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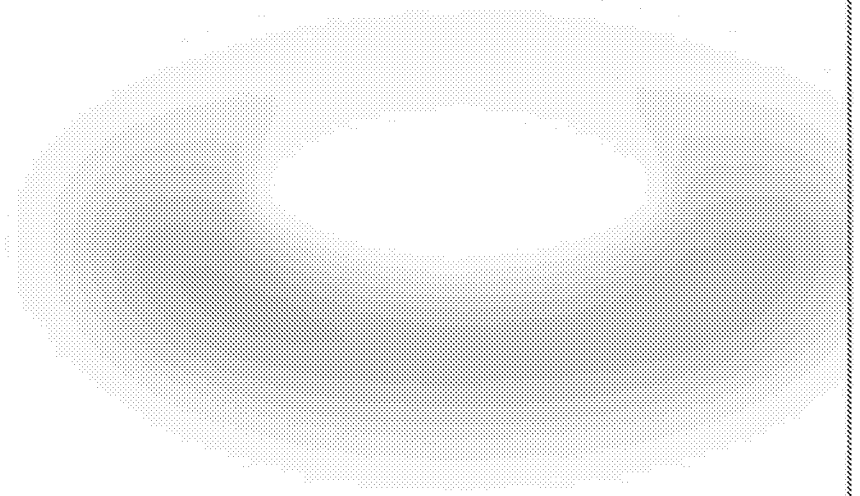
Project: Phase 1 Flood Risk Assessment (FRA)

Prepared for: Caldotec Ltd

Reference: 3070

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Site Location: 85 South Terrace, Littlehampton, West Sussex, BN17 5LJ

Proposed Development: It is understood that the development is for the demolition of the existing single storey rear extension and the construction of a new 1.5 storey extension.

Consultant		Date	Signature
Author	Oliver Harvey	27/03/2017	
Document Check	Thea Powell	28/03/2017	
Authorisation	Daniel Cook	29/03/2017	

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Contact Us:

Ambiental Technical Solutions Ltd
Science Park Square
Brighton, BN1 9SB
www.ambiental.co.uk

UK Office: + 44 (0) 203 857 8540 or + 44 (0) 203 857 8530

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1. Summary

- 1.1 Ambiental Technical Solutions Limited has been appointed by Caldotec Ltd to undertake a National Planning Policy Framework (NPPF) compliant Flood Risk Assessment (FRA) a development at 85 South Terrace, Littlehampton, West Sussex, BN17 5LJ.
- 1.2 The proposed development is for the demolition of the existing rear single storey extension and the construction of a larger 1.5 storey rear extension.
- 1.3 With reference to the NPPF and the Environment Agency (EA) standing advice on development and flood risk, as well as the low detail, national-scale flood mapping created on behalf of the EA, the proposed site is located within Flood Zone 3 (High Risk; having a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) and is considered to be a “More” Vulnerable development, under the NPPF.
- 1.4 Topographic levels across site vary between approximately 2.01mAOD and 2.41mAOD (Source: LiDAR). Comparison of the topographic site levels with modelled flood levels confirms the site partially resides within the extreme tidal flood extent for the present day 1:200 year event (2.37mAOD) and the 1:1000 year flood event (2.50mAOD). Possible maximum flood depth, based on the minimum topographic level on site (2.01mAOD), for the present day 1:200 year and 1:1000 year flood events has been shown to be 0.36m and 0.49m, respectively.
- 1.5 Comparison of the topographic site levels with modelled flood levels confirms the site fully resides within the 1:200 year flood event for the 2070 (3.00mAOD) and 2115 epoch (4.01mAOD). Possible maximum flood depths, based on the minimum topography on site, has been shown to be 0.99m and 1.99m, respectively.
- 1.6 The EA have provided information regarding the flood defences in the area. The EA have stated that the western side of the site is currently protected by a steel sheet pile wall with concrete cap and promenade with Designed Standard of Protection of 1:300. The flood defence wall is in fair condition with a downstream crest level of 4.76mOAD and an upstream crest level of 4.80mAOD.
- 1.7 As such, and given that:
 - a) the proposed development is for the extension of the existing use and is classified as a minor development;
 - b) the site lies within an existing developed area;
 - c) betterment can be provided by the formalisation of a flood warning and evacuation plan.

Following the guidelines contained within the NPPF, the proposed development is considered **to be suitable** assuming appropriate mitigation (including adequate warning procedures) can be maintained for the temporary lifetime of the development.

Development Description	Existing	Proposed
Development Type:	Residential	Demolition of existing rear extension and construction of a new 1.5 storey rear extension; extension of existing use.
(Number of Bedrooms):	10	10
EA Vulnerability Classification:	More Vulnerable	No Change
Ground Floor Level:	Topography ranges between approximately 2.01mAOD and 2.41mAOD (2m LiDAR)	Ground floor levels set no lower than existing ground floor levels
Level of Sleeping Accommodation:	Lower Ground Floor	No Change
Impermeable Surface Area:	N/A ¹	Small increase in impermeable surfaces, minor extension
Surface Water Drainage:	N/A ¹	Increase in built footprint, minor extension.
Site Size:	N/A ¹	No Change
Risk to Development	Summary	Comment
EA Flood Zone:	3	
Flood Source:	Tidal	River Arun/English Channel
1:200 year Flood Level (0.5%)	2.37mAOD	
1:200 + CC year Flood Level (2070Epoch)	3.00mAOD	River Arun to East Head model, completed in 2016 (Node 1)
1:200 + CC year Flood Level (2115 Epoch)	4.01mAOD	
Recorded Flood Events in Area:	Yes	
Recorded Flood Events at Site:	No	
SFRA Available:	Yes	Arun District SFRA (August 2016 Update)
Management Measures	Summary	Comment
Ground floor level above extreme flood levels:	N/A ¹	
Safe Access/Egress Route:	Yes	Safe egress can be provided via evacuation or via internal stairwells to upper floors
Flood Resilient Design:	Yes	
Site Drainage Plan:	N/A ¹	Increase in built footprint, minor extension
Flood Warning & Evacuation Plan:	Yes	EA Flood Warning Service
Offsite Impacts	Summary	Comment
Displacement of floodwater:	N/A ¹	Site lies in area of tidal flood risk
Increase in surface run-off generation:	N/A ²	Increase in built footprint, minor extension.
Impact on hydraulic performance of channels:	None	

Table 1: Summary of flood risks, impacts and proposed flood mitigation measures.

N/A¹ not required for this assessment; N/A² data not available.

2. Development Description and Site Area

Proposed Development and Location

- 2.1 The site is located at 85 South Terrace, Littlehampton, West Sussex, BN17 5LJ (Figure 1 and 2).
- 2.2 The existing site consists of a residential flats and associated hardstanding. It is understood that the proposed development is for the demolition of the existing rear single storey extension and the construction of a larger, 1.5 storey rear extension.
- 2.3 The nearest watercourse to the site is the River Arun, located approximately 130m to the west of the site. The River Arun has been classified as an EA main river. The site is also located approximately 300m north of the Mean High Water line of the English Channel.
- 2.4 Analysis of topographic levels (source: topographic survey) show the site to be relatively flat, with topographic levels varying between 2.01mAOD and 2.41mAOD.

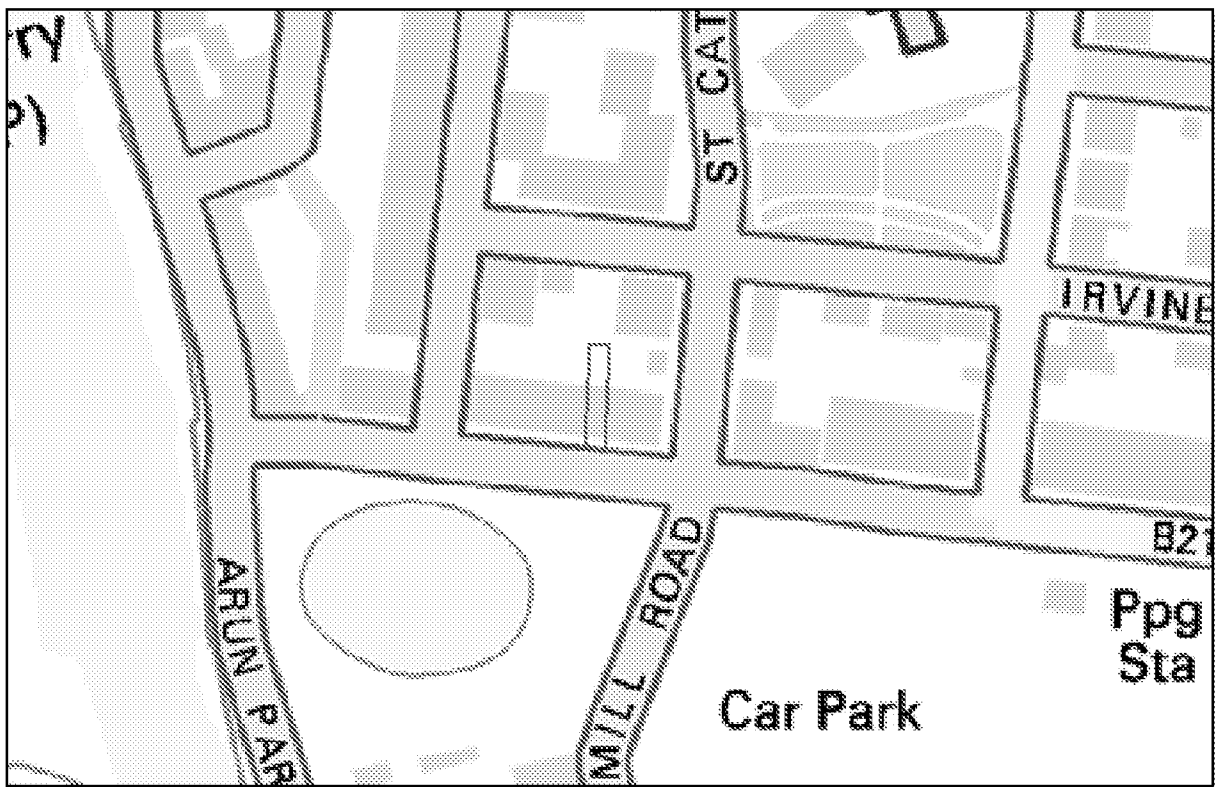


Figure 1: Wider Site Location Map (Source: OS)



Figure 2: Site location (Source: Google Earth).

Vulnerability Classification

- 2.4 According to the NPPF and the Environment Agency (EA) standing advice on development and flood risk, as well as the low detail, national-scale flood mapping created on behalf of the EA the site is located in Flood Zone 3 (High Risk; 1 in 200 or greater annual probability of flooding from the sea ($>0.5\%$)).
- 2.5 Under the NPPF guidance, the existing and proposed developments are classified as “More Vulnerable”.

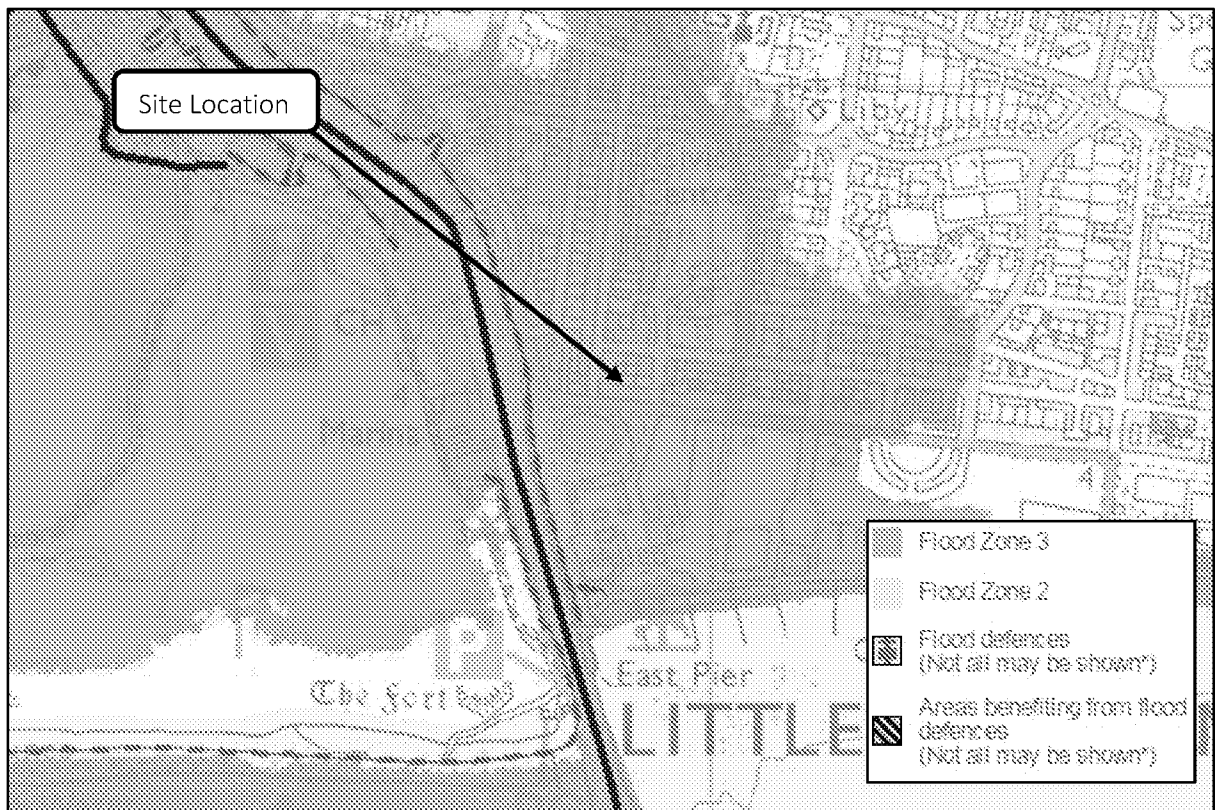


Figure 3: EA Flood Zone Map (Source: EA Online).

Geology

- 2.6 According to the British Geological Survey (BGS) the bedrock of the site is of the Lewes Nodular Chalk Formation, Newhaven Chalk Formation and Culver Chalk Forma. The superficial geology of the site is classified as Raised Beach Deposits formed of sand and gravel.

3. Sequential Test/Exception Test

- 3.1 Under the NPPF, all new planning applications must undergo a *Sequential Test*. This test must be implemented by local planning authorities with a view to locating particularly vulnerable new developments (e.g. residential, hospitals, mobile homes etc.) outside of the floodplain. The test refers to the EA Flood Zones described in Table 5. For reference, the NPPF *Sequential Test: Flood Risk Vulnerability and Flood Zone 'Compatibility' Table* is reproduced below.
- 3.2 The development is for the demolition of the existing rear single storey extension and the construction of a larger 1.5 storey rear extension. The existing and proposed development will be classified as “More Vulnerable”.

	Flood Risk Vulnerability Classification	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test Required	✓	✓
	Zone 3a	Exception Test Required	✓	✗	Exception Test Required	✓
	Zone 3b Functional Floodplain	Exception Test Required	✓	✗	✗	✗

Table 2: The Sequential Test: Flood Risk Vulnerability and Flood Zone 'Compatibility' Table as specified by NPPF. Shaded cells denote the proposed re-development. Please note: ✓ means development is appropriate; ✗ means the development should not be permitted.

- 3.3 Using the principles of the Sequential Test outlined above, the proposed development is 'More Vulnerable' and located within Flood Zone 3 (as defined by the EA online Flood Map, Figure 3) and as such, the development is required to implement the Exception Test.

For the Exception Test to be passed, the proposed development must meet the following criteria:

- it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh the flood risk, as informed by a Strategic Flood Risk Assessment;
- a Flood Risk Assessment demonstrates that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

(Source: the NPPF)

- 3.4 The Sequential Test does not need to be applied for individual developments on sites which have been allocated in development plans through the Sequential Test, or for applications for **minor development** or change of use.
- 3.5 As such, and in order to address these requirements, the planning application submitted by the applicant is required to be accompanied by a FRA which shows that the development can be achieved in a sustainable manner, with an overall reduction of flood risk to the site and surrounding area.

4. Site Flood Hazards

Sources of Flooding

- 4.1 As outlined in Figure 3, the proposed development is located within Flood Zone 3 (High Risk of flooding), and is considered to be “More Vulnerable” under the NPPF. Communication with the Environment Agency (EA) has identified the following potential sources of flooding to the site:

Source	Description
Fluvial	N/A
Tidal	River Arun/English Channel
Surface	On Site
Groundwater	In Area
Sewer	N/A

Table 3: Summary of flood sources.

Mechanisms and History of Flooding

- 4.2 According to the low detail, national-scale flood mapping created on behalf of the EA the proposed development is located within Flood Zone 3 of the tidal flood plains of the River Arun and the English Channel.
- 4.3 Figure 3 outlines only the potential floodplain; and the mitigating effects of flood defences currently in place are not considered. The site benefits from flood defences and the EA have stated that the western side of the site is currently protected by a steel sheet pile wall with concrete cap and promenade with Designed Standard of Protection of 1:300. The flood defence wall is in fair condition with a downstream crest level of 4.76mOAD and an upstream crest level of 4.80mAOD.

Tidal

- 4.4 The EA Flood Map for Planning (Figure 3) confirms that the site lies within Flood Zone 3 (High Risk), having a 1 in 200 or greater annual probability of flooding from the sea (>0.5%).
- 4.5 The nearest watercourse to the site is the River Arun, located approximately 130m to the west of the site. The River Arun has been classified as an EA main river. The site is also located approximately 300m north of the Mean High Water line of the English Channel.

- 4.6 Figure 4 demonstrates the node points for flood plain modelled flood levels from the River Arun to East Head model, completed in 2016. The flood plain nodes provided have modelled flood level for annual exceedance probabilities (AEP). The AEP and flood levels are demonstrated in Table 4 below.
- 4.7 The analysis focuses on the defended 1:200 year (0.5%AEP), 1:200 year (0.5%AEP) 2070 and 2115 epoch, 1:1000 year (0.1%AEP) flood levels. The EA has also provided data for the 1:20 year (5%AEP), however these have not been included in the final analysis as no flood depths were found at any node. Based on the EA data nodes the worst case scenario, highest flood level, has been used in the analysis.

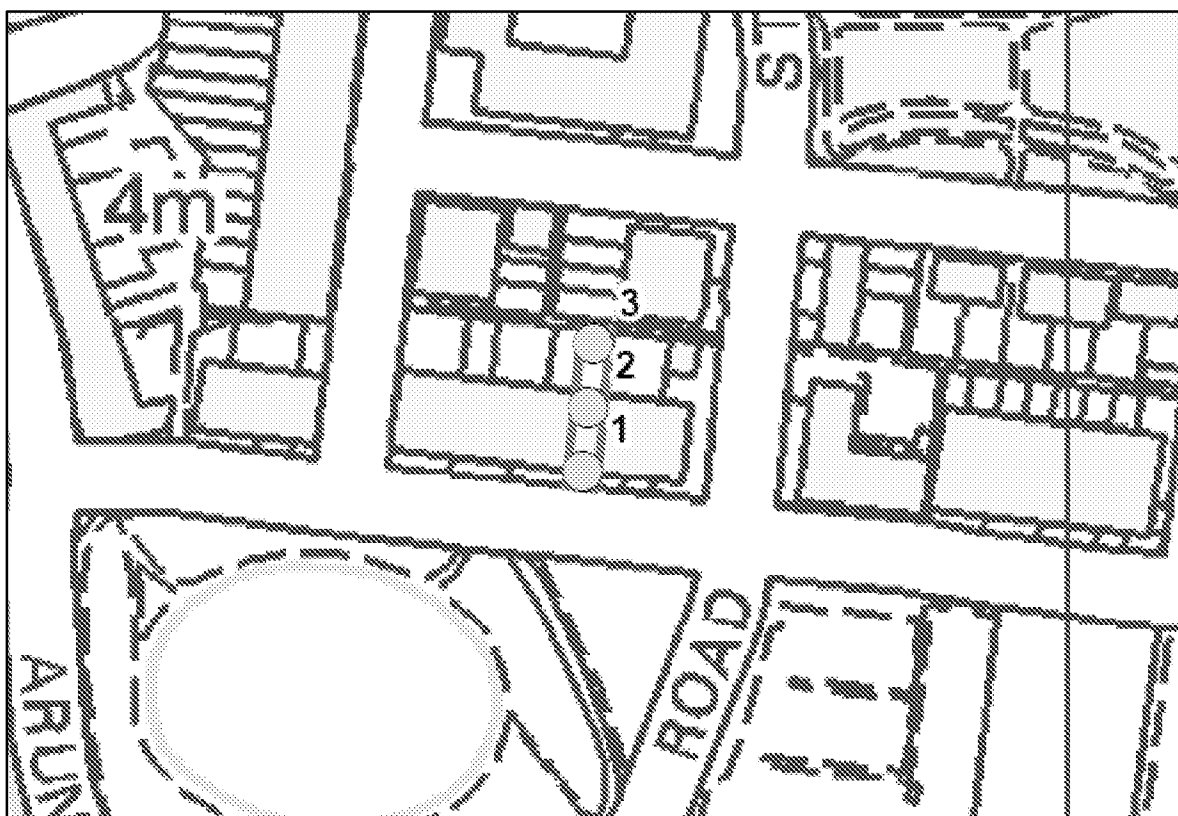


Figure 4: Node Location Map (Source: EA)

Modelled Flood Level for Annual Exceedance Probability (mAOD)					
Defended					
Node	5% AEP (1:20yr)	0.5% AEP (1:200yr)	0.5% AEP (2070)	0.5% AEP (2115)	0.1% AEP (1:1000yr)
1	-	2.37	3.00	4.01	2.50
2	-	2.16	3.00	4.01	2.45
3	-	-	3.00	4.01	2.44

Table 4: Modelled Flood Plain Flood Levels (Source: EA).

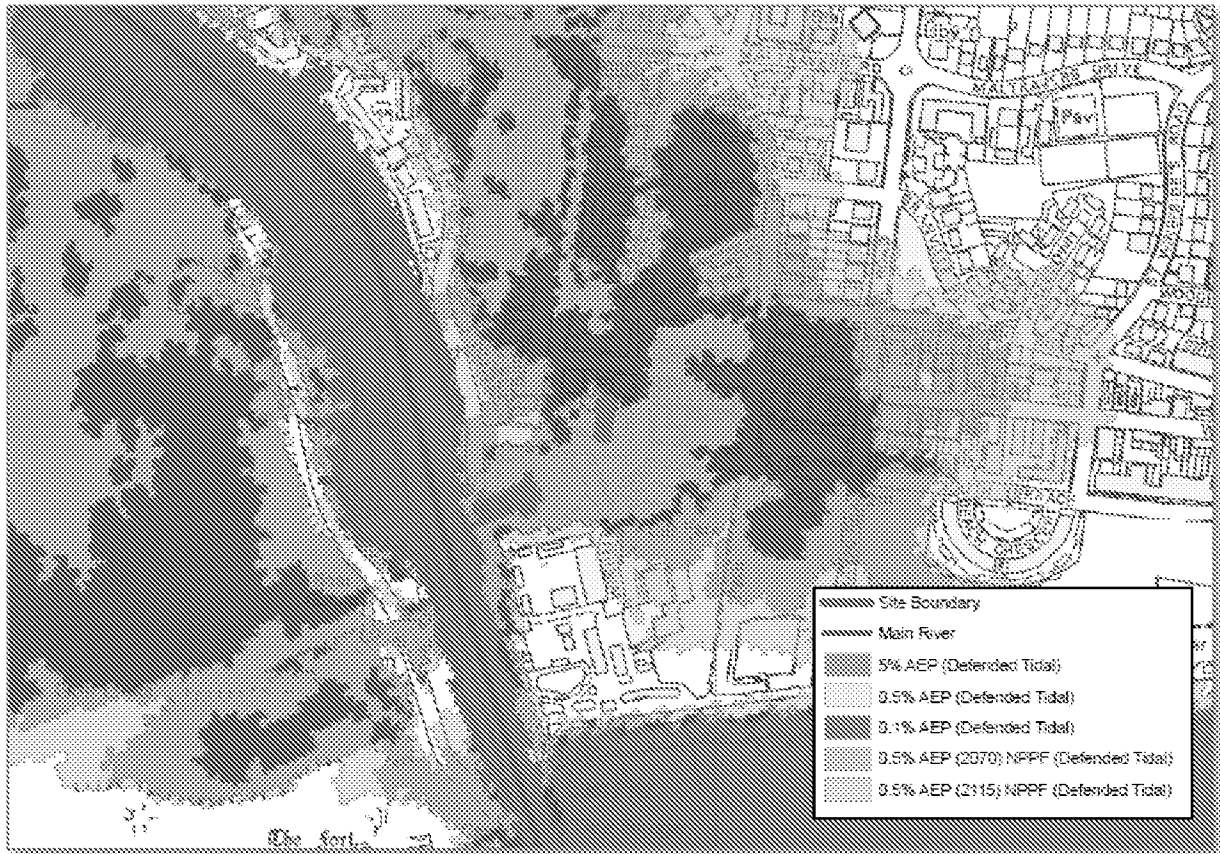


Figure 5: Modelled Flood Extents (Source: EA)

- 4.8 The data provided shows a flood level for the present day 1:200 year flood event, worst case (Node 1) of 2.37mAOD, and a flood level of 2.50mAOD (Node 1) for the 1:1000 year flood event.
- 4.9 The data provided by the EA has also given a climate change flood level for the 2070 and 2115 epoch 1:200 year flood event which is estimated to be 3.00mAOD (Node 1, 2 and 3) for the 2070 epoch and 4.01mAOD (Node 1, 2 and 3) for the 2115 epoch.
- 4.10 Topographic levels across site vary between approximately 2.01mAOD and 2.41mAOD (Source: LiDAR). Comparison of the topographic site levels with modelled flood levels confirms the site partially resides within the extreme tidal flood extent for the present day 1:200 year event (2.37mAOD) and the 1:1000 year flood event (2.50mAOD).
- 4.11 Possible maximum flood depth, based on the minimum topographic level on site (2.01mAOD), for the present day 1:200 year and 1:1000 year flood events has been shown to be 0.36m and 0.49m, respectively.
- 4.12 Comparison of the topographic site levels with modelled flood levels confirms the site fully resides within the 1:200 year flood event for the 2070 (3.00mAOD) and 2115 epoch (4.01mAOD). Possible maximum flood depths, based on the minimum topography on site, has been shown to be 0.99m and 1.99m, respectively.

- 4.13 The Arun District Council SFRA (August 2016 Update) has shown that the site does benefit from the presence of defences in the form of a privately owned wall. The estimated design standard for the area is 1:75 for the defences along the River Arun and 1:200 along the beach to the south.
- 4.14 The EA have further provided information regarding the flood defences in the area. The EA have stated that the western side of the site is currently protected by a steel sheet pile wall with concrete cap and promenade with Designed Standard of Protection of 1:300. The flood defence wall is in fair condition with a downstream crest level of 4.76mOAD and an upstream crest level of 4.80mAOD.
- 4.15 The scheme to strengthen the defences in the area is stated in the Beachy Head to Selsey Bill Shoreline Management Plan (2006), the management policy for Angmering-on-Sea to Littlehampton (Policy Unit: 4d18) is "Hold the Line" - maintain or upgrade the level of protection provided by defences. The management policy will continue to apply at present day and across the medium (2025 to 2055) to long term (2105). It can therefore be assumed the improvements in defences will be maintained and upgraded in the future.
- 4.16 The EA have provided details of historic flood incidents in the area of the site. Preceding 1985 flooding of properties, roads and industrial areas have been recorded in the vicinity of the site, caused by overtopping mainly through the harbour masters yard where water gates were reported to be left open. Between 40 and 100 houses were affected by this incident. However, flood defences have been improved in the area which has subsequently reduced the risk of flooding in the vicinity of the site.
- 4.17 It is important to note that tidal flooding is generally caused by low pressure weather systems creating storm-surges (or storm tides), chiefly via high speed winds. These winds (and to a certain extent, the low pressure) create a 'bulge' of water which, if it coincides with high tide, can generate very high, stormy, water levels. However, because this mechanism is well understood, it is very likely that an early warning will be issued before such an event strikes. As such, it is very unlikely that the site would be subject to tidal flooding without several hours of early warning.
- 4.18 As such the risk of flooding is considered to be **moderate**.

Surface Water (Pluvial)

- 4.19 The EA's Risk of Flooding from Surface Water map shows the site to be primarily within an area of 'Very Low' and 'Low' risk of flooding from surface water (Figure 6), with a less than 0.1% chance of flooding from this source annually in areas of 'Very Low' risk and between 0.1% and 1% chance of flooding in areas of 'Low' risk.
- 4.20 There is a small area at the rear of the existing property identified to be at 'Medium' risk of surface water flooding. Areas of 'Medium' risk have between 1 in 100 (1%) and 1 in 30 (3.3%) chance of surface water flooding annually.
- 4.21 The EA Surface Water Depth Map – High Chance of Occurring shows that the site and surrounding area would not be affected by any flood depths during this flood event (Figure 7).

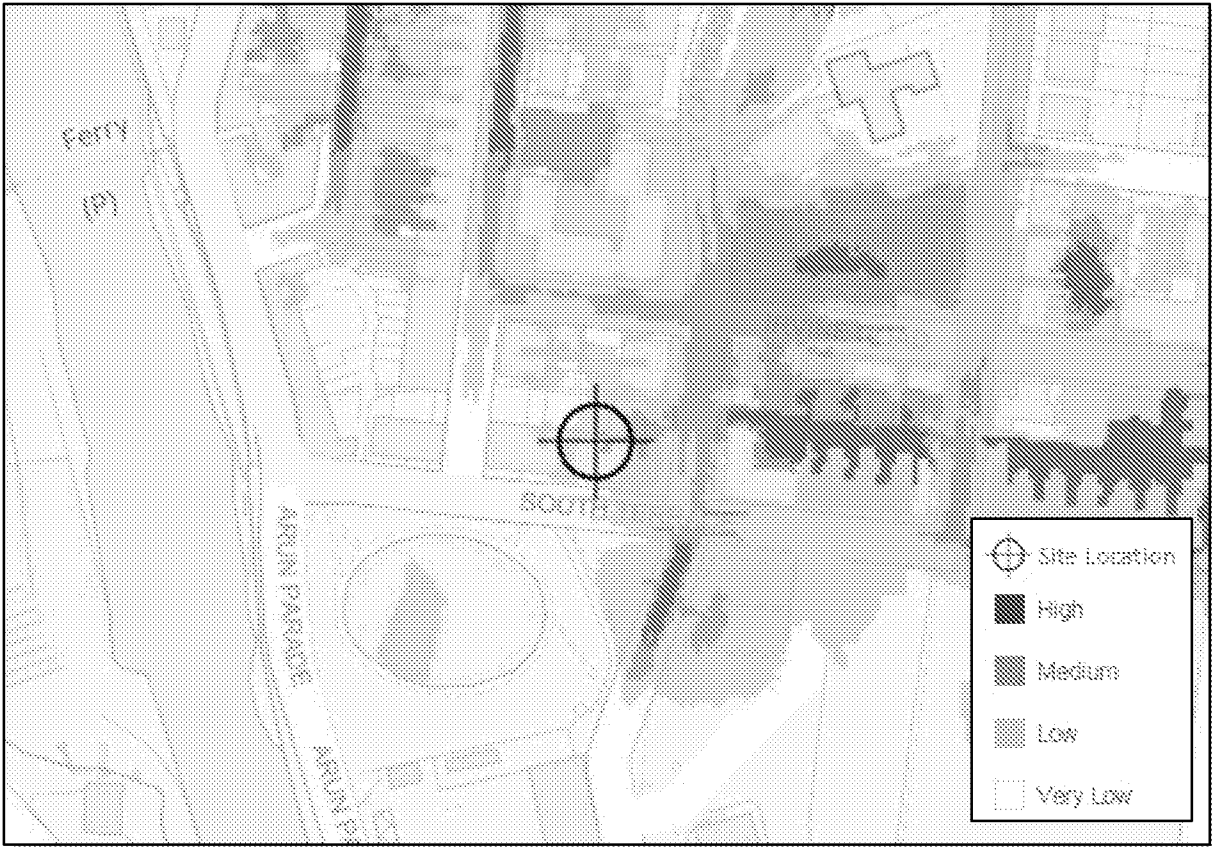


Figure 6: EA Surface Flood Risk Map (Source: EA Online)

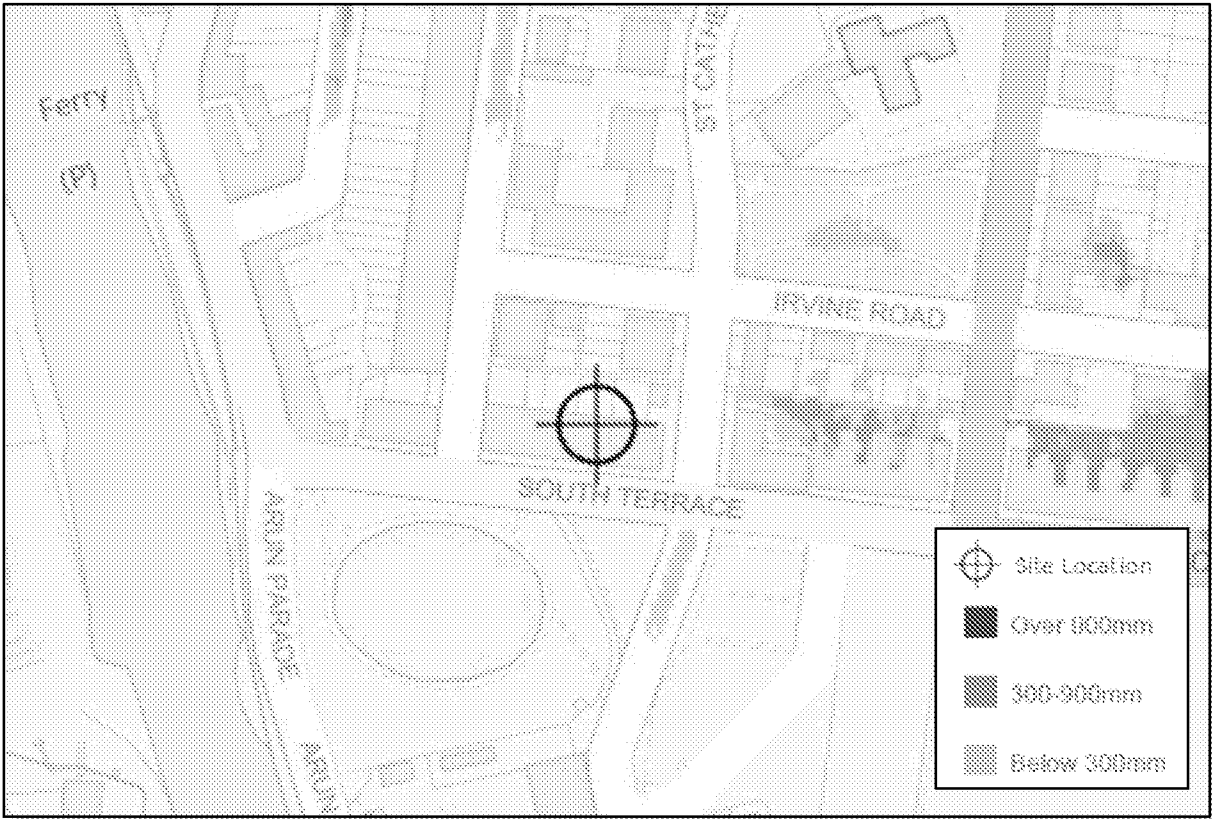


Figure 7: Surface Water Depth --- High Chance of Occurring (Source: EA Online).

- 4.22 A number of surface water flooding incidents have also been recorded in close proximity to the site along St Catherine's Road and on the junction of Irvine Road and Beach Road. No further information has been provided regarding these incidents, however the SFRA states that the primary source of surface water flooding was attributed to heavy rainfall overloading highway carriageways and paved areas, drains and gullies, as well as blockages and high water levels impeding free discharge from surface water drains and gullies.
- 4.23 As such the risk of flooding to the site from surface water is deemed to be **relatively low**.

Groundwater

- 4.24 The EA has shown the site to not be located within a groundwater source protection zone. The EA has however identified the site to be located over a major aquifer with high vulnerability.
- 4.25 The Arun District Council SFRA (August 2016 Update) Area Susceptible to Groundwater (Appendix A) shows the site to be located in an area susceptible to groundwater flooding classified as $\geq 75\%$.
- 4.26 The Arun District Council Strategic Flood Risk Assessment (2016 Update) has no records of historical groundwater flooding in the area have been found.
- 4.27 As such, the risk of flooding from this source can be considered to be **moderate**.

Sewer

- 4.28 The Arun District Council SFRA (2016 Update) Historic Incidents of Flooding from Sewers Map (Figure 8 below, and Appendix A, Figure 4) shows the area surrounding the site has had six recorded historic sewer flooding incidents. However, there have been no recorded historic sewer flood events on site.

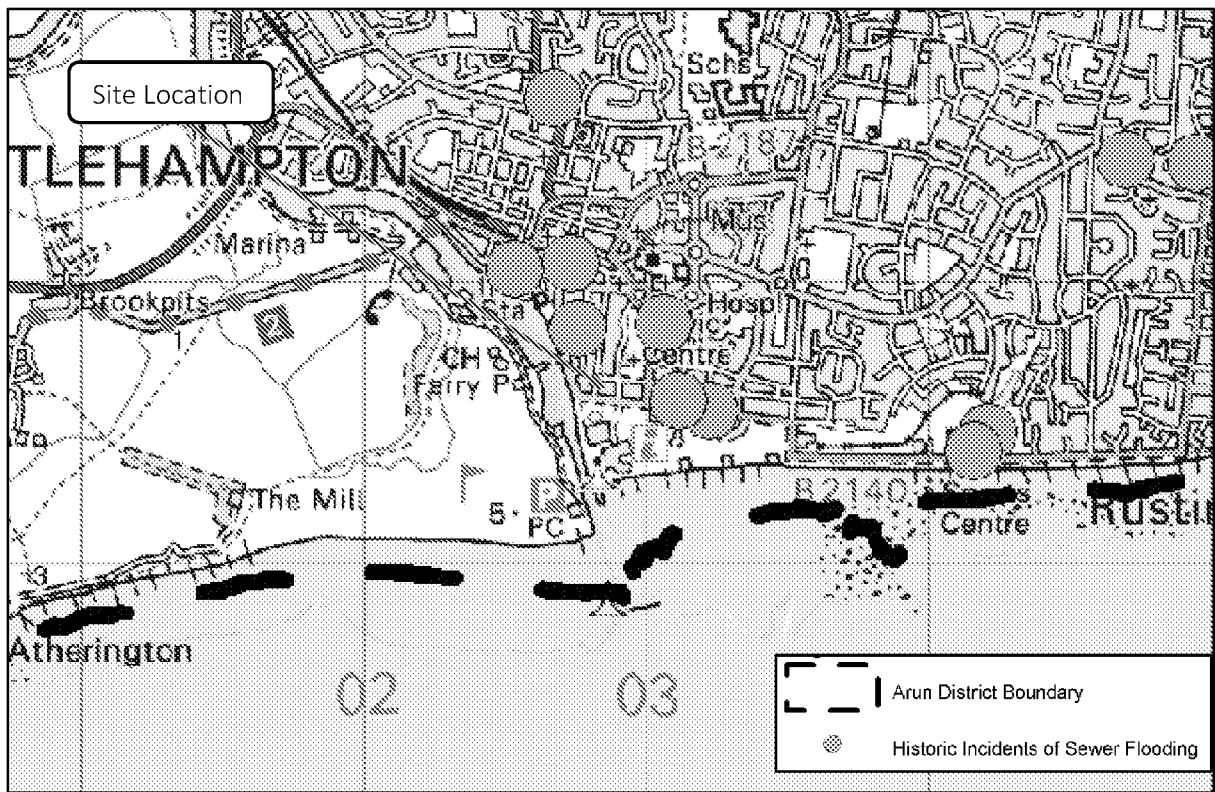


Figure 8: Historic Incidents of Sewer Flooding Map (Source: Arun District Council SFRA).

- 4.29 The Arun District Council SFRA (August 2016 Update) does not provide any further information about when the incidents occurred, severity or cause.
- 4.30 As such, the risk to the site from sewer flood sources can be considered **relatively low** given that the development is for a minor extension and internal reconfiguration of the existing property.

Surface Water Drainage Strategy

- 4.31 The existing site is developed. It is understood that the development is for the demolition of the existing single storey rear extension and the construction of a new 1.5 storey extension and internal reconfigurations.
- 4.32 The development is for an extension of the existing use and is viewed as a minor development, and as such the applicant will discharge surface water by means of the existing drainage infrastructure associated with the existing property.

Records of Historical Flooding

- 4.33 The Arun District Council SFRA (August 2016 Update) Historic Flooding Records Map show one historic flood event approximately 120m west of the development site, however the source of flooding is unknown. One recorded flood outline has been identified in close proximity to the site, approximately 190m north west along Pier Road (Figure 9, and Appendix A, Figure 3).
- 4.34 The EA have provided historic flood incidents in the area of the site. Preceding 1985, flooding of properties, roads and industrial areas have been recorded in the vicinity of the site, caused by

- overtopping mainly through the harbour masters yard where water gates were reported to be left open. Between 40 and 100 houses were affected by this incident. However, flood defences have been improved in the area which has subsequently reduced the risk of flooding in the vicinity of the site.
- 4.35 A number of surface water flooding incidents have also been recorded in close proximity to the site along St Catherine’s Road and on the junction of Irvine Road and Beach Road. No further information has been provided regarding these incidents, however the SFRA states that the primary source of surface water flooding was attributed to heavy rainfall overloading highway carriageways and paved areas, drains and gullies, as well as blockages and high water levels impeding free discharge from surface water drains and gullies.

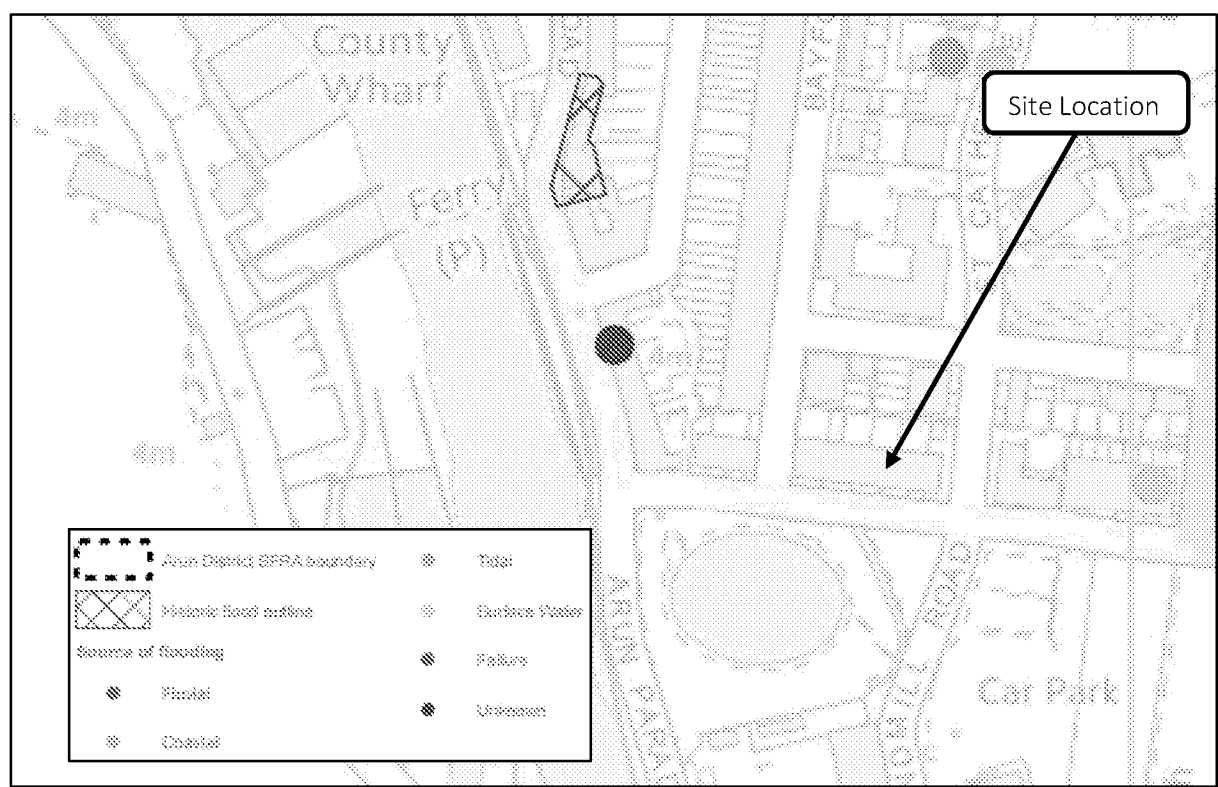


Figure 9: Historic Flooding Records (Source: Arun District Council SFRA 2016 Update).

5. Probability of Flooding

- 5.1 According to the low detail, national-scale flood mapping created on behalf of the EA the site is located in Flood Zone 3, the probability of tidal flooding at the site is greater than 0.5% chance of annual tidal flooding.
- 5.2 Tidal flooding is generally caused by low pressure weather systems creating storm-surges (or storm tides), chiefly via high speed winds. These winds (and to a certain extent, the low pressure) create a 'bulge' of water which, if it coincides with high tide, can generate very high, stormy, water levels. However, because this mechanism is well understood, it is very likely that an early warning will be issued before such an event strikes. As such, it is very unlikely that the site would be subject to tidal flooding without several hours of early warning.
- 5.3 This information is supported by the EA Flood Map for Planning (Figure 3) which has been produced in part using JFLOW/HYDRO-F – a relatively coarse, national scale flood modelling strategy and in part using detailed flood models. These maps indicate the potential spatial extent of a tidal flood event which has a magnitude that is, on average, likely to occur once in every two hundred years (i.e. the 1:200 year tidal floodplain). It is important to note that only the *potential* floodplain is shown; ***the mitigating effects of any flood defences currently in place are not considered***. For reference, the definition of the NPPF flood risk zones is included in Table 5.

Zone	Description
1	Low Probability. This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
2	Medium Probability. This zone comprises 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.
3a	High Probability. This zone comprises 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.
3b	The Functional Floodplain. This zone comprises land where water has to flow or be stored in times of flood. SFRA's should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the EA, including water conveyance routes).

Table 5: Definition of the NPPF Flood Zones. Shaded cells denote the proposed development (Source: EA).

Climate Change on Site

- 5.4 Climate change is likely to increase the flow in rivers, and raise sea levels and storm intensity.
- 5.5 The EA have recently updated the peak river flow allowances to use for different types of development. Communication with the EA, Flood and Coastal Risk Management Officer has confirmed that the changes are only focused to river flow and rainfall allowances. Tidal

allowances are detailed in Table 3 of the new changes (<https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>). As a result of this dialogue, it has been confirmed that the EA detailed data sets provided are relevant for the purposes of this assessment given that the dominant source of flooding is tidal.

- 5.6 The EA have also stated that the climate change will increase the peak rainfall intensity allowance in small and urban catchments.

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 change anticipated for the '2080s' (2070 to 2115)
South East	Upper end	25%	50%	105%
	Higher central	15%	30%	45%
	Central	10%	20%	35%

Table 6: Peak river flow allowances for the South East River basin district (Source: EA).

6. Residual Risks

- 6.1 Residual risks are those remaining after applying the sequential approach to the location of development and taking mitigating actions. Examples of residual flood risk include:

- the failure of flood management infrastructure such as a breach of a raised flood defence, blockage of a surface water conveyance system, overtopping of an upstream storage area, or failure of a pumped drainage system;
- failure of a reservoir, or;
- a severe flood event that exceeds a flood management design standard, such as a flood that overtops a raised flood defence, or an intense rainfall event which the drainage system cannot cope with. At the time of writing, the EA has not provided tidal breach data.

- 6.2 The controlling residual flood risk mechanism on site is tidal. Tidal flooding is generally caused by low pressure weather systems creating storm-surges (or storm tides), chiefly via high speed winds. These winds (and to a certain extent, the low pressure) create a 'bulge' of water which, if it coincides with high tide, can generate very high, stormy, water levels. However, because this mechanism is well understood, it is very likely that an early warning will be issued before a tidal flood event occurs. As such, it is very unlikely that the site would be subject to tidal flooding without several hours of early warning.

- 6.3 Given the nature of the tidal cycle flood waters on site will likely recede as in-channel water levels fall.

Overtopping

- 6.4 At the time of writing, the EA and Arun District Council SFRA (August 2016 Update) has not provided data relating to overtopping of defences.
- 6.5 The Beachy Head to Selsey Bill Shoreline Management Plan (2006) states that the 'hold the line' strategy will cause no loss of property or land behind the existing defences, but properties may become more exposed and subject to overtopping and flood damage (See Table 7).

Location reference:	Angmering-on-Sea to Littlehampton
Policy Unit reference:	4d18

IMPLICATIONS OF THE PREFERRED PLAN FOR THIS LOCATION

Time Period	Management Activities	Property, Built Assets & Land Use	Landscape	Nature Conservation	Historic Environment	Amenity & Recreational Use
2005 – 2025	Continue with current management practices.	No loss of property or land behind the existing defences.	No nature conservation gains or losses.	No loss or gain to landscape character of seafront.	No loss of heritage sites landward of defences.	No loss of community or recreational facilities landward of defences. Narrow beach retained.
2025 – 2055	Increased engineering and beach management practices.	No loss of property or land behind the existing defences.	No nature conservation gains or losses.	Landscape character of seafront may change due to greater defence works, with possible loss of beach habitat.	No loss of heritage sites landward of defences.	No loss of community or recreational facilities landward of defences. Some land may need to be sacrificed to establish new defences. Reduction in beach.
2055 – 2105	Increased engineering and beach management practices. New replacement defences required. Esplanade may need to be relocated/ set back.	No loss of property or land behind the existing defences. Properties may become more exposed and subject to overtopping and flood damage.	No nature conservation gains or losses.	Landscape character of seafront may change due to greater defence works.	No loss of heritage sites landward of defences. Some potential loss of conservation areas.	No loss of community or recreational facilities landward of defences. Blue Flag status may be lost due to reduced beach width.

Table 7: Implications of the Preferred Strategy for this Location (Source: Beachy Head to Selsey Bill SMP, 2006).

Defence Breach

- 6.6 The Arun District SFRA (August 2016 Update) has shown that the site does benefit from the presence of defences in the form of a privately owned wall. The estimated design standard for the area is 1:75 for the defences along the River Arun and 1:200 along the beach to the south.
- 6.7 The EA have further provided information regarding the flood defences in the area. The EA have stated that the western side of the site is currently protected by a steel sheet pile wall with concrete cap and promenade with Designed Standard of Protection of 1:300. The flood defence wall is in fair condition with a downstream crest level of 4.76mOAD and an upstream crest level of 4.80mAOD.
- 6.8 No further information has been provided by the EA or SFRA in regards to possible effects of a breach of the defences in the area.

7. Flood Risk Management Measures

- 7.1 The site is located in Flood Zone 3 (High Risk of flooding as defined in the NPPF) according to the EA Floodmap, as such the proposed development will require flood mitigation measures.
- 7.2 The controlling residual flood risk mechanism on site is tidal. Tidal flooding is generally caused by low pressure weather systems creating storm-surges (or storm tides), chiefly via high speed winds. These winds (and to a certain extent, the low pressure) create a 'bulge' of water which, if it coincides with high tide, can generate very high, stormy, water levels. However, because this mechanism is well understood, it is very likely that an early warning will be issued before such an event strikes. As such, it is very unlikely that the site would be subject to tidal flooding without several hours of early warning.
- 7.3 Given the nature of the tidal cycle and fluvial channel setting flood waters on site will likely recede as the in-channel water levels fall.
- 7.4 The existing site is currently developed. The proposed development is for the demolition of the existing single storey rear extension and the construction of a new 1.5 storey extension.
- 7.5 As such the following mitigation measures are proposed;
- bringing down electrical services from ceilings toward sockets, where possible;
 - all plumbing insulation to be of closed-cell design;
 - finished floor levels of the proposed extension to be set no lower than existing;
 - subscribe to the EA Flood Warning Service and ensure that this service is made available to all site users, future owners and residents, and;
 - formulate an evacuation plan to be implemented in the event of severe flood or weather warnings.

Safe Access/Egress

- 7.6 The site resides within Flood Zone 3 (tidal) and is located within an EA Flood Warning Service Area (Figure 10).
- 7.7 It is recommended the site owner and site staff sign up to the EA flood warning service if they have not done so already in order to provide betterment to the site. It is recommended that all new site owners and new site staff are made aware are of the potential flood risk to the site and that they sign up to the EA flood warning service. It is recommended that all site users are also made aware of the potential flood risk posed to the site.

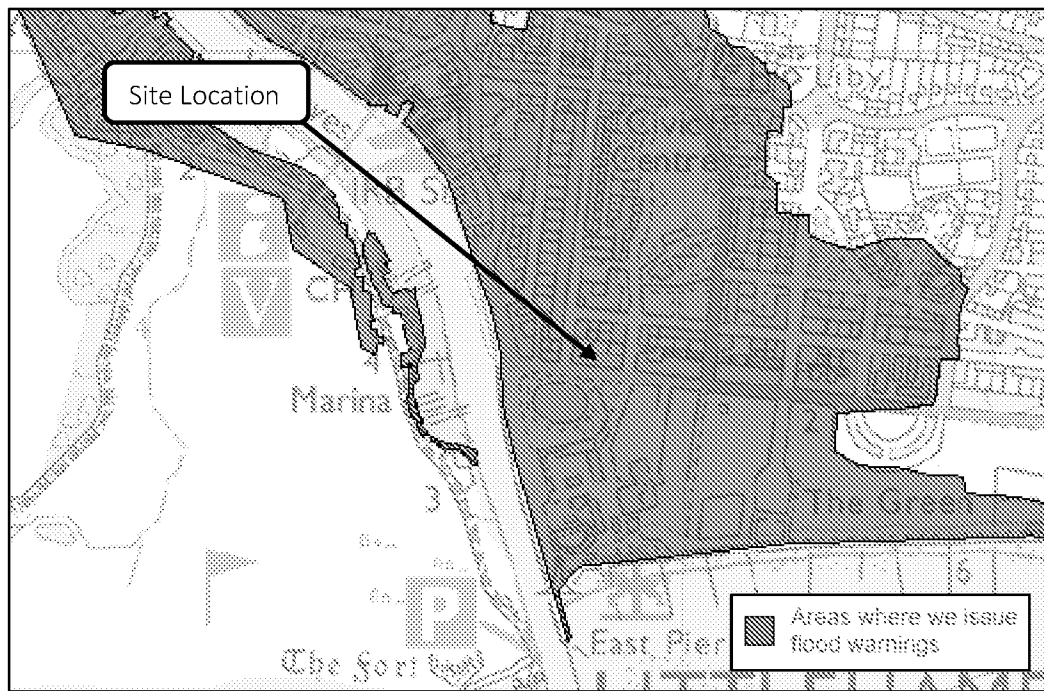


Figure 10: EA Flood Warning Area (Source: EA Online).

7.8 The EA operates a 24-hour telephone service on 0345 988 1188 that provides frequently updated flood warnings and associated floodplain information. Further information can be found on www.environment-agency.gov.uk/floodline. Floodline Warnings Direct is a free service operated by the EA that provides flood warnings direct to occupants by telephone, mobile phone, fax or pager.

- On receipt of a **FLOOD ALERT**, the owners/occupiers of the property should:
 - monitor the situation via local media;
 - make themselves aware of forecast local weather conditions;
 - alert others resident in the property of the situation;
 - prepare to evacuate if necessary.
- On receipt of a **FLOOD WARNING**, the owners/occupiers of the property should:
 - follow advice to “go in, stay in, and tune in”;
 - be prepared to follow instruction from the Emergency Services.
- On receipt of a **SEVERE FLOOD WARNING**, the owners/occupiers of the properties should:
 - follow advice to “go in, stay in, and tune in”;
 - remain attentive to local media forecasts and news bulletins;
 - do not evacuate unless instructed to do so by the Emergency Services;
 - only when instructed to evacuate by the Emergency Services, leave the property and follow the agreed evacuation route – detailed previously.

- 7.9 Safe egress from the site can be achieved by migrating away from the source of flooding on receipt of a severe flood warning.
- 7.10 If flooding has already occurred prior to evacuation, it is advised to remain on the upper floors of the property and await instruction from the emergency services or until it is deemed safe to evacuate. Residents should move via internal stairwells to the upper floors of the property so as to be located within an area of safe refuge. No evacuation should be sought if flood depths exceed 25cm, evacuation should only be sought with the assistance of the emergency services in these circumstances.
- 7.11 The maximum and minimum sea level (tidal peak and trough) are approximately 6 hours apart. As such, it is expected that tidal waters will drain away well within 6 hours. In practicality, the peak of the surge would last for a much shorter period of time and as such, it would be likely that water would recede much faster. However, due to the potential hazard of overtopping via wave-action, it is not recommended that occupants leave the building until low tide (or until the emergency services instruct them to do so).
- 7.12 Tidal flooding is generally caused by low pressure weather systems creating storm-surges (or storm tides), chiefly via high speed winds. These winds (and to a certain extent, the low pressure) create a 'bulge' of water which, if it coincides with high tide, can generate very high, stormy, water levels. However, because this mechanism is well understood, it is very likely that early warning will be issued before such an event strikes.
- 7.13 **As such, it is very unlikely that the site would be subject to tidal flooding without several hours of early warning.**

8. Off Site Impacts

Impact to Flood Risk Elsewhere

8.1 The site is located in Flood Zone 3, (tidal flood risk) and under the NPPF:

“unless the development is located in an area which is subject to tidal flooding and which serves no conveyance function, land raising must be accompanied by compensatory provision of flood storage either on- or off-site”

as such there is no requirement for compensatory flood storage.

Generation of Runoff

8.2 The existing site is developed. It is understood that the development is for the demolition of the existing single storey rear extension and the construction of a new 1.5 storey extension and internal reconfigurations.

8.3 The development is for an extension of the existing use and is viewed as a minor development, and as such the applicant will discharge surface water by means of the existing management infrastructure associated with the existing property.

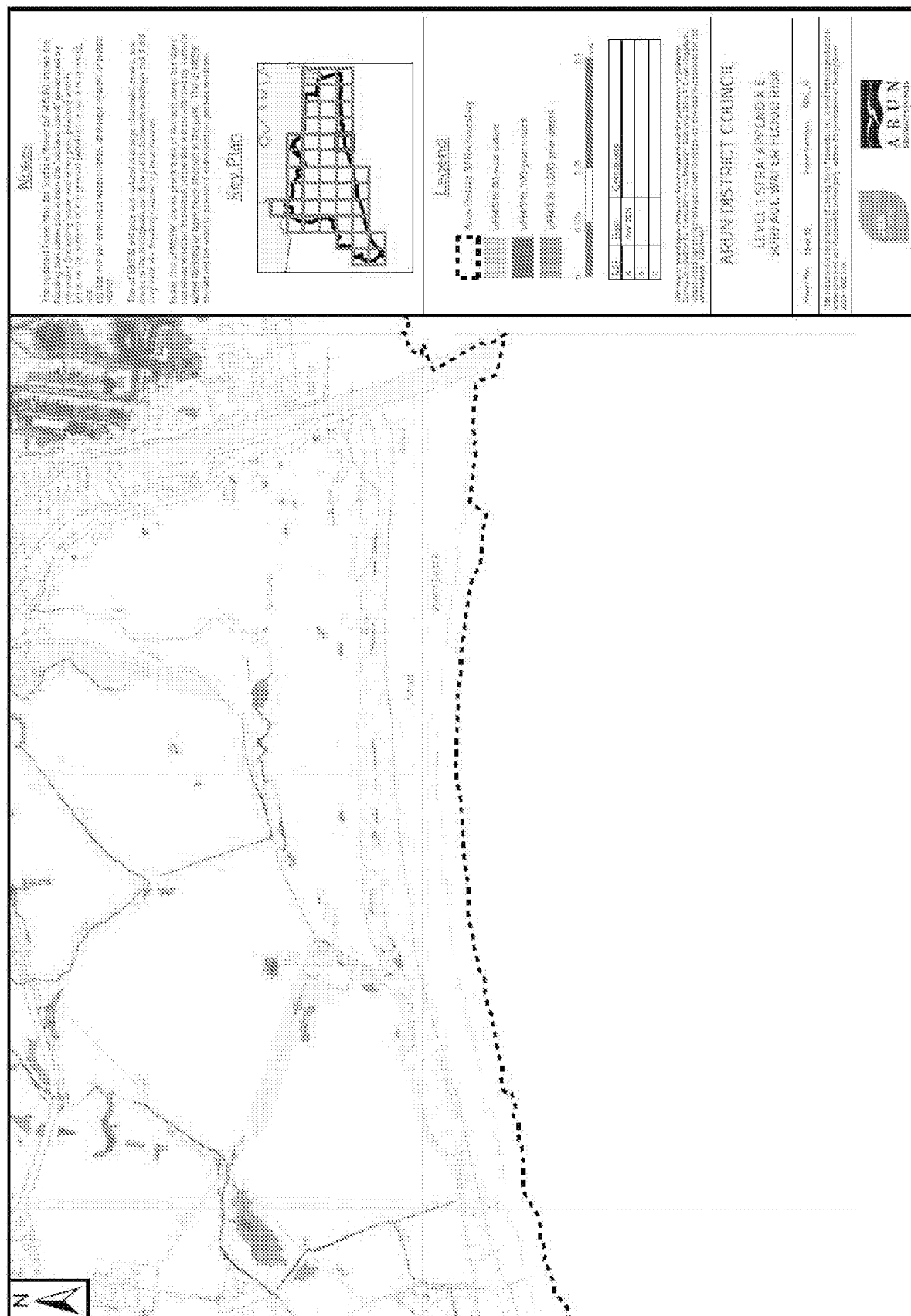
9. Conclusion

- 9.1 Ambiental Technical Solutions Limited has been appointed by Caldotec Ltd to undertake a National Planning Policy Framework (NPPF) compliant Flood Risk Assessment (FRA) a development at 85 South Terrace, Littlehampton, West Sussex, BN17 5LJ.
- 9.2 The proposed development is for the demolition of the existing rear single storey extension and the construction of a larger 1.5 storey rear extension.
- 9.3 With reference to the NPPF and the Environment Agency (EA) standing advice on development and flood risk, as well as the low detail, national-scale flood mapping created on behalf of the EA, the proposed site is located within Flood Zone 3 (High Risk; having a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) and is considered to be a “More” Vulnerable development, under the NPPF.
- 9.4 Topographic levels across site vary between approximately 2.01mAOD and 2.41mAOD (Source: LiDAR). Comparison of the topographic site levels with modelled flood levels confirms the site partially resides within the extreme tidal flood extent for the present day 1:200 year event (2.37mAOD) and the 1:1000 year flood event (2.50mAOD). Possible maximum flood depth, based on the minimum topographic level on site (2.01mAOD), for the present day 1:200 year and 1:1000 year flood events has been shown to be 0.36m and 0.49m, respectively.
- 9.5 Comparison of the topographic site levels with modelled flood levels confirms the site fully resides within the 1:200 year flood event for the 2070 (3.00mAOD) and 2115 epoch (4.01mAOD). Possible maximum flood depths, based on the minimum topography on site, has been shown to be 0.99m and 1.99m, respectively.
- 9.6 The EA have provided information regarding the flood defences in the area. The EA have stated that the western side of the site is currently protected by a steel sheet pile wall with concrete cap and promenade with Designed Standard of Protection of 1:300. The flood defence wall is in fair condition with a downstream crest level of 4.76mOAD and an upstream crest level of 4.80mAOD.
- 9.7 As such, and given that:
- a) the proposed development is for the extension of the existing use and is classified as a minor development;
 - b) the site lies within an existing developed area;
 - c) betterment can be provided by the formalisation of a flood warning and evacuation plan.

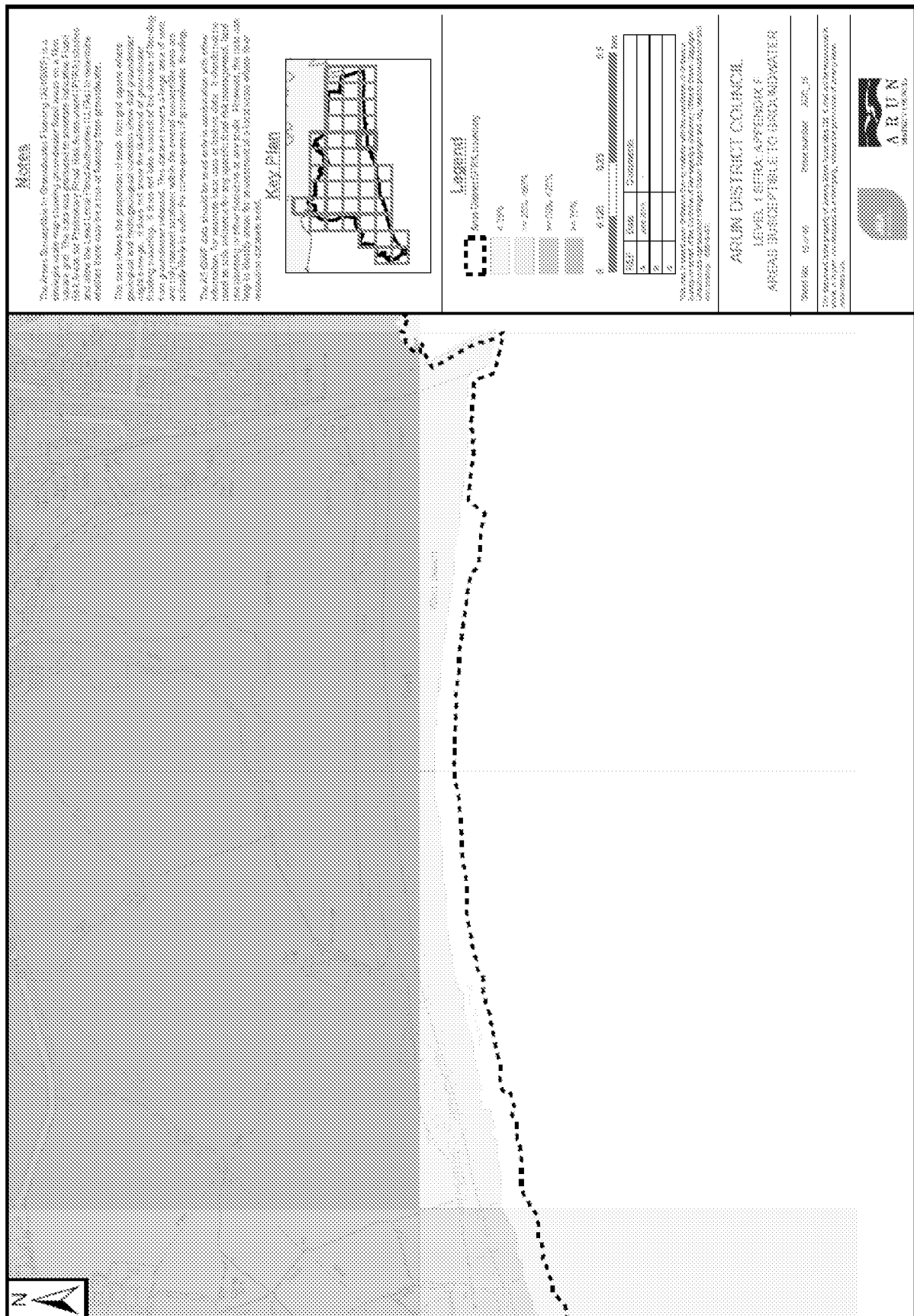
Following the guidelines contained within the NPPF, the proposed development is considered **to be suitable** assuming appropriate mitigation (including adequate warning procedures) can be maintained for the temporary lifetime of the development.

Appendix A – Supporting Information

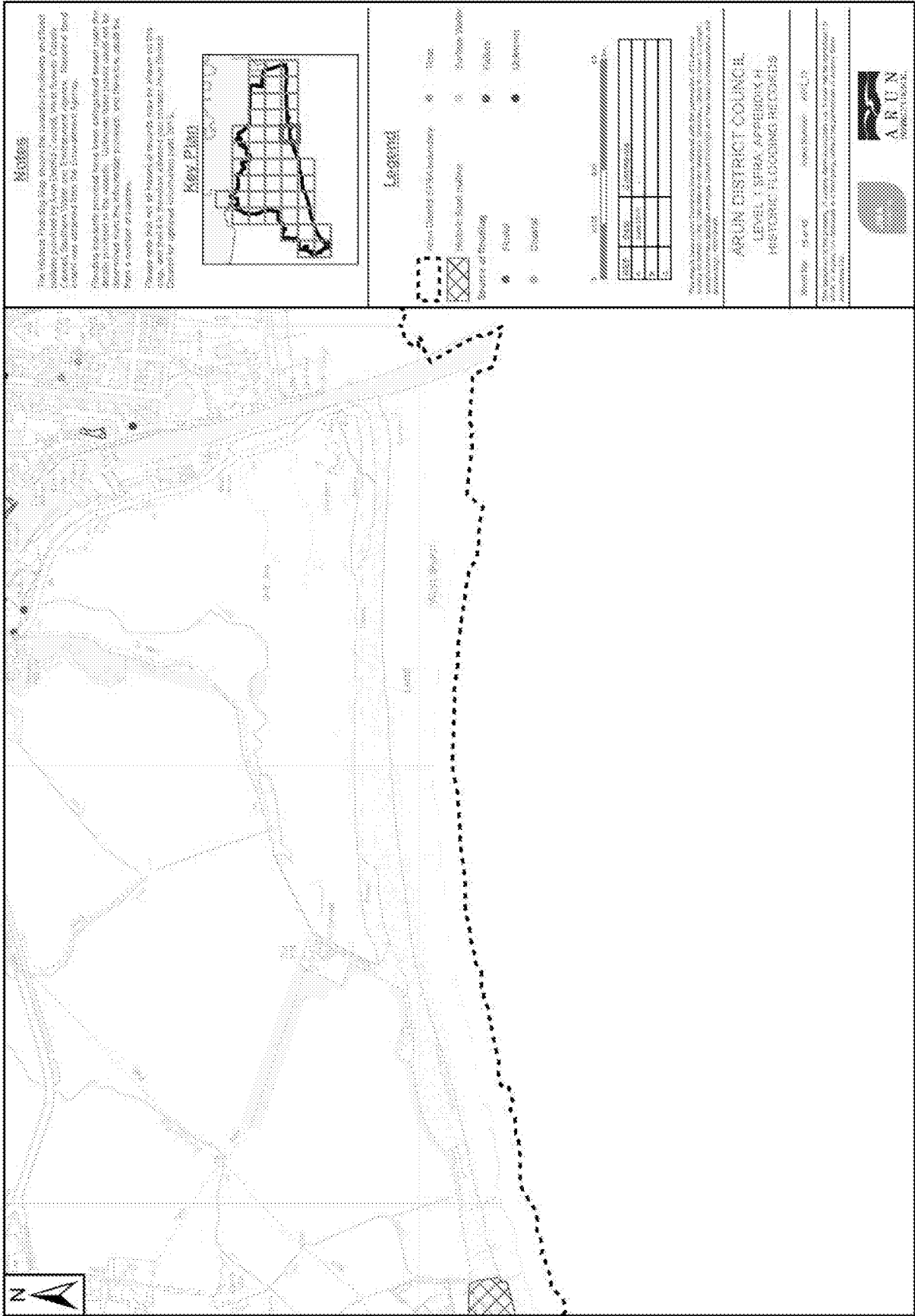
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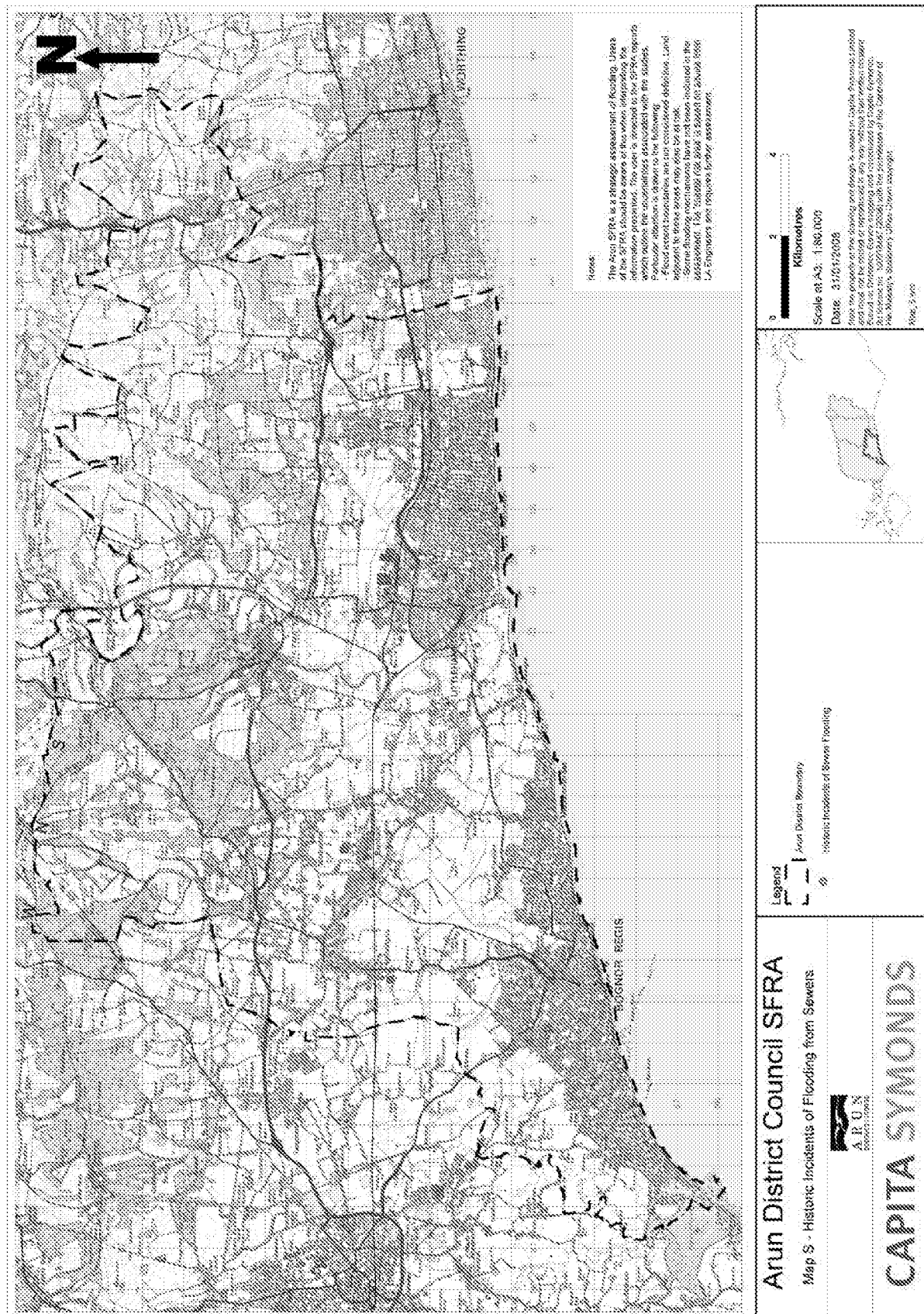
Appendix A, Figure 1: Surface Water Flooding Risk (Arun District Council SFRA, 2016 Update)



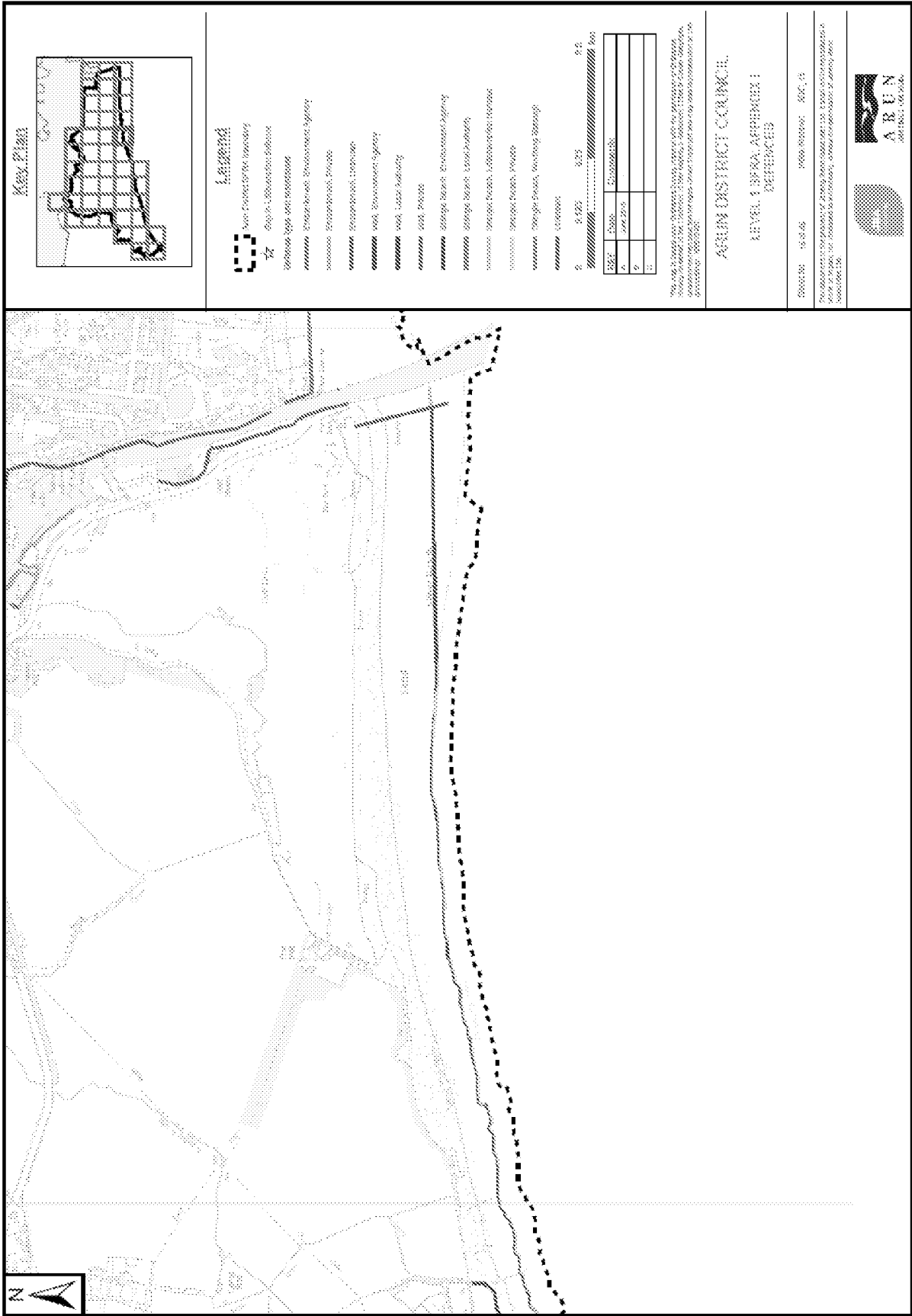
Appendix A, Figure 2: Areas Susceptible to Groundwater Flooding Map (Arun District Council SFRA, 2016 Update)



Appendix A, Figure 3: Historic Flooding Records (Arun District SFRA, 2016 Update)

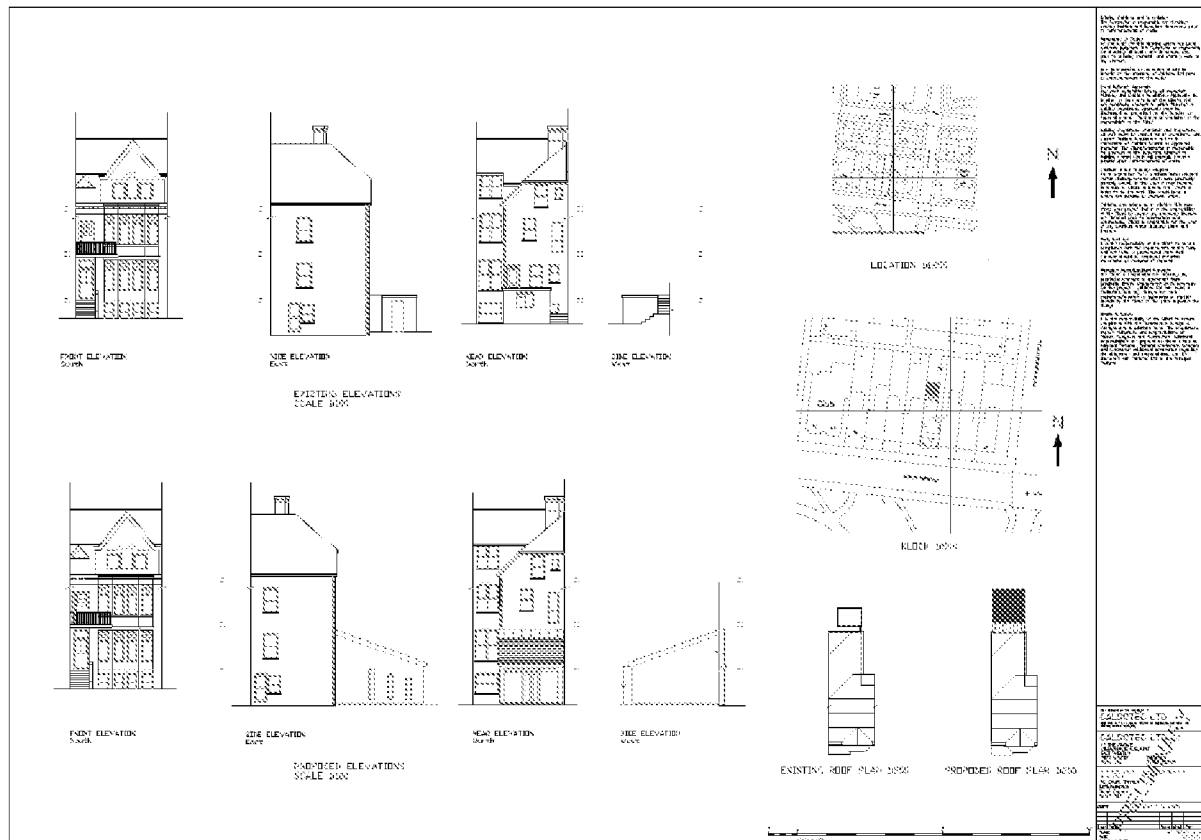


Appendix A, Figure 4: Historic Incidents of Flooding from Sewers (Arun District Council SFRA, 2016 Update)



Appendix A, Figure 5: Flood Defence Information (Arun District Council SFRA, 2016 Update)





Appendix A, Figure 8: Existing/Proposed Elevations

Appendix B – Information Relating To JFLOW

JFLOW and flood outlines (Source: EA)

Flood Zones have been produced using JFLOW, a nationally consistent model. JFLOW has been used to produce the 1% (1 in 100 year) and 0.1% (1 in 1000 year) flood outlines.

The flood outlines have been developed by applying flow and tide models to a 3D ground level map of England and Wales, known as a Digital Terrain Model (DTM). This is created by flying an aircraft over the whole of the country using radar to record and create a contoured model of the land. This DTM is used as the basis of a grid of cells which is used to estimate the extent of flooding in a flood of a given return period or probability.

The size of the flood event (1 in 100 or 1 in 1000 year) is determined by the inflows to the JFLOW model, which are calculated using statistical techniques from the Flood Estimation Handbook. The technique used is based upon catchment descriptors and data transfer, the details of these can be found in the Flood Estimation Handbook volume 3. The Flood Estimation Handbook provides a consistent technique for estimating inflows to the national model and its methods are widely accepted.

The methodology is a raster-based approach, driven by an underlying Digital Elevation Model (DEM).

- Each cell has a ground level and water depth.
- Water can move to any of surrounding 8 cells where the water level is lower.
- Water will pond in low spots until the water level is high enough to spill.
- The velocity of movement depends on water surface slope and surface roughness.

The above points describe the basic principles of the model. The two underlying principles are:

- mass conservation within each cell;
- calculation of the fluxes between the cells.

Each grid cell is treated as a small storage area. Mass conservation is applied to each grid cell. The flux between cells is calculated using a form of the generalised weir equation.

Efficient coding is achieved by keeping a list of all currently wet cells and a list of newly wet cells. This avoids having to search through each cell in the ground grid.

For whole catchment modelling, the hydrographs used as inflow boundary conditions represent the whole hydrograph at that inflow location and a simple conceptual method has been derived to account for the amount of flow within the channel banks. A simple solution was therefore sought which would approximately account for the proportion of flow contained within the channel without requiring further information about the channel.

The simple conceptual method used involves two assumptions:

1. That bankfull flow (Q_b) is equal to QMED as calculated by the Flood Estimation Handbook (FEH) methods. QMED has a return period of 2 years. This assumption derives from the

concept of dominant discharge in fluvial geomorphology (Wolman and Leopold, 1957; Wolman and Miller, 1960) where the cross-section shape is assumed to be formed by a discharge with a recurrence interval of 1 - 2years.

2. That the additional channel flow (Q_c) scales with both Q_b and depth above bankfull (d).

The basis of the current model is that each grid cell acts as a small flood cell and the links to each of the surrounding cells are automatically calculated. It is therefore capable of simulating the inundation extent at a level of detail equal to the underlying DEM. It is fundamentally volume conservative and so, in a given time period, will simulate the peak water levels across the floodplain depending on the volume of water that has entered the floodplain. This approach is a half-way house between the common 1D hydrodynamic models and a 2D hydrodynamic model.

Limitations

JFLOW was used to produce flood maps for the whole of England and Wales for all catchments greater than 3 sq-km in a consistent manner. The method is therefore very generalised and therefore cannot take account of information that may be very significant locally. This might include:

1. effects of bridges and other structures including flood defences are not taken into account;
2. errors in the DTM, caused by trees and buildings for example;
3. the effect of reservoirs and urban drainage and other man made influences on the flow regime can only be taken into account in a very general sense in JFLOW;
4. the channel is assumed to be able to take the 2 year flow. This may not be true especially in those modified by man;
5. hydraulic roughness is assumed to be the same everywhere in JFLOW, but of course it is not.

For these and many other reasons, the flood outlines produced by JFLOW can only be taken as a rough guide, showing where more detailed flood risk assessments are essential. Flood risk assessments should also be undertaken near small watercourses whose catchments are too small to have been included in the JFLOW modelling.