UK Flood Risk
Flood Risk Consultants

Flood Risk Assessment

49 Warren Way, Barnham, Bognor Regis, West Sussex PO22 0JX

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ARUN DISTRICT COUNCIL EG/16/19/HH

Executive Summary

UK Flood Risk Consultants has been commissioned to prepare this Flood Risk Assessment (FRA) in support of a proposal consisting of erection of an extension to the residential dwelling located at 49 Warren Way, Barnham, Bognor Regis, West Sussex PO22 0JX.

The main sources of information to undertake flood risk assessment are the flood maps and data of the Environment Agency and the previous flood studies by the Local Authority.

The proposed development is categorised as ‘more vulnerable’.

The nearest main river from the site is the Barnham Rife with the risk of fluvial flooding.

According to the information available from the SFRA and the Environment Agency, there were some flooding events in the area. The Environment Agency’s historic flood records show that the site has been flooded by the Barnham Rife in 1974 and 1993. However, no further information was available on the extent of flooding.

The Environment Agency’s Flood Maps show that the site lies within the Flood Zone 3 (high probability flooding). The Environment Agency’s flood risk map indicates that the risk of flooding to the site is 'medium'.

The flood maps also show that site is located in an area not benefiting from the flood defences.

The Environment Agency’s modelling data indicated that the site is subject to flooding from the 1% AEP (1 in 100 year) and the 1% AEP (1 in 100 year) plus 45% Higher Central CC and 105% Upper End CC events with the maximum flood depths of 1.58m and 2.20m respectively. This implies that the flood hazard to the people and the property is high.

The overall risk of surface water flooding to the site is 'low'.

The flood risk from other sources including underground water, sewer and reservoir is low.

In order to provide a level of protection against flooding, the floor level of the proposed extension will be set no lower than the existing level of the property, and flood proofing of the proposed development will be incorporated where appropriate.

ARUN DISTRICT COUNCIL EG/16/19/HH

In order to minimise the damage and to enable quick recovery and clean up after the flooding event, it is proposed that flood resilient measures will be implemented.

As the site is located within a flood zone area, it will be necessary to make sure that the residents are fully aware of the flood risk and flood warning and evacuation during an extreme event.

The residents are advised to utilise the Environment Agency's Flood Warning Service available in the area.

The surface runoff will be improved by implementing appropriate SuDS measures. A rainwater harvesting (water butt) will be implemented to improve the surface runoff.

The development will not give rise to backwater affects or divert water towards other properties.

This report demonstrates that the proposal will be safe, in terms of flood risk, for its design life and will not increase the flood risk elsewhere.

ARUN DISTRICT COUNCIL EG/16/19/HH

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Contents

1.0 BACKGROUND 1

2.0 FRA REQUIREMENTS 1

3.0 GENERAL DESCRIPTION OF THE SITE AND THE PROPOSALS 2

3.1. Description of the site 2

3.2. Proposed Development 2

4.0 DEVELOPMENT AND FLOOD RISK POLICY 3

4.1. National Planning Policy Framework (NPPF) 3

4.2. Flood Zones 3

4.3. Sequential and Exception Tests 3

4.4. Vulnerability of Use and Flood Risk Assessment 4

4.5. NPPF Flood Zones 4

5.0 ASSESSMENT OF FLOOD RISK 9

5.1. History of Flooding 9

5.2. Risk of Fluvial Flooding 9

5.3. Modelled Water Levels 9

5.4. Risk of Tidal/ Flooding 10

5.5. Risk of Flooding From Artificial Water Bodies 10

5.6. Risk of Groundwater Flooding 10

5.7. Risk of Surface Water Flooding 11

5.8. Risk of flooding from Reservoirs 11

5.9. Flood Risk from Sewers 11

5.10. Impact of Climate Change 12

6.0 MITIGATION MEASURES 15

6.1. Recommended Finished Floor Level 15

6.2. Flood Resilient Measures 16

6.3. Flood Warning and Evacuation 16

6.4. Surface Water Runoff (SuDS) 18

7.0 ASSESSMENT OF IMPACT ON FLOW OF FLOODWATER 20

8.0 CONCLUSION 20

ARUN DISTRICT COUNCIL EG/16/19/HH

APPENDIX A COLLECTION OF FIGURES ……..……..I
APPENDIX B EXISTING SITE AND PROPOSED PLANS……..…..II
APPENDIX C ENVIRONMENT AGENCY'S DATA AND INFORMATION….……..…..III
APPENDIX D ENVIRONMENT AGENCY'S GUIDANCE ON HOUSEHOLDER AND MINOR EXTENSIONS……..…..…IV

Abbreviations

Abbreviation	Description
mAOD	Metres Above Ordnance Datum
DEFRA	Department for Environment, Food, and Rural Affairs
EA	Environment Agency
FRA	Flood Risk Assessment
LLFA	Lead Local Flood Authority
NPPF	National Planning Policy Framework
SFRA	Strategic Flood Risk Assessment
PFRA	Preliminary Flood Risk Assessment
SuDS	Sustainable Drainage Systems

ARUN DISTRICT COUNCIL EG/16/19/HH

1.0 Background

UK Flood Risk Consultants has been commissioned to prepare this Flood Risk Assessment (FRA) in support of a proposal consisting of erection of an extension to the residential dwelling located at 49 Warren Way, Barnham, Bognor Regis, West Sussex PO22 0JX.

This FRA has been carried out in accordance with the requirements of the Revised National Planning Policy Framework (NPPF) published on 24 July 2018 and the Environment Agency's Flood Risk Assessment (FRA) Guidance Notes and the best practices in flood risk management.

The National Planning Policy Framework sets out planning policy in order to avoid inappropriate development in areas at risk of flooding by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere.

2.0 FRA Requirements

A flood risk assessment should be undertaken for most developments located within one of the flood zones. This included developments:

- in flood zone 2 or 3 including minor development and change of use,
- more than 1 hectare (ha) in flood zone 1,
- less than 1 ha in flood zone 1, including a change of use in development type to a more vulnerable, where they could be affected by sources of flooding other than rivers and the sea (eg, surface water drains, reservoirs),
- in an area within flood zone 1 which has critical drainage problems as notified by the Environment Agency.

The Environment Agency's standing advice should be followed if carrying out a flood risk assessment of a development classed as:

- a minor extension (household extensions or non-domestic extensions less than 250 square metres) in flood zone 2 or 3
- 'more vulnerable' in flood zone 2 (except for landfill or waste facility sites, caravan or camping sites)
- 'less vulnerable' in flood zone 2 (except for agriculture and forestry, waste treatment, mineral processing, and water and sewage treatment)
- 'water compatible' in flood zone 2.

ARUN DISTRICT COUNCIL EG/16/19/HH

3.0 General Description of the Site and the Proposals

3.1. Description of the site

The proposal site is located at 49 Warren Way, Barnham, Bognor Regis, West Sussex PO22 0JX approximately centred on the OS NGR 496054,104516 (**Appendix A Figure 1**). The site is located within the administrative boundary of Arun District Council, which is the Local Planning Authority.

The access to the site is via Warren Way. The surrounding area consists of predominantly residential use (**Appendix A Figure 2)**.

The nearest watercourse from the site is an unnamed watercourse with the risk of fluvial flooding. The site topography is relatively flat and level. Further details about the existing site are provided in **Appendix B**.

3.2. Proposed Development

The proposal consists of erection of an extension to the residential dwelling. Further details about the proposals have been provided in **Appendix B**.

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4.0 Development and Flood Risk Policy

4.1. National Planning Policy Framework (NPPF)

The revised National Planning Policy Framework was published on 24 July 2018 and sets out the government's planning policies for England. The NPPF sets out planning and policies related to development planning and flood risk using a sequential characterisation of risk based on planning zones and the Environment Agency's Flood Maps. The aim of the flood risk assessment is to identify which Flood Zones the site is located in and vulnerability classification relevant to the proposed development, based on an assessment of current and future conditions.

4.2. Flood Zones

The Flood Zones refer to the probability of river and sea flooding which ignores the presence of defences. The national flood maps have been developed by the Environment Agency that shows the risk of tidal and/or fluvial flooding across England and Wales for different return period events. The Environment Agency's Flood Maps are the maps which have been developed using broad scale hydraulic modelling. It is therefore important to understand that the flood maps may not be very accurate at a site-specific level which may need further field observation and measurements. The Flood Zones do not take into account of the climate change impacts which must be considered in any flood risk assessment as required by the NPPF.

4.3. Sequential and Exception Tests

As set out in the NPPF, the overall aim of the Sequential Test should be to steer new development to Flood Zone 1 (Low Probability Flooding). Where there are no reasonably available sites in Flood Zone 1, the Local Authority should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2, applying the Exception Test if required. Where there are no reasonably available sites in Flood Zones 1 or 2, the suitability of sites in Flood Zone 3 should be considered, taking into account the flood risk vulnerability of land uses and applying the Exception Test if required.

As the proposal consists of minor extension, the Sequential Test will not be required.

The Exception Test, as set out in paragraph 102 of the Framework, is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available. There are two requirements to meet for the Exception Tests. The proposed development will provide wider sustainability benefits to the community that outweigh flood risk, and that it will be safe

ARUN DISTRICT COUNCIL EG/16/19/HH

for its lifetime, without increasing flood risk elsewhere and where possible reduce flood risk overall.

4.4. Vulnerability of Use and Flood Risk Assessment

The proposed development is categorised as 'more vulnerable' (**Table 2**). The site is located in Flood Zone 3 (high probability flooding). It should be ensured that all types of flood risk are considered as part of the Flood Risk Assessment: *'A site-specific Flood Risk Assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall'.*

This FRA aims to demonstrate that the proposal will remain safe for its lifetime and will not increase flood risk elsewhere.

4.5. NPPF Flood Zones

Table 1 below shows the NPPF Flood Zones and the requirements and policy aims in terms of undertaking site-specific flood risk assessment.

Table 1 - NPPF Flood Zones and Requirements (NPPF Technical Guidance Table 1)

Zone 1: Low Probability Flood Zone	**This is defined as the land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).**
Appropriate uses	All uses of land are appropriate in this zone.
FRA requirements	For development proposals on sites comprising 1 ha or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a FRA.
Policy aims	Developers and local authorities should seek opportunities to reduce the overall level of flood risk through the layout and form of the development, and the appropriate application of sustainable drainage techniques.

ARUN DISTRICT COUNCIL EG/16/19/HH

Zone 2: Medium Probability Flood Zone	**This is defined as the land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1%) in any year.**
Appropriate uses	The water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure in Table 2 are appropriate in this zone. Highly vulnerable uses in Table 2 are only appropriate in this zone if the Exception Test is passed.
FRA requirements	All proposals in this zone should be accompanied by a FRA.
Policy aims	Developers and local authorities should seek opportunities to reduce the overall level of flood risk through the layout and form of the development, and the appropriate application of sustainable drainage techniques.
Zone 3a: High Probability Flood Zone	**This is defined as the land assessed as having a 1 in 100 or greater annual probability of river flooding (<1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.**
Appropriate uses	The water-compatible and less vulnerable uses of land in Table 2 are appropriate in this zone. The highly vulnerable uses (Table 2) should not be permitted in this zone. The more vulnerable and essential infrastructure uses in Table 2 should only be permitted in this zone if the Exception Test is passed.
FRA requirements	All proposals in this zone should be accompanied by a FRA.
Policy aims	Developers and local authorities should seek opportunities to:

	❖ reduce the overall level of flood risk through the layout and form of the development and the appropriate application of sustainable drainage techniques; ❖ relocate existing development to land with a lower probability of flooding; ❖ create space for flooding to occur by allocating and safeguarding open space for flood storage.
Zone 3b: Functional Floodplain	**This is the land where water has to flow or be stored in times of flood. This zone is generally defined as the land which would flood with an annual probability of 1 in 20 (5%AEP) or greater in any year. The Local Council may define the Functional Floodplain area with a different annual probability of event.**
Appropriate uses	Only the water-compatible uses and the essential infrastructure listed in Table 2 that has to be there should be permitted. It should be designed and constructed to: ❖ remain operational and safe for users in times of flood; ❖ result in no net loss of floodplain storage; ❖ not impede water flows; ❖ not increase flood risk elsewhere.
FRA requirements	All proposals in this zone should be accompanied by a FRA.
Policy aims	In this zone, developers and local authorities should seek opportunities to: ❖ reduce the overall level of flood risk through the layout and form of the development and the appropriate application of sustainable drainage techniques; ❖ relocate existing development to land with a lower probability of flooding.

Table 2 - Flood Risk Vulnerability Classification (NPPF Technical Guidance Table 2)

Essential Infrastructure	Essential transport infrastructure and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
Highly Vulnerable	❖ Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations and emergency dispersal points. ❖ Basement dwellings, caravans, mobile homes and park homes intended for permanent residential use. ❖ Installations requiring hazardous substances consent.
More Vulnerable	❖ Hospitals, residential institutions such as residential care homes, children's homes, ❖ Social services homes, prisons and hostels. ❖ Buildings used for: dwelling houses, student halls of residence, drinking establishments, nightclubs, hotels and sites used for holiday or short-let caravans and camping. ❖ Non–residential uses for health services, nurseries and education. ❖ Landfill and waste management facilities for hazardous waste.
Less Vulnerable	❖ Buildings used for shops, financial, professional and other services, restaurants and cafes, offices, industry, storage and distribution, 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). ❖ Water treatment plants and sewage treatment plants (if adequate pollution control measures are in place).

Water-compatible Development	❖ Flood control infrastructure, water transmission infrastructure and pumping stations. ❖ Sewage transmission infrastructure and pumping stations. ❖ Sand and gravel workings. ❖ Docks, marinas and wharves, navigation facilities. ❖ MOD 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. ❖ Essential sleeping or residential accommodation for staff required by uses in this category, subject to a warning and evacuation plan.

Table 3 - Flood Risk Vulnerability and Flood Zone 'compatibility'

Vulnerability Classification (Refer Table 2)		**Essential Infrastructure**	**Water Compatible**	**Highly Vulnerable**	**More Vulnerable**	**Less Vulnerable**
Flood Zones	Flood Zone 1	✓	✓	✓	✓	✓
	Flood Zone 2	✓	✓	Exception Test	✓	✓
	Flood Zone 3a	Exception Test	✓	✗	Exception Test	✓
	Flood Zone 3b	Exception Test	✓	✗	✗	✗

✓ Development is appropriate

✗ Development should not be permitted

5.0 Assessment of Flood Risk

5.1. History of Flooding

The Arun District Council's Strategic Flood Risk Assessment (SFRA, February 2008) has provided a brief summary of the historical flooding events within the borough. The SFRA reported flooding incidents in the area, however there were no records of flooding events at the site.

In addition, information on historic floods was obtained from the Environment Agency (**Appendix C**). The Environment Agency's historic flood records show that the site has been flooded by the Barnham Rife in 1974 and 1993. However, no further information was available on the extent of flooding.

Information on the past flooding event was also obtained from the landowner. They were not aware of any flooding issues at the site.

5.2. Risk of Fluvial Flooding

The site is located in close proximity to the Barnham Rife with the risk of fluvial flooding. The Environment Agency's Flood Map around the site is shown in **Appendix A Figure 3** which shows that the site lies within the Flood Zone 3 (high probability flooding). The Flood Zone 3 fluvial outline shows a 1 in 100 chance of flooding at a location in any one given year (i.e., a 1% annual probability of flooding).

The flood map also shows that the site is located in an area not benefiting from the flood defences. **Figure 4** shows the Environment Agency's flood risk map which indicates that the risk of flooding to the site is 'medium'.

5.3. Modelled Water Levels

Information on modelled water levels was obtained from the Environment Agency (**Appendix C**). The site-specific modelled flood levels at the proposed development site have been taken from the 2015 Aldingbourne Flood Risk Mapping study, completed by JBA Consulting. The modelled flood extent maps for a range of events are shown in **Appendix C**. The modelled flood extent map around the site shows that the site is located within the 1% AEP (1 in 100 year) and the 1% AEP (1 in 100 year) plus CC events.

Appendix C also contains a 2D model node location map near the site. The map shows that the nearest model node from the site is Node Ref 1.

Comparison of Modelled Water Levels and Site Levels

The modelled water levels (Node Ref 1) have been compared against the existing site levels (**Table 4**). **Table 4** below shows that the site is subject to flooding from the 1% AEP (1 in 100 year) and the 1% AEP (1 in 100 year) plus 45% Higher Central CC and 105% Upper End CC events with the maximum flood depths of 1.58m and 2.20m respectively. This implies that the flood hazard to the people and the property is high.

Table 4 – Comparison of modelled water levels against the site level

Events	Modelled levels, mAOD	Modelled flood depths, m
5% AEP (1 in 20 year)	-	-
1% AEP (1 in 100 year)	4.84	0.80
♯1% AEP (1 in 100 year) plus 45% CC	5.62	1.58
♯1% AEP (1 in 100 year) plus 105% CC	6.24	2.20
0.1 %AEP (1 in 1000 year)	6.07	2.03

♯45% Higher Central and 105% Upper End climate change allowances applicable for this site, see Chapter 5.10.

5.4. Risk of Tidal/ Flooding

The unnamed watercourse is not influenced by tidal waves at this location. The risk of tidal flooding is therefore low.

5.5. Risk of Flooding From Artificial Water Bodies

There were no known flood risks from any artificial water bodies near the site.

5.6. Risk of Groundwater Flooding

In recent years groundwater has been recognised as a significant source of flooding in the UK. According to the British Geological Survey, groundwater flooding occurs when the water table in permeable rocks rises to enter basements/cellars or comes up above the ground surface. Groundwater flooding is not necessarily linked directly

to a specific rainfall event and is generally of longer duration than other causes of flooding (possibly lasting for weeks or even months).

Evidence of historical groundwater flooding within the SFRA is very limited, however it is important to recognise that the risk of groundwater flooding is highly variable and heavily dependent upon local conditions at any particular time.

According to the information available from the landowner, there were no records of any groundwater flooding incidents around the site. Based on these evidences and information, it is reasonable to consider that the risk of groundwater flooding to the site is low.

5.7. Risk of Surface Water Flooding

The surface water flooding arises when the infiltration capacity of land or the drainage capacity of a local sewer network is exceeded and the excess rainwater flows overland. The severity of surface water flooding depends on several factors such as the degree of saturation of the soil before the event, the permeability of soils and geology, hill slope steepness and the intensity of land use.

Information on the risk of surface water flooding is held by the Environment Agency. The Environment Agency's Surface Water Flood Risk Maps are provided in **Appendix A Figure 5 and Figure 6** which indicate that the risk of surface water flooding to the site is 'low'.

5.8. Risk of flooding from Reservoirs

The Environment Agency's reservoir flood map in **Appendix A Figure 7** indicated that the proposal site is located outside of the maximum extent of flooding from reservoir. According to the Environment Agency, the reservoir flooding is extremely unlikely to happen and reservoirs in the UK have an extremely good safety record; indeed there has been no loss of life in the UK from reservoir flooding since 1925. The Environment Agency is the enforcement authority for the Reservoirs Act 1975 in England and Wales. All large reservoirs must be inspected and supervised by reservoir panel engineers on a regular basis. It is therefore assumed that these reservoirs are regularly inspected and essential safety work is carried out. These reservoirs therefore present a managed residual risk.

5.9. Flood Risk from Sewers

Sewer flooding is often caused by excess surface water entering the drainage network causing sewers to surcharge. The SFRA has provided very limited information on

sewer flooding within the area, however, there were no records of sewer flooding incidents at the site. It is important to note that previous sewer flood incidents or the lack thereof do not indicate the current or future risk to the site as upgrade work could have been carried out to alleviate any issues or conversely in areas that have not experienced sewer flooding incidents the local drainage infrastructure could deteriorate leading to future flooding.

According to the information obtained from the landowner, there were no records of sewer flooding incidents at the site in the past.

5.10. Impact of Climate Change

The Environment Agency released new climate change guidance for flood risk assessments on 19th February 2016 outlining the allowances for the impact of climate change on peak river flows, peak rainfall intensities, sea level rise, offshore wind speeds and extreme wave height. They are based on climate change projections and different scenarios of carbon dioxide (CO2) emissions to the atmosphere. There are different allowances for different epochs or periods of time over the next century.

The range of allowances in **Table 5** below is based on percentiles. A percentile is a measure used in statistics to describe the proportion of possible scenarios that fall below an allowance level. The 50th percentile is the point at which half of the possible scenarios for peak flows fall below it and half fall above it. The central allowance is based on the 50th percentile, higher central is based on the 70th percentile and the upper end is based on the 90th percentile.

Table 5 - Peak river flow allowances by river basin district (use 1961 to 1990 baseline)

River basin district	Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential ange anticipated for the '2080s' (2070 to 2115)
Northumbria	Upper end	20%	30%	50%
	Higher central	15%	20%	25%
	Central	10%	15%	20%
Humber	Upper end	20%	30%	50%
	Higher central	15%	20%	30%
	Central	10%	15%	20%

Anglian	Upper end	25%	35%	65%
	Higher central	15%	20%	35%
	Central	10%	15%	25%
South East	Upper end	25%	50%	105%
	Higher central	15%	30%	45%
	Central	10%	20%	35%
Thames	Upper end	25%	35%	70%
	Higher central	15%	25%	35%
	Central	10%	15%	25%
South West	Upper end	25%	40%	85%
	Higher central	20%	30%	40%
	Central	10%	20%	30%
Severn	Upper end	25%	40%	70%
	Higher central	15%	25%	35%
	Central	10%	20%	25%
Dee	Upper end	20%	30%	45%
	Higher central	15%	20%	25%
	Central	10%	15%	20%
North West	Upper end	20%	35%	70%
	Higher central	20%	30%	35%
	Central	15%	25%	30%
Solway	Upper end	20%	30%	60%
	Higher central	15%	25%	30%
	Central	10%	20%	25%

Tweed	Upper end	20%	25%	45%
	Higher central	15%	20%	25%
	Central	10%	15%	20%

Using peak river flow allowances for flood risk assessments

The guideline suggests to consider the flood zone and the appropriate flood risk vulnerability classification to decide which allowances applies to the development or plan.

In flood zone 2

Essential infrastructure – use the higher central and upper end to assess a range of allowances

Highly vulnerable – use the higher central and upper end to assess a range of allowances

More vulnerable – use the central and higher central to assess a range of allowances

Less vulnerable – use the central allowance

Water compatible – use none of the allowances

In flood zone 3a

Essential infrastructure – use the upper end allowance

Highly vulnerable – development should not be permitted

More vulnerable – use the higher central and upper end to assess a range of allowances

Less vulnerable – use the central and higher central to assess a range of allowances

Water compatible – use the central allowance

In flood zone 3b

Essential infrastructure – use the upper end allowance

Highly vulnerable – development should not be permitted

More vulnerable – development should not be permitted

Less vulnerable – development should not be permitted

Water compatible – use the central allowance

Assessment of Climate Change Impact for the Site

The site is located within the South East River Basin District. As the proposed development is categorised as 'more vulnerable' and the site is located in Flood Zone 3 (high probability flooding), the guideline recommends to use the Higher Central and Upper End allowances for assessing the impact of climate change. The Higher Central and Upper End allowances for the South East River Basin District are 45% & 105% respectively for the period between 2070 and 2115. These allowances have been used for assessing the impact of climate change to the flood risk to the site.

6.0 Mitigation Measures

6.1. Recommended Finished Floor Level

The Environment Agency has issued a guidance (Ver 3.1, April 2012) on 'Householder and other minor extensions in Flood Zones 2 and 3' (**Appendix D**). This guidance is for domestic extensions and non-domestic extensions where the additional footprint created by the development does not exceed 250m^2. The additional footprint created by the development is less than 250m^2. As such, there are two options available for flood mitigation from which the applicant needs to choose one option as shown in **Table 6** below.

Table 6 – Flood Mitigation Measures for Minor Extensions in Flood Zone 2 and 3

Applicant to choose one or other of the flood mitigation measures below	**Applicant to provide the LPA with the supporting Information detailed below as part of their FRA**	**Applicant to indicate their choice in the box below. Enter 'yes' or 'no'**
Either ; Floor levels within the proposed development will be set no lower than existing levels AND, flood proofing of the proposed development has been incorporated where appropriate.	Details of any flood proofing / resilience and resistance techniques, to be included in accordance with `*Improving the flood performance of new buildings*' CLG (2007)	**Yes**
Or; Floor levels within the extension will be set 300mm above the known or modelled 1 in 100 annual probability river flood (1%) or 1 in 200 annual probability sea flood (0.5%) in any year. This flood level is the extent of the Flood Zones	This must be demonstrated by a plan that shows finished floor levels relative to the known or modelled flood level. All levels should be stated in relation to Ordnance Datum[1]	

For the proposed development, the first option has been chosen for flood mitigation. According to this option, the floor level of the proposed extension will be set no lower than the existing level of the property, and flood proofing of the proposed development will be incorporated where appropriate.

It is recommended that flood resilient measures are used in the development as far as practicable to manage the residual risk, reduce the damage and clean up time following a flood. The flood resilient measures have been briefly discussed below.

6.2. Flood Resilient Measures

The following flood resilient measures will be adopted to minimise the damage and to enable quick recovery and clean up after the flooding event:

- Water, electricity and gas meters will be located above predicted flood level.
- Non-return valves will be used in the drainage system to prevent back-flow of diluted sewage in situations where there is an identified risk of the foul sewer surcharging.
- All service entries will be sealed (e.g. with expanding foam or similar closed cell material).
- Closed cell insulation will be used for pipes which are below the predicted flood level.
- Boiler units and ancillary devices will be installed above predicted flood level and preferably on the first floor of two-storey properties.
- Wiring for telephone, TV, Internet and other services will be protected by suitable insulation to minimise damage.

6.3. Flood Warning and Evacuation

As the site is located within a flood zone area, it will be necessary to make sure that the occupants are fully aware of the flood risk and flood warning and evacuation during an extreme event.

6.3.1. Flood Warnings Direct

The occupants are advised to utilise the Environment Agency's Flood Warnings Direct which is a free flood warning service called Floodline Warnings Direct (FWD). This service generally gives an advance notice of when flooding is likely to happen and time to prepare for a flood event. Property owners on the proposed development site will be able to sign up to FWD online using the following contact details (**Table 7**):

Table 7- Contacts for flood warning services

Methods	Remarks
Online	https://fwd.environment-agency.gov.uk/app/olr/register
Telephone	0345 988 1188

6.3.2. Flood Warning Service

The Flood Warning Service is provided by the Environment Agency across England and Wales in areas at risk of flooding from rivers or the sea. This is provided using up to date rainfall, river level and sea condition monitoring 24 hours a day to forecast the possibility of flooding. If flooding is forecast, the Environment Agency will issue warnings using a set of three different warning types **(Table 8).** Many areas of England are covered by the full four stages of the Environment Agency's Flood Warning Service. The site is located in an area covered by the Flood Alert Services **(Appendix A Figure 8).** The Environment Agency's Flood Warning target lead time; the time between a flood warning being issued and the onset of flooding is approximately two hours. Providing the Environment Agency can meet their target Flood Warning lead time, the residents of the proposed development will have two hours to ensure that property is relocated to minimise risk and evacuation to safe locations can be carried out.

Table 8 - Environment Agency's Flood Warning Codes

Flood Warning Code	Meaning	Actions to be taken
	Flooding is possible. Be prepared.	• Be prepared to act on your flood plan. • Prepare a flood kit of essential items. • Monitor local water levels and the flood forecast on our website.

	Flooding is expected. Immediate action required.	• Move family, pets and valuables to a safe place. • Turn off gas, electricity and water supplies if safe to do so. • Put flood protection equipment in place.
	Severe flooding. Danger to life.	• Stay in a safe place with a means of escape. • Be ready should you need to evacuate from your home. • Co-operate with the emergency services. • Call 999 if you are in immediate danger.
Warnings no longer in force	No further flooding is currently expected in your area.	• Be careful. Flood water may still be around for several days. • If you've been flooded, ring your insurance company as soon as possible.

6.4. Surface Water Runoff (SuDS)

The surface runoff from the site will be improved by implementing appropriate SuDS. The requirements for SuDS will ensure that any redevelopment or new development does not negatively contribute to the surface water flood risk of other properties and instead provides a positive benefit to the level of risk in the area. It will also ensure that appropriate measures are taken to increase the flood resilience of new properties and developments in surface water flood risk areas, such as those identified as being locally important flood risk areas.

The SuDS hierarchy and management train has been discussed in the SuDS Manual (C753) which aims to mimic the natural catchment processes as closely as possible. The general hierarchy of the SuDS measures is provided in **Table 9** below.

Table 9 General Hierarchy of SuDS Measures

Measures	Definition/Description
Prevention	The use of good site design and housekeeping measures to prevent runoff and pollution (e.g. rainwater harvesting/reuse).
Source control	Control of runoff at or very near its source (e.g. soakaways, porous and pervious surfaces, green roofs).
Site control	Management of water in a local area on site (e.g. routing water to large soakaways, infiltration or detention basins)
Regional control	Management of runoff from a site or several sites (e.g. balancing ponds, wetlands).

Table 10 below presents the feasibility assessment of the SuDS measures for the site.

Table 10 General Assessment of SuDS measures for the site

SuDS Measures	Issues/Description	Feasibility for the site
Prevention Good site design and housekeeping/rainwater harvesting/infiltration devices/education.	Surface runoff can be improved by implementing rainwater harvesting using water butt.	Yes
Source Control Porous and pervious materials/soakaways/green roof/infiltration trenches/disconnect downpipes to drain to lawns or infiltrate to soakaway.	Presence of Clay and fine soil means the infiltration measures may not be appropriate.	No
Site and Regional Control Infiltration/detention basins/ balancing ponds/ wetlands/underground storage/swales/retention ponds.	Balancing pond/storage will not be feasible due to limited space available.	No

Based on the general assessment of the potential SuDS measures above, it is proposed that a rainwater harvesting (water butt) will be implemented in order to

improve the surface runoff from the site. The location of the water butt can be changed in order to suit the location condition.

7.0 Assessment of Impact on flow of floodwater

The proposed development consists of erection of a small extension to the residential dwelling. This means the amount of displaced floodwater due to the increase in building footprint is not significant. The development will not give rise to backwater affects or divert water towards other properties.

8.0 Conclusion

The proposal consists of erection of an extension to the residential dwelling located at 49 Warren Way, Barnham, Bognor Regis, West Sussex PO22 0JX.

The proposed development is categorised as ‘more vulnerable’.

The nearest main river from the site is the Barnham Rife with the risk of fluvial flooding.

According to the information available from the SFRA and the Environment Agency, there were some flooding events in the area. The Environment Agency’s historic flood records show that the site has been flooded by the Barnham Rife in 1974 and 1993. However, no further information was available on the extent of flooding.

The Environment Agency’s Flood Maps show that the site lies within the Flood Zone 3 (high probability flooding). The Environment Agency’s flood risk map indicates that the risk of flooding to the site is 'medium'.

The flood maps also show that site is located in an area not benefiting from the flood defences.

The Environment Agency’s modelling data indicated that the site is subject to flooding from the 1% AEP (1 in 100 year) and the 1% AEP (1 in 100 year) plus 45% Higher Central CC and 105% Upper End CC events with the maximum flood depths of 1.58m and 2.20m respectively. This implies that the flood hazard to the people and the property is high.

The overall risk of surface water flooding to the site is 'low'.

The flood risk from other sources including underground water, sewer and reservoir is low.

ARUN DISTRICT COUNCIL EG/16/19/HH

In order to provide a level of protection against flooding, the floor level of the proposed extension will be set no lower than the existing level of the property, and flood proofing of the proposed development will be incorporated where appropriate.

In order to minimise the damage and to enable quick recovery and clean up after the flooding event, it is proposed that flood resilient measures will be implemented.

As the site is located within a flood zone area, it will be necessary to make sure that the residents are fully aware of the flood risk and flood warning and evacuation during an extreme event.

The residents are advised to utilise the Environment Agency's Flood Warning Service available in the area.

The surface runoff will be improved by implementing appropriate SuDS measures. A rainwater harvesting (water butt) will be implemented to improve the surface runoff.

The development will not give rise to backwater affects or divert water towards other properties.

This report demonstrates that the proposal will be safe, in terms of flood risk, for its design life and will not increase the flood risk elsewhere.

ARUN DISTRICT COUNCIL EG/16/19/HH

Appendix A Collection of Figures

Appendix B Existing Site and Proposed Plans

UK Flood Risk
Flood Risk Consultants

Appendix C Environment Agency's Data and Information

UK Flood Risk
Flood Risk Consultants

Appendix D Environment Agency's Guidance on Householders and Minor Extensions