to be safe to a 1 % AEP fluvial event.

Taking into account climate change to 2110, the undefended scenario for fluvial flooding results in levels of up to 3.33 mAOD on site.

For the tidal flood scenarios for 0.5 % AEP, the undefended scenario would result in 2.99 mAOD flood levels on site, and with the impact of climate change 3.59 mAOD. However, the defended scenario would result in flood levels of 3.50 mAOD on site only when climate change is taken into account for the year 2115.

As the EA are committed to maintaining the SoP conferred by their local defences for at least the next 100 years, it is unlikely that overtopping of the defences during a fluvial 1 % (+CC) or tidal 0.5 % (+CC) AEP event would ever occur in reality, during the lifetime of the development.

Nevertheless, to protect against the residual impacts of tidal and fluvial flooding the following mitigation measures are proposed for the scheme:

1. ***Raising of ground floor levels to above the maximum predicted current undefended 1 % AEP fluvial or 0.5 % AEP tidal flood level:*** the maximum current flood level is predicted to be the 0.5 % AEP tidal event of 2.99 mAOD. The current ground floor level of the existing dwelling is set at 2.79 mAOD, approximately 290 mm above existing external ground levels. For the new dwellings it is proposed to raise the ground floor level by a further 260 mm to 3.05 mAOD, placing it safely above all predicted current 1 % AEP fluvial and 0.5 % AEP tidal flood levels. This will act as a water exclusion strategy for the undefended flood scenarios for the present risk. An appropriate ramp will be provided to the shared front door and hallway of the apartments to enable access for wheelchair users, buggies etc.
2. ***Use of demountable barrier on the front door and flood resistant design to protect against the residual future defended risk:*** although it is predicted that the site will not be inundated by fluvial flooding up to at least 2110 due to the protection afforded by locale defences, modeling predicts that if the current SoP of the defences is not maintained then the site could be susceptible to a tidal flood level of 3.50 mAOD in 2115. As explained above, it is unlikely that such inundation of the site would ever occur during the lifetime of the development as the EA has committed to maintaining the current 1 in 75 year SoP for the Arundel Strategy Unit for at least the next 100 years. Nevertheless, as a precautionary measure the ground floor of the new building will be made resilient to a potential flood level of 3.50 mAOD (this flood level will be 450 mm above the proposed ground floor slab level, so as per the UK Government's "*Improving the Flood Performance of New Buildings: Flood Resilient Construction*" guidance¹⁸ this will ensure that a water exclusion strategy will be feasible). Consequently, the following measures are proposed:
 - Provision of a suitable demountable flood barrier of at least 600 mm height to be placed within the frame of the shared front door. The demountable barrier will be stored in a dedicated store beneath the stairs in the ground floor and signed clearly and appropriately. All occupiers will be familiarised with the location and mode of deployment of the barrier on taking up residence in the flats by the landlord. There will be a shared responsibility to deploy the barrier, which will ensure its deployment should any of the occupiers be away at the time of receiving a Flood Warning (see below).



- Flood resilient construction of the ground floor as per “*Improving the Flood Performance of New Buildings: Flood Resilient Construction*”, to include:
 - No air bricks within the floor slab construction;
 - All window sills set to at least 600 mm above the fixed floor level (FFL);
 - Use of building materials that are effective for a ‘water exclusion strategy’ including engineering bricks, cement-based materials including water retaining concrete and dense stone.
 - External walls capable of withstanding a hydrostatic head up to 3.50 mAOD;
 - Closed cell insulation will be used for all pipes which are below the predicted flood level.
 - The provision of non-return valves in the drainage system to prevent back-flow of diluted sewage if there is an identified risk of the foul sewer surcharging.
 - Location of water, electricity and gas meters above 3.50 mAOD.
 - Electrical sockets to be installed above 3.50 mAOD to minimise damage to electrical services and allow speedy re-occupation - electric ring mains will be installed at first floor level with drops to ground floor sockets and switches.
 - Boiler units and ancillary devices, including controls such as thermostats to be installed above 3.50 mAOD.
 - Communications wiring: wiring for telephone, TV, Internet and other services will be protected by suitable insulation in the distribution ducts to prevent damage - any proposed design solution for flood insulation on all potentially vulnerable wiring will be discussed with the relevant service providers.
- 3. **Identification of safe access & egress routes:** The NPPF states that safe access and escape routes for emergency services to and from the development during a flood event should be identified, where required. However, in the unlikely event of flooding of the site there is the possibility of external ground levels within the vicinity of the development being around 1 m below the 1 in 200 year (+CC) tidal flood level in 2115 (should the EA not maintain the current SoP). Two options exist; if adequate warning is given prior to any anticipated flooding occurring then the first option is to evacuate the proposed development via the shortest route to land outside of the zone of flood risk. This would require the future occupants of the proposed development to travel a total distance of around 100 m up the access road to the Causeway and eastwards along this highway which is above the predicted flood levels from the junction with access road eastwards. The second option would therefore be to stay within the proposed building and follow a dry ingress route upwards into the proposed development itself. This is discussed below.
- 4. **Provision of safe “invacuation” route and refuge**
If instructed to stay within the premises by the emergency services, if deemed necessary (e.g. in the every unlikely event that there was a failure of the above flood resilience provisions or if floodwaters were anticipated to be higher than the maximum design flood level for which a water exclusion strategy is deemed effective) then there is the ability of ground floor occupants to enter the shared hallway and traverse up the stairs to a refuge area of approximately 12 m² on the 1st floor landing. This area would be well above any anticipated



flood level and occupants could remain here safely until either the floodwaters had subsided or were rescued by the emergency services.

5. ***Signing up to the EA's Flood Warning Service:*** The EA is responsible for issuing flood warnings to the public based on meteorological reports and forecasts, including the use of radar to track storms and rainfall intensity, and data from the national tide gauge network. The warnings are issued by local radio, supplemented by direct dial telephone systems and other local systems as appropriate. The EA operates a 24-hour telephone service on 0845 988 1188 that provides frequently updated flood warnings and associated floodplain information. In addition, this information can also be found on Floodline, along with recommendations on what steps should be taken to prepare for floods, what to do when warnings are issued and how best to cope with the aftermath of floods. Consequently, it is intended that on taking up residence all occupiers will be advised to sign up for the EA's free Automated Voice Messaging Flood Warning Service (AVM) (refer to: <https://fwd.environment-agency.gov.uk/app/olr/register>) by means of information provided with the sale or lease documents for each property.



6. Assessment of Residual Risk

The ADC SFRA indicates that the proposed development is wholly located in the EA's Flood Zone 3. However, the site currently benefits from flood defences which when modelled indicate that the site is not within the modelled flood extent. In addition, it is proposed that the ground floor level of the dwellings is raised and a demountable flood barrier provided for the shared front door along with flood resilient design of the building to mitigate against the effects of flooding with the impact of climate change taken into account. Consequently, the residual risk of fluvial/coastal flooding is deemed to be of **low significance**.

A review of EA, ADC SFRA information demonstrates that the site lies within an area with 50-75 % susceptibility to groundwater flooding, however the geology of the site and borehole records indicate that groundwater incursion would be unlikely due to clay surface geology. The raising of the ground floor will also reduce the impact, should groundwater flooding become an issue. Consequently the risk of groundwater flooding to the proposed development is therefore considered of **negligible/neutral significance**.

EA and ADC resources demonstrate that the site is at low risk of surface water flooding. The residual risk of flooding of the proposed development from surface water flooding is therefore considered **negligible/neutral significance**.

There are no records of surface water sewer problems or flooding incidents from highway drainage within the vicinity of the site. Consequently, the residual risk of flooding of the site from sewers is therefore considered **negligible/neutral significance**.

It is anticipated that the proposed redevelopment will lead to a small increase in foul water discharges from the site (there would have been previous loadings on the foul sewer network associated with the former usage of the site). The developer will augment the existing sewer infrastructure accordingly. In accordance with Building Regulations Part G, it is also anticipated that low water consumption appliances (low-flow taps and white goods) will be introduced throughout the proposed redevelopment, which will minimise foul water discharges. Following the introduction of these measures, the residual impact of the proposed redevelopment on the local sewerage infrastructure is deemed to be of **neutral/negligible significance**.

Neither the ADC SFRA nor the EA identify any potential flooding from reservoirs, canals and/or other artificial sources specifically within the application site. The residual risk of flooding of the site from artificial drainage bodies is therefore considered **negligible/neutral significance**.



7. Summary and Conclusions

Birchside Management Ltd has commissioned Hilson Moran Partnership to prepare a NPPF-compliant FRA for its residential development located on the 0.03 ha plot of land at Land at Roseland, Station Approach, The Causeway, Arundel, BN18 9JL, National Grid Reference TQ 36690 16421.

This document constitutes a formal FRA to NPPF guidelines, appropriate to the scale and nature of the development and risks involved.

The residual risk from fluvial, coastal, groundwater and sewer flooding has been identified as negligible to low. In light of the above, the principle of the proposed development is deemed acceptable on flood risk grounds.



Appendix A Arun District Council Consultation Response



Paul Bond

From: Karen Garner [Karen.Garner@arun.gov.uk]
Sent: 14 October 2016 15:59
To: Paul Bond
Subject: RE: Requirement for SuDS on minor developments
Categories: Filed by Newforma

Dear Mr Bond

Thank you for your email which I have forwarded to the Engineers department.

For the purposes of your application for 4No. flats that you wish to submit, they advise me that your application can made valid without a drainage statement in this case. We will add a drainage condition to any approval made, to be discharged at a later date.

However, if you already have the drainage information, please submit it to us with the application.

The details required for 10 or more dwellings will be more onerous than for 4 dwellings.

We are awaiting clarification from the Chief Engineer for all future applications and thank you for bringing this to our attention.

Kind regards

Karen

Karen Garner | Technical Support Unit Assistant, Planning Department, Arundel District Council | Location: First Floor,
Arundel Civic Centre, Maltravers Road, Littlehampton, BN17 5LF
Internal: 37467 | External: +44 (0) 1903 737711 | E-mail: karen.garner@arun.gov.uk

Visit Arundel's web site at www.arundel.gov.uk  Save the environment - think before you print.

From: Paul Bond [mailto:]
Sent: 12 October 2016 15:59
To: Karen Garner
Cc: Pippa Messenger
Subject: Requirement for SuDS on minor developments

Dear Karen,

As discussed, we are currently looking at the planning application requirements relating to surface water drainage for a potential residential redevelopment in your district. However, we are often asked to provide drainage and flood risk advice on developments within your district and our inquiry is also of a general nature relating to your local policy.

The proposed site that we are looking at is currently occupied by a bungalow and workshop, with the remainder of the site being largely hardstanding. The intention is to demolish the existing buildings and probably replace with 4 flats over two storeys, with the area of the built footprint staying close to the original area.

From 6th April 2015, new national planning guidance came into force for the implementation of sustainable drainage systems within all "major" new housing developments (i.e. developments of 10 dwellings or more) (please refer to



the attached House of Commons Written Statement). The guidance states that "we expect local planning policies and decisions on planning applications relating to major development - developments of 10 dwellings or more; or equivalent non-residential or mixed development (as set out in Article 2(1) of the Town and Country Planning (Development Management Procedure) (England) Order 2010) - to ensure that sustainable drainage systems for the management of run-off are put in place, unless demonstrated to be inappropriate."

With reference to the Arun DC "Local Validation Requirements List update 2016" it is stated that a "Foul and Surface Water Drainage statement" is required for "Development proposals for buildings/hard surfacing/extensions". The document then refers the reader to the following link: <http://www.arun.gov.uk/surfacewater> which subsequently takes you to the Arun DC "Supplementary Requirements for Surface Water Drainage Proposals" web page. This states that "Any proposed surface water scheme must consider sustainable drainage principles" and then goes on to describe various guidance on SuDS selection, design, maintenance, management etc.

My question is this - I accept that a "Foul and Surface Water Drainage statement" is required for any development proposals for buildings, hard surfacing and extensions, but if the development is not a major development (e.g. 10 dwellings or more) does Arun DC still require a SuDS Strategy to be designed and to accompany the planning application, or can the required Foul and Surface Water Drainage statement simply describe how the proposed development would be connected to the existing adopted surface water sewer system, as there is no reference in your guidance as to whether it applies only to major development or not? In other words, does Arun DC policy seek to align itself with national policy relating to SuDS or is the intent to go above and beyond the requirements of national policy?

Consequently, the answer to this question would be relevant to all developments of 9 dwellings or less seeking planning permission in your district.

I look forward to hearing from you in the near future.

Kind regards

Paul

Paul Bond
PhD MSc BSc CEnv CSci MEnvSc MCIEEM
Associate Sustainability Consultant

HILSON
MORAN

Environments for Life.





Appendix B Environment Agency Product 4

Pipp Messenger
One Discovery Place
Columbus Drive
Southwood West
Farnborough
Hampshire
GU14 0NZ

Our ref: SSD/29725

Date: 15/02/2017

Dear Pippa Messenger

Provision of Product 4 for address: Station Approach, Arundel, BN18 9JL

Thank you for your request of 15th November 2016 to use Environment Agency data, Product 4. The information is attached.

The information on Flood Zones in the area relating to this address is as follows:

The site is in an area located within Flood Zone 3 shown on our Flood Map for Planning (Rivers and Sea).

Note - This information relates to the area that the above named property is in and is not specific to the property itself.

Please find attached a copy of the Flood Map for Planning (Rivers and Sea) for the area relating to your address.

Further details about the Environment Agency information supplied can be found on the GOV.UK website:

<https://www.gov.uk/browse/environment-countryside/flooding-extreme-weather>

If you have requested this information to help inform a development proposal, then you should note the information on GOV.UK on the use of Environment Agency Information for Flood Risk Assessments

<https://www.gov.uk/planning-applications-assessing-flood-risk>

<https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion>

Guildbourne House, Chatsworth Road, Worthing, West Sussex, BN11 1LD

Customer services line: 037 00 000 000

Supporting Information

Flood Defences

To the North of the site there are embankments to a standard of protection of a of 1 in 50 year flood event. Based on our records these defences are in fair to poor condition.

Model Information

The flood outlines, depths and levels are taken from the Lower Tidal River Arun Strategy Study, completed in 2010 by Atkins.

Flood History

We do not have any records of previous flood events affecting this site. I would suggest contacting Arun District Council for a more comprehensive flood history check.

Please note our records are not comprehensive and may not include all events, you can contact your Local Authority to check if they hold any relevant information regarding your application.

You are encouraged to use and re-use this information freely and flexibly, with only a few conditions. Details of which can be found here:

<http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/>

We respond to requests for recorded information that we hold under the Freedom of Information Act 2000 (FOIA) and the associated Environmental Information Regulations 2004 (EIR).

If you are not satisfied with our response to your request for information you can contact us within 2 calendar months to ask for our decision to be reviewed.

If you have any queries or would like to discuss the content of this letter further please call us on 03708 506506.

Yours faithfully
Freddie Fielding
PSO West Sussex

Enc. Flood Map for Planning (Rivers and Sea) / Node point locations / Flood levels/depths / Modelled flood outlines / Flood Defence Locations

Use of Environment Agency Information for Flood Risk Assessments

Important

If you have requested this information to help inform a development proposal, then we recommend that you undertake a formal pre-application enquiry using the form available from our website:-

<https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion>

Depending on the enquiry, we may also provide advice on other issues related to our responsibilities including flooding, waste, land contamination, water quality, biodiversity, navigation, pollution, water resources, foul drainage or Environmental Impact Assessment.

You should refer to the Environment Agency's Flood Risk Standing Advice, Planning Practice Guidance, and the existing PPS25 Practice Guide for information about what flood risk assessment is needed for new development in the different Flood Zones. These documents can be accessed via:

<https://www.gov.uk/flood-risk-assessment-standing-advice>

<http://planningguidance.planningportal.gov.uk/>

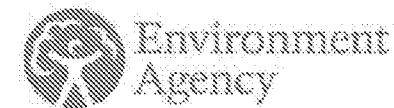
<http://www.planningportal.gov.uk/planning/planningpolicyandlegislation/previousenglishpolicy/ppqpps/pps25>

You should also consult the Strategic Flood Risk Assessment produced by your local planning authority.

You should note that:

1. Information supplied by the Environment Agency may be used to assist in producing a Flood Risk Assessment (FRA) where one is required, but does not constitute such an assessment on its own.
2. This information covers flood risk from main rivers and the sea, and you will need to consider other potential sources of flooding, such as groundwater or overland runoff. The information produced by the local planning authority referred to above may assist here.
3. Where a planning application requires a FRA and this is not submitted or deficient, the Environment Agency may well raise an objection.
4. For more significant proposals in higher flood risk areas, we would be pleased to discuss details with you ahead of making any planning application, and you should also discuss the matter with your local planning authority.

Flood Map for Planning (Rivers and Sea). Centred BN18 9JL. Created 15/02/2017



Scale 1: 10,000



Flood Map for Planning (Rivers & Sea)

- Defences
- Flood Storage Areas
- Areas benefiting from flood defences
- Flood Zone 3
- Flood Zone 2

Flood Map Areas (assuming no defences)

Flood Zone 3 shows the area that could be affected by flooding:

- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

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Flood Defence Locations. Centred BN18 9JL. Created 15/02/2017

Legend

Defences

- | | |
|--|---------------------|
| | Embankment |
| | Wall |
| | Flood Gate |
| | Demountable Defence |
| | Bridge Abutment |
| | High Ground |
| | Beach |
| | Barrier Beach |
| | Promenade |
| | Quay |
| | Cliff |
| | Dunes |
| | Culvert |



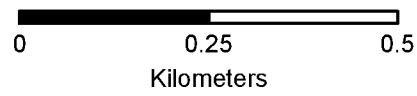
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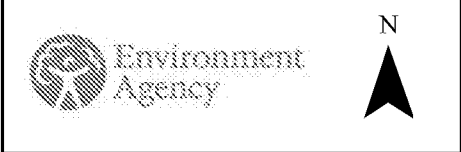


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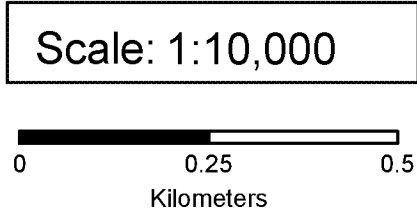
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- Main River
- 5% AEP (Undefended Fluvial)
- 1% AEP (Undefended Fluvial)
- 0.1% AEP (Undefended Fluvial)
- 1% AEP Plus Climate Change (Undefended Fluvial)

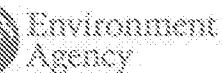
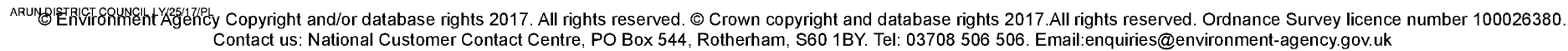
Scale: 1:10,000





- Legend**
- Site Boundary
 - Main River
 - 5% AEP (Un defended Tidal)
 - 0.5% AEP (Un defended Tidal)
 - 0.1% AEP (Un defended Tidal)
 - 0.5% AEP (2110) (Un defended Tidal)

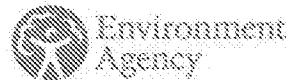




 Site Boundary
 Main River
 20% AEP (Defended Fluvial)
 5% AEP (Defended Fluvial)
 1.3% AEP (Defended Fluvial)
 1% AEP (Defended Fluvial)
 1% AEP Plus Climate Change (Defended Fluvial)
 0.1% AEP (Defended Fluvial)

0 0.25 0.5

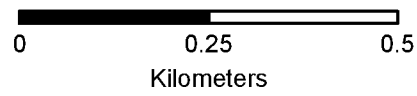
Kilometers

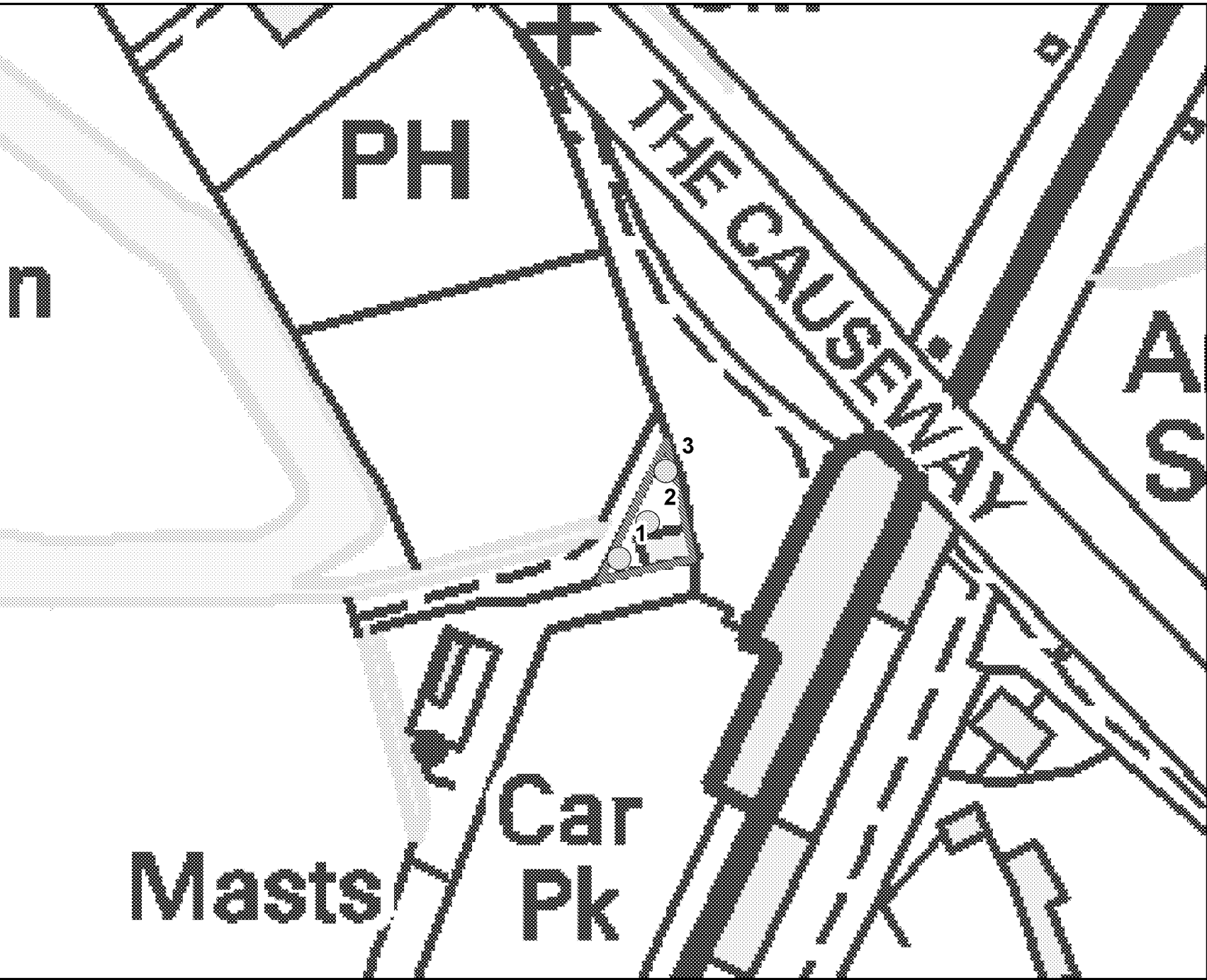


Legend

- Site Boundary
- Main River
- 5% AEP (Defended Tidal)
- 0.5% AEP (Defended Tidal)
- 0.1% AEP (Defended Tidal)
- 0.5% AEP (2110) (Defended Tidal)

Scale: 1:10,000







Environment
Agency

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Legend

 Site Nodes

 Site Boundary

Scale: 1:1,000


0 0.025 0.05
Kilometers

Product 4 Flood Risk Data Requested by: Pippa Messenger

Site: Station Approach, Arundel, BN18 9JL

Table 1: Water Levels: Fluvial Undefended

Node Reference	NGR		Modelled Flood Levels in Metres			
	Eastings	Northings	Undefended Annual Exceedance Probability			
			5%	1%	1% Plus Climate Change	0.1%
1	502394	106409	-	2.41	3.33	2.72
2	502399	106416	-	-	3.33	2.72
3	502403	106426	2.32	2.41	3.33	2.72

Table 2: Water Levels: Fluvial Defended

Node Reference	NGR		Modelled Flood Levels in Metres					
	Eastings	Northings	Defended Annual Exceedance Probability					
			20%	5%	1.3%	1%	1% + CC	0.1%
1	502394	106409	-	-	-	-	-	-
2	502399	106416	-	-	-	-	-	-
3	502403	106426	-	-	-	-	-	-

Table 3: Water Levels: Tidal Undefended

Node Reference	NGR		Modelled Flood Levels in Metres			
	Eastings	Northings	Undefended Annual Exceedance Probability			
			5%	0.5%	0.5% (2110)	0.1%
1	502394	106409	2.76	2.99	3.59	3.05
2	502399	106416	2.76	2.99	3.59	3.05
3	502403	106426	2.76	2.99	3.59	3.05

Table 4: Water Levels: Tidal Defended

Node Reference	NGR		Modelled Flood Levels in Metres			
	Eastings	Northings	Defended Annual Exceedance Probability			
			5%	0.5%	0.5% (2110)	0.1%
1	502394	106409	-	-	3.50	-
2	502399	106416	-	-	3.50	-
3	502403	106426	-	-	3.50	-

All levels taken from: Lower Tidal River Arun Strategy Study, completed in 2010 by Atkins.

There is no additional information or health warnings for these levels/depths or the model from which they have been produced.

Produced on 15/02/2017

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Appendix C Large Scale Extracts from Environment Agency Defended Product 4 Outputs



Appendix D Explanation of the Levels of Significance Used in FRAs

Significance	Impact of Proposed Development on both local and catchment hydrology	Risk of flooding of Proposed Development following completion
Not Significant	Proposed Development does not affect the quantity/quality of surface run-off and does not alter surface/groundwater flow locally or elsewhere within the catchment.	Proposed Development is not located in a 1:100 year fluvial or 1:200 year tidal floodplain. Flooding as a result of the accumulation of surface run-off on site, or elsewhere in the catchment is highly unlikely.
Low Significance	Proposed Development has a minor effect on the quantity/quality of surface run-off or surface/groundwater flow either locally or elsewhere within the catchment. Such changes may be sustainable without mitigation measures.	Proposed Development is located in a 1:100 year fluvial and/or 1:200 year tidal floodplain, although no mitigation measures are required due to regional flood defences. Existing local drainage measures are sufficient to ensure that the accumulation of surface run-off does not result in flooding on site or increase the risk of flooding elsewhere within the catchment.
Moderate Significance	Proposed Development has a notable effect on the quantity/quality of surface run-off and has a discernible impact upon surface/groundwater flow either locally or elsewhere within the catchment. Mitigation measures may be required in order for the development to be sustainable throughout the duration of its intended lifetime.	Proposed Development is located in a 1:100 year fluvial and/or 1:200 year tidal floodplain and mitigation measures are required to reduce flood risk to an acceptable level. Surface run-off attenuation methods may be required to ensure that the accumulation of surface run-off does not result in flooding on site or increase the risk of flooding elsewhere within the catchment.
Moderate – High Significance	Proposed Development has a large effect on the quantity/quality of surface run-off and has a considerable impact upon surface/groundwater flow either locally or elsewhere within the catchment. A primary commitment to successful mitigation measures will be required in order for the development to be sustainable throughout the duration of its intended lifetime.	Proposed Development is located in a 1:100 year fluvial and/or 1:200 year tidal floodplain and significant mitigation measures are required to reduce flood risk to an acceptable level. A range of surface run-off attenuation methods will be required to ensure that the accumulation of surface run-off does not result in flooding on site or increase the risk of flooding elsewhere within the catchment.
High Significance	Proposed Development has a major effect on the quantity/quality of surface run-off and has a severe impact upon surface/groundwater flow locally or elsewhere within the catchment. The incorporation of even a wide range of practicable mitigation measures may not ensure that the development remains sustainable throughout the duration of its intended lifetime.	The Proposed Development is considered to be particularly susceptible to either tidal or fluvial flooding or a combination of both. Resultant changes in the rates of surface run-off as a result of the development will increase flood risk both on site and elsewhere in the catchment. The incorporation of even a wide range of practicable mitigation measures may not ensure that the development remains sustainable in terms of flood risk for the duration of its intended lifetime.

Appendix E Source Protection Zone Definitions

In assessing the potential risk of contamination to groundwater resources, the Environment Agency has subdivided groundwater source catchments into four zones (see Figure A.1).

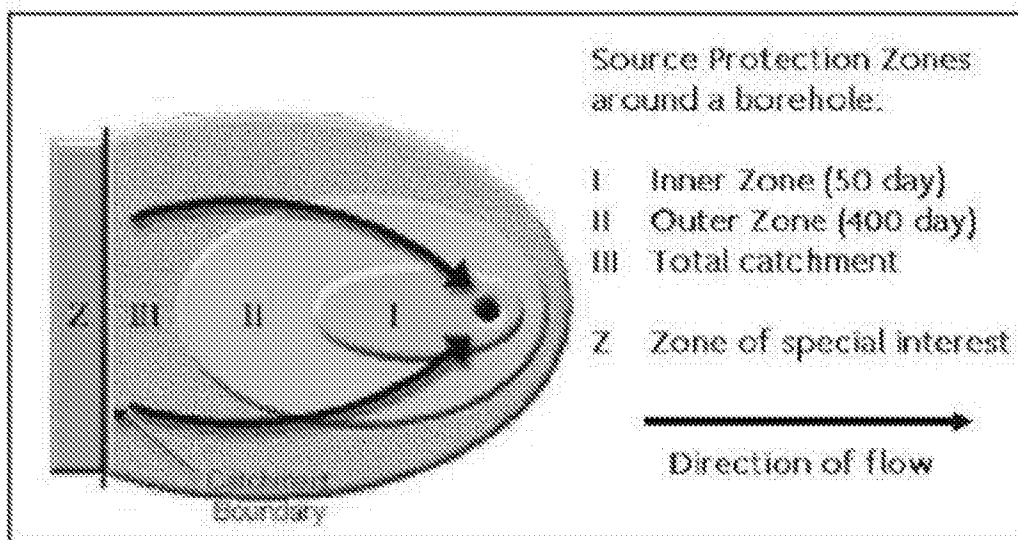


Figure A.1 EA Source Protection Zones

Two of these zones are defined by the travel time of potential pollutants, the third by the source catchment area itself and the fourth is a 'Zone of Special Interest'. The definitions for the zones are:

- **Zone I (Inner Protection Zone)** – This zone is defined by a travel time of 50-days or less from any point within the zone at, or below, the water table. Additionally, the zone has a minimum 50 m radius. It is based principally on biological decay criteria and is designed to protect against the transmission of toxic chemicals and water-borne disease;
- **Zone II (Outer Protection Zone)** – This zone is defined by the 400-day travel time, or 25% of the source catchment area, whichever is larger. The travel time is derived from consideration of the minimum time required to provide delay, dilution and attenuation of slowly degrading pollutants;
- **Zone III (Total Catchment)** – This zone is defined as the total area needed to support the abstraction or discharge from the protected groundwater source;
- **Zone of Special Interest** – For some groundwater sources an additional Zone of Special Interest may be defined. These zones highlight areas (mainly on non-aquifers) where known local conditions mean that potentially polluting activities could impact on a groundwater source, even though the area is outside the normal catchment of that source.



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