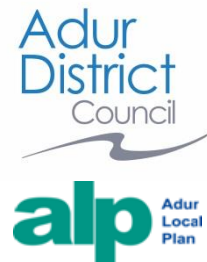


Proposed Submission Adur Local Plan 2014



Representation Form

Return Address:

planning.policy@adur-worthing.gov.uk


Or:

Planning Policy Team, Adur and Worthing Councils, Town Hall, Chapel Road,
Worthing, BN11 1BR

Or hand in at:

- Adur Civic Centre, Ham Road, Shoreham-by-Sea, BN43 6PR or
- Portland House, 44 Richmond Road, Worthing, BN11 1HS

**Please return to Adur District Council by 5pm on 1st December 2014
Late representations will not be considered.**

 **Use of your information** Respondent details and representations will be forwarded to the Secretary of State for consideration when the Adur Local Plan is submitted for examination. All documents will be held by Adur District Council and representations will be published including on the internet e.g. www.adur-worthing.gov.uk. Personal contact details (address, email and phone number) will be removed from published copies of representations. Your information will be handled in accordance with Data Protection Act 1998.

Contact details will be added to the Adur Planning Policy consultees database to keep you informed on the progress of the Adur Local Plan and other related documents.

Please tick if you do **not** want to be informed.

This form has two parts:

- Part A - Respondent Details. You only need to fill this in once.
- Part B - Your representation(s). Please fill in a separate sheet for each representation you make.

It is recommended that you read the Guidance Notes provided for an explanation of terms used in this form.

Part A – Personal Information
You only need to complete this section once

Personal Details

First name	<input type="text" value="David"/>	
Last name	<input type="text" value="Johnson"/>	
Organisation (where applicable)	<input type="text" value="Campaign to Protect Rural England (Sussex)"/>	
Address line 1	<input type="text" value="Brownings Farm"/>	
Address line 2	<input type="text" value="Blackboys"/>	
Address line 3	<input type="text" value="East Sussex"/>	
Post Code	<input type="text" value="TN22 5HG"/>	Telephone <input type="text" value="██████████"/>
Email address	<input type="text" value="██"/>	

Agent's Details (if applicable)

First name	<input type="text"/>	
Last name	<input type="text"/>	
Organisation	<input type="text"/>	
Job Title	<input type="text"/>	
Address line 1	<input type="text"/>	
Address line 2	<input type="text"/>	
Address line 3	<input type="text"/>	
Post Code	<input type="text"/>	Telephone <input type="text"/>
Email address	<input type="text"/>	

Part B – Representation

Please use separate sheets for each representation

1. Which part of the Adur Local Plan does this representation relate to?

Policy No. Paragraph No.

Map Other section
(please specify)

2. Do you consider the Adur Local Plan to be: (tick as appropriate)

2.1 Legally Compliant Yes No

2.2 Sound Yes No

Please read the Guidance Note for guidance on legal compliance and soundness.

**If you have ticked no to 2.1, please continue to Q4.
If you have ticked no to 2.2, please continue to Q3.
If you have ticked yes to 2.1 and 2.2 please go to Q7.**

3. Do you consider the Adur Local Plan to be unsound because it is not: (tick as appropriate)

3.1 Positively Prepared

3.2 Justified

3.3 Effective

3.4 Consistent with National Policy

4. If you consider the Adur Local Plan to be unsound or not legally compliant, please explain why in the box below:

The National Planning Policy Framework states that “*The purpose of the planning system is to contribute to the achievement of sustainable development*” (paragraph 6) and that there are three dimensions to sustainable development: economic, social and environmental (paragraph 7). The Framework explains that ‘*These roles should not be taken in isolation, because they are mutually dependent.....Therefore, to achieve sustainable development, economic, social and environmental gains should be sought jointly and simultaneously*’ (paragraph 8). This makes it clear that any activity that results in detriment to one or more of these “roles” is not sustainable development.

In fact, the Framework indicates that merely not causing harm to economic, social or environmental interests is not sufficient: “*Pursuing sustainable development involves seeking positive improvements in the quality of the built, natural and historic environment, as well as in people’s quality of life*” (paragraph 9).

At the heart of the National Planning Policy Framework is a “*presumption in favour of sustainable development, which should be seen as a golden thread running through both plan-making and decision-taking*”. For plan-making, the Framework states that “*Local Plans should meet objectively assessed needs, with sufficient flexibility to adapt to rapid change, ... unless any adverse impacts of doing so would significantly and demonstrably outweigh the benefits, when assessed against the policies in this Framework taken as a whole; or specific policies in this Framework indicate development should be restricted*” (Paragraph 14). Also “*all plans should be based upon and reflect the presumption in favour of sustainable development*” (paragraph 15).

In order to “objectively assess” housing needs, the Framework requires local planning authorities to prepare a Strategic Housing Market Assessment” (SHMA) (paragraph 159). This of course is purely an assessment of need. When it comes to seeking to meet those needs through allocations of land for housing in a Local Plan, account has to be taken of environmental, infrastructure and other constraints. In accordance with paragraph 14 of the Framework, quoted above, where meeting these needs in full would lead to adverse impacts that significantly and demonstrably outweigh the benefits, or where specific policies indicate development should be restricted, it is appropriate for the local planning authority not to seek these needs in full.

Adur’s housing needs have been objectively assessed through two particular studies: the Sussex Coast SHMA and Adur’s own Locally Generated Housing Needs Study. Paragraph 1.28 of the Plan explains that the main finding of the Sussex Coast SHMA is that “*it was highly unlikely that the level of objectively assessed housing need required in these local authority areas can be achieved in the sub-region in the light of environmental, landscape and infrastructure constraints*” (e.g. the National Park designation, river and coastal flood risk and biodiversity sites). Adur’s own Locally Generated Housing Needs Study (LGHNS) identified an even higher need than the Sussex Coast SHMA.

For Adur District, the Plan “*seeks to deliver a package of measures over the plan period in order to work towards meeting the objectively assessed development needs of Adur as far as possible, taking into account environmental assets and constraints*” (paragraph 2.2).

However, the corresponding paragraph in the Revised Draft Local Plan was more explicit, explaining that the District will not be able to meet its full housing requirement due to, inter alia, “*significant flood risk issues and landscape constraints*”. Paragraph 2.22 of the Revised Draft Plan recognised that meeting the high level of demand in the LGHNS “*would mean an extremely high level of development, with a severe impact on the Local Green Gaps, the landscape quality of Adur, biodiversity and on areas at risk of flooding*”.

The District Council therefore concluded at the Revised Draft Local Plan stage, rightly and justifiably in the opinion of CPRE Sussex, that it should not seek to meet its own objectively assessed needs in full. Although the Council now aims to meet the objectively assessed needs of Adur as far as possible (Objective 1 of the Proposed Submission Plan is now to deliver between 3,488 – 3,638 dwellings up to 2031 to potentially meet the lower end of the objectively assessed needs), it remains clear that “*taking into account environmental assets and constraints*”, that it would still not be sustainable to meet the objectively-assessed needs in full.

In fact, on that very point, the delivery of this increased range of dwellings depends on the development of two greenfield sites at New Monks Farm and West Sompting (paragraph 2.22). The Spatial Strategy also relies on the allocation of land at Shoreham Airport for employment floorspace. CPRE Sussex considers that the proposed strategic development allocations at New Monks Farm and Shoreham Airport are unsound, at this time at least, and at West Sompting is unsound, for the reasons we set out in our comments on Policies 5, 6 and 7.

Accordingly, CPRE Sussex considers the Spatial Strategy as set out in Policy 2 to be unsound as it relies on the release of the sites at New Monks Farm, West Sompting and Shoreham Airport.

5. Please explain in the box below what change(s) you consider necessary to make the Adur Local Plan legally compliant and sound having regard to the reason you identified above.

(You will need to say why this change will make the Plan legally compliant or sound. It will be helpful if you are able to put forward your suggested or revised wording of any policy or supporting text. Please be as precise as possible).

In order to be compliant with the National Planning Policy Framework and therefore sound, the Spatial Strategy of the Local Plan needs to be revised to

omit the proposed greenfield site allocation at West Sompting and to recognise that the proposed allocations at New Monks Farm and Shoreham Airport are only acceptable if it can be demonstrated that viable attenuation is possible to avoid ground/surface water flood risk to existing and new build properties.

We suggest the following amendments to Policy 2:

“If it can be demonstrated that viable attenuation is possible to avoid ground/surface water flood risk to existing and new buildings. Shoreham Airport will also be a focus for new employment floorspace.

Likewise, only if it can be demonstrated that viable attenuation is possible to avoid ground/water flood risk to existing and new build properties, the greenfield site at New Monks Farm, Lancing (residential, employment and community uses) will be released.....”

6. If your representation concerns soundness or legal compliance and is seeking a change, do you consider it necessary to attend and give evidence at the hearing part of the examination? (tick as appropriate)

No, I wish to communicate through written representations

Yes, I wish to speak to the Inspector at the hearing sessions **YES**

Please note: The Inspector will determine the most appropriate procedure to hear those who have indicated that they wish to participate at the hearing part of the examination.

7. If you wish to participate at the hearing part of the examination, please outline why you consider this to be necessary.

CPRE Sussex wishes to submit evidence to the Inspector of flood risk, and the sustainability and deliverability of the sites referred to above.

8. Please tick if you do not wish to be informed of the following:

When the Plan has been submitted for Examination

When the recommendations from the Examination have been Published

When the Local Plan has been adopted

Part B – Representation

Please use separate sheets for each representation

1. Which part of the Adur Local Plan does this representation relate to?

Policy No.

3

Paragraph No.

Map

Other section
(please specify)

2. Do you consider the Adur Local Plan to be: (tick as appropriate)

2.1 Legally Compliant Yes No

2.2 Sound Yes No

Please read the Guidance Note for guidance on legal compliance and soundness.

If you have ticked no to 2.1, please continue to Q4.

If you have ticked no to 2.2, please continue to Q3.

If you have ticked yes to 2.1 and 2.2 please go to Q7.

3. Do you consider the Adur Local Plan to be unsound because it is not: (tick as appropriate)

3.1 Positively Prepared

3.2 Justified

3.3 Effective

3.4 Consistent with National Policy

4. If you consider the Adur Local Plan to be unsound or not legally compliant, please explain why in the box below:

CPRE Sussex considers that the proposed strategic development allocation at New Monks Farm is unsound, at this time at least, and at West Sompting is unsound, for the reasons we set out in our comments on Policies 2, 5 and 6.

Accordingly, CPRE Sussex considers the Housing Provision as set out in Policy 3 to be unsound as it relies on the release of the sites at New Monks Farm and West Sompting.

5. Please explain in the box below what change(s) you consider necessary to make the Adur Local Plan legally compliant and sound having regard to the reason you identified above.

(You will need to say why this change will make the Plan legally compliant or sound. It will be helpful if you are able to put forward your suggested or revised wording of any policy or supporting text. Please be as precise as possible).

The Housing Provision of the Local Plan needs to be revised to omit the proposed greenfield site allocation at West Sompting and to recognise that the development of New Monks Farm would only be acceptable if it can be demonstrated that viable attenuation is possible to avoid ground/water flood risk to existing and new build properties.

We suggest the following rewording:

Over the period 2011 – 2031 a minimum of 2558 dwellings will be developed in Adur, as follows:

1456 within the built up area of Adur

1100 as part of the Shoreham Harbour Regeneration Area Western Arm

A further 450 - 600 may be developable at New Monks Farm if it can be demonstrated that viable attenuation is possible to avoid ground/surface water flood risk to existing and new build properties.

6. If your representation concerns soundness or legal compliance and is seeking a change, do you consider it necessary to attend and give evidence at the hearing part of the examination? (tick as appropriate)

No, I wish to communicate through written representations

Yes, I wish to speak to the Inspector at the hearing sessions YES

Please note: The Inspector will determine the most appropriate procedure to hear those who have indicated that they wish to participate at the hearing part of the examination.

7. If you wish to participate at the hearing part of the examination, please outline why you consider this to be necessary.

CPRE Sussex wishes to submit evidence to the Inspector of flood risk, and the sustainability and deliverability of the sites referred to above.

8. Please tick if you do not wish to be informed of the following:

When the Plan has been submitted for Examination

When the recommendations from the Examination have been Published

When the Local Plan has been adopted

Part B – Representation

Please use separate sheets for each representation

1. Which part of the Adur Local Plan does this representation relate to?

Policy No.	<input type="text" value="4"/>	Paragraph No.	<input type="text"/>
Map	<input type="text"/>	Other section (please specify)	<input type="text"/>

2. Do you consider the Adur Local Plan to be: (tick as appropriate)

- 2.1 Legally Compliant Yes No
- 2.2 Sound Yes No

Please read the Guidance Note for guidance on legal compliance and soundness.

If you have ticked no to 2.1, please continue to Q4.

If you have ticked no to 2.2, please continue to Q3.

If you have ticked yes to 2.1 and 2.2 please go to Q7.

3. Do you consider the Adur Local Plan to be unsound because it is not: (tick as appropriate)

- 3.1 Positively Prepared
- 3.2 Justified
- 3.3 Effective
- 3.4 Consistent with National Policy

4. If you consider the Adur Local Plan to be unsound or not legally compliant, please explain why in the box below:

CPRE Sussex considers that the proposed strategic development allocations at New Monks Farm and Shoreham Airport are unsound, at this time at least, for the reasons we set out in our comments on Policies 5 and 7.

Accordingly, CPRE Sussex considers the economic growth strategy as set out in Policy 4 to be unsound as it relies on the release of the sites at New Monks Farm and Shoreham Airport.

5. Please explain in the box below what change(s) you consider necessary to make the Adur Local Plan legally compliant and sound having regard to the reason you identified above.

(You will need to say why this change will make the Plan legally compliant or sound. It will be helpful if you are able to put forward your suggested or revised wording of any policy or supporting text. Please be as precise as possible).

Policy 4 and its supporting text should recognise that the proposed strategic development allocations at New Monks Farm and Shoreham Airport will only be acceptable if it can be demonstrated that viable attenuation is possible to avoid ground/surface water flood risk to existing and new build properties.

We suggest the following amendment to Policy 4:

“To facilitate.....16,000.....iin Adur up to 2031 at Shoreham Harbour Regeneration Area.

In addition, if it can be demonstrated that viable attenuation is possible to avoid ground/surface water flood risk to existing and new buildings, an additional approximate 25,000 sq.m will be allocated for appropriate employment generating uses in Adur up to 2031 at the following locations:

- ***Shoreham Airport (approximately 15,000 sqm)***
- ***New Monks Farm (approximately 10,000sqm)***

6. If your representation concerns soundness or legal compliance and is seeking a change, do you consider it necessary to attend and give evidence at the hearing part of the examination? (tick as appropriate)

No, I wish to communicate through written representations

Yes, I wish to speak to the Inspector at the hearing sessions **YES**

Please note: The Inspector will determine the most appropriate procedure to hear those who have indicated that they wish to participate at the hearing part of the examination.

7. If you wish to participate at the hearing part of the examination, please outline why you consider this to be necessary.

CPRE Sussex wishes to submit evidence to the Inspector of flood risk, and the sustainability and deliverability of the sites referred to above.

8. Please tick if you do not wish to be informed of the following:

When the Plan has been submitted for Examination

When the recommendations from the Examination have been Published

When the Local Plan has been adopted

3.4 Consistent with National Policy ✓

4. If you consider the Adur Local Plan to be unsound or not legally compliant, please explain why in the box below:

When commenting on the Revised Draft Local Plan CPRE Sussex objected to the allocation of the strategic site at New Monks Farm for a number of reasons, including flooding issues.

Paragraph 2.53 of the Local Plan explains that “*The site is predominantly located in Flood Zone 3a with parts in Flood Zones 1 and 2. However it has, in accordance with the guidance set out in the National Planning Policy Framework, passed both the sequential and exceptions tests. Parts of the site are at risk from surface water flooding, particularly the northern section, and the site is also susceptible to ground water flooding. Any application will have to demonstrate that current flood risk from all sources is mitigated, that flood risk to other areas is not increased and that where possible flood risk overall is reduced. The developer will need to work with Adur District Council, West Sussex County Council and the Environment Agency.*” This is reflected in Policy 5.

However, CPRE Sussex notes that West Sussex County Council, as Lead Local Flood Authority, expressed concerns at the allocation of major sites within the high flood risk zones 3a and 3b, especially New Monks Farm and Shoreham Airport, when commenting on the Revised Draft Local Plan. The County Council accepted that these sites passed the Sequential Test (due to a lack of available developable land outside of flood risk areas) and Part 1 of the Exception Test but considered that it had yet to be proven that Part 2 of the Exception Test could be definitively passed at this stage.

The County Council explained that in order to meet the requirements of Part 2 of the Exception Test as set out in the National Planning Policy Framework and associated guidance, the Local Plan should *demonstrate* (WSCC emphasis) that the development will be safe for its lifetime, the residual risks of flooding to people and property (including the likely effects of climate change) are acceptable and can be satisfactorily managed.

The County Council noted that the Strategic Flood Risk Assessment (SFRA) 2012 does not include the level of detail required that is set out in paragraph 8 of the Technical Guidance to the NPPF to demonstrate that Part 2 can be met according to paragraph 102 of the NPPF at the Local Plan stage.

The County Council accepted that that the majority of this detail should be provided at the application stage but pointed out that the Planning Practice Guidance (then in draft form, but now finalised) indicated that this should also be done at the Local Plan stage. As Lead Local Flood Authority, the County Council

stated that “Adur District Council should ensure that it is satisfied that it has been demonstrated that flood risk issues at Shoreham Airport and New Monks Farm can be technically and practically overcome to meet Part 2 of the Exception Test”.

However, notwithstanding these concerns expressed by the Lead Local Flood Authority, the District Council is still proposing that all of the responsibility for demonstrating that flood risks from all sources can be mitigated without worsening flood risk elsewhere lies with the developer. Although CPRE Sussex understands that the County Council has since given approval to this allocation, CPRE Sussex still considers that the District Council is abdicating its responsibilities under the National Planning Policy Framework and its associated guidance.

In addition, CPRE Sussex has commissioned its own independent Flood Risk Assessment of the three proposed key strategic sites at New Monks Farm, West Sompting and Shoreham Airport. A copy of this Assessment is submitted with these representations, but the conclusions of the Assessment include:

- *The EA Floodmap shows the sites to be located within Flood Zone 3b, 3a, 2 and 1, and the sites do not appear to benefit directly from the presence of defences to the required standard for planning.*
- *The Worthing and Adur SFRA shows:*
 - *New Monks Farm: surface water flooding event close to east of the site, numerous sewer, groundwater and fluvial flooding events in north west of site.*
- *Modelled surface water flooding shows all of the sites to be affected by predicted surface water ponding.*
- *With significant surface water flooding predicted in the north of the New Monks Farm site and along Old Shoreham Road and around the numerous drains and tributaries across all three sites.*
- *The Worthing and Adur SFRA shows areas of Intermediate Susceptibility to surface water flooding across all three sites.*
- *Numerous anecdotal records of flooding have been provided, including photographic evidence and anecdotal evidence suggests the following combined flood mechanisms occur:*
 - *surface water flooding occurs in these areas as surface water cannot drain into the ground because of very high groundwater levels;*
 - *surface waters cannot discharge into ditches and tributaries that ultimately drain in the River Adur when tidal levels are high (i.e. tide locking occurs).*
- *Given the underlying geology, it is clear that most if not all of the allocated*

areas are going to be unsuitable for infiltration SUDS and all developments will need to be connected to mains drainage. The sustainability of the infrastructure requirements of draining potentially hundreds of new homes, plus commercial space and associated roads and car parking into mains drainage may be questionable.

- In addition, further investigation will be required into any built construction or land re-profiling which could affect overland flow routes or surface water flood conveyance routes across the sites.*
- Further investigation is also recommended into the access and egress arrangements for the sites given the historical flooding records and potential for surface water flooding of the site access routes and adjacent roads.*
- The SFRA has highlighted 'significant' risks of groundwater flooding in the allocation areas.*
- There is a spring line at the base of the South Downs, where the Chalk aquifer dips below a cover of low permeability superficial deposits. There is firm evidence of groundwater emergence along this geological boundary (which is also, roughly, along the route of the A27). Emergence of groundwater here already causes local flooding issues. In addition, the superficial deposits can be seen to communicate tidal and river levels inland.*
- To date the modelling and strategic flood risk assessments take into account each flood mechanism as an isolated event. Convergence of several flood drivers (e.g. high groundwater levels plus high rainfall) may combine to cause unanticipated levels of flooding.*

It is clear from this Assessment that there is still significant uncertainty over the ability to develop the strategic site at New Monks Farm (and the strategic sites at West Sompting and Shoreham Airport) without encountering substantive flooding problems and quite possibly, exacerbating flooding problems elsewhere (flooding is not constrained to the proposed development area: whatever is developed in the north of the Lancing-Shoreham Gap will impact the drainage for the whole flood plain area – upstream and downstream, particularly West Beach, which will be at further risk of flooding from displaced surface water).

CPRE Sussex is aware that West Sussex County Council has commissioned CM2MHill (Halcrow) to undertake a complete study of the surface and groundwater flows across the Lancing Gap with flow and capacity measurements. We understand that this report will not be available until the Spring of 2015 and that it will propose solutions to stabilise and improve the drainage of the area for conditions which currently exist, taking no account of future developments arising from allocations in the Adur Local Plan.

CPRE Sussex considers that the submission of the Local Plan would be premature until this report is available and its conclusions can be used to inform

the Plan's policies and proposals, particularly the allocations of strategic sites at New Monks Farm and Shoreham Airport.

CPRE Sussex further considers that in the absence of this report and any further work undertaken by the District Council, and with the conclusions of the CPRE Sussex Assessment, the Council has failed to demonstrate that development at New Monks Farm would achieve clause V9 of the Local Plan's Vision – that *'flood risk will have been greatly reduced through..... the careful consideration of the location of new development'* – and, critically as regards the soundness of the Plan, that it would not be contrary to paragraph 100 of the National Planning Policy Framework, which states *"Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere"* and that Part 2 of the Exception Test can be met according to paragraph 102 of the NPPF.

Accordingly, CPRE Sussex does not consider the allocation of land at New Monks Farm, at this time at least, to be sound.

5. Please explain in the box below what change(s) you consider necessary to make the Adur Local Plan legally compliant and sound having regard to the reason you identified above.

(You will need to say why this change will make the Plan legally compliant or sound. It will be helpful if you are able to put forward your suggested or revised wording of any policy or supporting text. Please be as precise as possible).

CPRE Sussex believes that the correct procedure would be not to submit the Local Plan until the conclusions and recommendations of the CM2MHill Report are published (and publicly available) with, if necessary revisions to the Plan to take account of these conclusions and recommendations.

If the Council nevertheless proposes to submit the Plan before the CM2MHill Report is published, Policy 5 and its supporting text should be revised to make it clear that the development of the New Monks Farm strategic site will only be acceptable if this Report demonstrates that viable attenuation is possible to avoid ground/surface water flood risk to existing and new build properties (i.e., if this Report demonstrates that viable attenuation is not possible, the development of the site will not be acceptable. It should then be deleted from the Plan as a main modification).

We suggest the following amendment:

"If it can be demonstrated that viable attenuation is possible to avoid

ground/surface water flood risk to existing and new build properties, land at New Monks Farm.....”

6. If your representation concerns soundness or legal compliance and is seeking a change, do you consider it necessary to attend and give evidence at the hearing part of the examination? (tick as appropriate)

No, I wish to communicate through written representations

Yes, I wish to speak to the Inspector at the hearing sessions **YES**

Please note: The Inspector will determine the most appropriate procedure to hear those who have indicated that they wish to participate at the hearing part of the examination.

7. If you wish to participate at the hearing part of the examination, please outline why you consider this to be necessary.

CPRE Sussex wishes to submit evidence to the Inspector of flood risk, and the sustainability and deliverability of the sites referred to above.

8. Please tick if you do not wish to be informed of the following:

When the Plan has been submitted for Examination

When the recommendations from the Examination have been Published

When the Local Plan has been adopted

Part B – Representation

Please use separate sheets for each representation

1. Which part of the Adur Local Plan does this representation relate to?

Policy No.	<input type="text" value="6"/>	Paragraph No.	<input type="text"/>
Map	<input type="text"/>	Other section (please specify)	<input type="text"/>

2. Do you consider the Adur Local Plan to be: (tick as appropriate)

- 2.1 Legally Compliant Yes No
- 2.2 Sound Yes No

Please read the Guidance Note for guidance on legal compliance and soundness.

If you have ticked no to 2.1, please continue to Q4.

If you have ticked no to 2.2, please continue to Q3.

If you have ticked yes to 2.1 and 2.2 please go to Q7.

3. Do you consider the Adur Local Plan to be unsound because it is not: (tick as appropriate)

- 7.1 Positively Prepared
- 7.2 Justified
- 7.3 Effective

7.4 Consistent with National Policy ✓

4. If you consider the Adur Local Plan to be unsound or not legally compliant, please explain why in the box below:

Paragraph 2.70 of the Local Plan explains that “*The site lies predominantly within Flood Zone 1 with small areas in Flood Zone 2, 3a and 3b. Parts of the site are at risk from surface water flooding, particularly the southernmost part. The site is also susceptible to ground water flooding. The site layout will be expected to direct development away from the areas most at risk and appropriate mitigation measures will be required to reduce all forms of flood risk across the site. A Flood Risk Assessment will be required at the planning application stage and this will need to show that not only can flood risk be mitigated on site but that flood risk will not be worsened elsewhere. Opportunities to improve flood risk in the area should also be sought where possible.*” This is reflected in Policy 6.

CPRE Sussex has commissioned its own independent Flood Risk Assessment of the three proposed key strategic sites at New Monks Farm, West Sompting and Shoreham Airport. A copy of this Assessment is submitted with these representations, but the conclusions of the Assessment include:

- *The EA Floodmap shows the sites to be located within Flood Zone 3b, 3a, 2 and 1, and the sites do not appear to benefit directly from the presence of defences to the required standard for planning.*
- *The Worthing and Adur SFRA shows:
 - *Land to the west of Sompting: fluvial flooding event in north east corner of site, groundwater flooding events in north west corner of site, surface water event in south eastern corner of site.**
- *Modelled surface water flooding shows all of the sites to be affected by predicted surface water ponding.*
- *With significant surface water flooding predicted in the north of the New Monks Farm site and along Old Shoreham Road and around the numerous drains and tributaries across all three sites.*
- *The Worthing and Adur SFRA shows areas of Intermediate Susceptibility to surface water flooding across all three sites.*
- *Numerous anecdotal records of flooding have been provided, including photographic evidence and anecdotal evidence suggests the following combined flood mechanisms occur:
 - *surface water flooding occurs in these areas as surface water**

cannot drain into the ground because of very high groundwater levels;

- surface waters cannot discharge into ditches and tributaries that ultimately drain in the River Adur when tidal levels are high (i.e. tide locking occurs).

- Given the underlying geology, it is clear that most if not all of the allocated areas are going to be unsuitable for infiltration SUDS and all developments will need to be connected to mains drainage. The sustainability of the infrastructure requirements of draining potentially hundreds of new homes, plus commercial space and associated roads and car parking into mains drainage may be questionable.*
- In addition, further investigation will be required into any built construction or land re-profiling which could affect overland flow routes or surface water flood conveyance routes across the sites.*
- Further investigation is also recommended into the access and egress arrangements for the sites given the historical flooding records and potential for surface water flooding of the site access routes and adjacent roads.*
- The SFRA has highlighted 'significant' risks of groundwater flooding in the allocation areas.*
- There is a spring line at the base of the South Downs, where the Chalk aquifer dips below a cover of low permeability superficial deposits. There is firm evidence of groundwater emergence along this geological boundary (which is also, roughly, along the route of the A27). Emergence of groundwater here already causes local flooding issues. In addition, the superficial deposits can be seen to communicate tidal and river levels inland.*
- To date the modelling and strategic flood risk assessments take into account each flood mechanism as an isolated event. Convergence of several flood drivers (e.g. high groundwater levels plus high rainfall) may combine to cause unanticipated levels of flooding.*

It is clear from this Assessment that there is still significant uncertainty over the ability to develop the strategic site at West Sompting (and the strategic sites at New Monks Farm and Shoreham Airport) without encountering substantive flooding problems and quite possibly, exacerbating flooding problems elsewhere.

CPRE Sussex therefore considers that development at West Sompting would not achieve clause V9 of the Local Plan's Vision – that '*flood risk will have been greatly reduced through..... the careful consideration of the location of new development*' – and would be contrary to paragraph 100 of the National Planning Policy Framework, which states '*Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood*

risk elsewhere.'

Accordingly, CPRE Sussex does not consider the allocation of land at West Sompting to be sound.

5. Please explain in the box below what change(s) you consider necessary to make the Adur Local Plan legally compliant and sound having regard to the reason you identified above.

(You will need to say why this change will make the Plan legally compliant or sound. It will be helpful if you are able to put forward your suggested or revised wording of any policy or supporting text. Please be as precise as possible).

The strategic development site allocation at West Sompting should be removed from the Local Plan.

6. If your representation concerns soundness or legal compliance and is seeking a change, do you consider it necessary to attend and give evidence at the hearing part of the examination? (tick as appropriate)

No, I wish to communicate through written representations

Yes, I wish to speak to the Inspector at the hearing sessions **YES**

Please note: The Inspector will determine the most appropriate procedure to hear those who have indicated that they wish to participate at the hearing part of the examination.

7. If you wish to participate at the hearing part of the examination, please outline why you consider this to be necessary.

CPRE Sussex wishes to submit evidence to the Inspector of flood risk, and the sustainability and deliverability of the sites referred to above.

8. Please tick if you do not wish to be informed of the following:

When the Plan has been submitted for Examination

When the recommendations from the Examination have been Published

When the Local Plan has been adopted

Part B – Representation

Please use separate sheets for each representation

1. Which part of the Adur Local Plan does this representation relate to?

Policy No. Paragraph No.

Map Other section (please specify)

2. Do you consider the Adur Local Plan to be: (tick as appropriate)

2.1 Legally Compliant Yes No

2.2 Sound Yes No

Please read the Guidance Note for guidance on legal compliance and soundness.

If you have ticked no to 2.1, please continue to Q4.

If you have ticked no to 2.2, please continue to Q3.

If you have ticked yes to 2.1 and 2.2 please go to Q7.

3. Do you consider the Adur Local Plan to be unsound because it is not: (tick as appropriate)

7.5 Positively Prepared

7.6 Justified

- 7.7 Effective
- 7.8 Consistent with National Policy

4. If you consider the Adur Local Plan to be unsound or not legally compliant, please explain why in the box below:

When commenting on the Revised Draft Local Plan CPRE Sussex objected to the allocation of the strategic site at Shoreham Airport for a number of reasons, including flooding issues.

Paragraph 2.80 of the Local Plan explains that “*Shoreham Airport is currently located within Flood Zone 3b (functional floodplain). The airport is at risk from tidal and fluvial flooding and has a high susceptibility to groundwater flooding. There are also potential surface water flooding issues but these are less significant. The construction of the Shoreham Adur Tidal Walls Project led by the Environment Agency will reduce the likelihood of tidal and fluvial flooding at the airport and would result in a change to the Flood Zone of the airport from 3b to 3a (high probability). This change will facilitate the allocation of approximately 15,000 sqm of employment floorspace at Shoreham Airport to be constructed. The allocation is therefore dependent on the construction of the Tidal Walls. Technical approval has now been received for the Shoreham Adur Tidal Walls Project and the Environment Agency has secured funding to start the detailed design phase of the scheme. The Tidal Walls Scheme is not anticipated to be completed until approximately 2017 but the improvement of flood defences adjacent to the airport is likely to be undertaken as one of the early phases of this scheme.*” This is reflected in Policy 7.

However, CPRE Sussex notes that West Sussex County Council, as Lead Local Flood Authority, expressed concerns at the allocation of major sites within the high flood risk zones 3a and 3b, especially New Monks Farm and Shoreham Airport, when commenting on the Revised Draft Local Plan. The County Council accepted that these sites passed the Sequential Test (due to a lack of available developable land outside of flood risk areas) and Part 1 of the Exception Test but considered that it had yet to be proven that Part 2 of the Exception Test could be definitively passed at this stage.

The County Council explained that in order to meet the requirements of Part 2 of the Exception Test as set out in the National Planning Policy Framework and associated guidance, the Local Plan should *demonstrate* (WSSC emphasis) that the development will be safe for its lifetime, the residual risks of flooding to people and property (including the likely effects of climate change) are acceptable and can be satisfactorily managed.

The County Council noted that the Strategic Flood Risk Assessment (SFRA) 2012 does not include the level of detail required that is set out in paragraph 8 of

the Technical Guidance to the NPPF to demonstrate that Part 2 can be met according to paragraph 102 of the NPPF at the Local Plan stage.

The County Council accepted that that the majority of this detail should be provided at the application stage but pointed out that the Planning Practice Guidance (then in draft form, but now finalised) indicated that this should also be done at the Local Plan stage. As Lead Local Flood Authority, the County Council stated that “*Adur District Council should ensure that it is satisfied that it has been demonstrated that flood risk issues at Shoreham Airport and New Monks Farm can be technically and practically overcome to meet Part 2 of the Exception Test*”.

CPRE Sussex acknowledges that Policy 7 prevents any development on the proposed allocated site until the relevant section of the Shoreham Adur Tidal Walls on the west bank has been completed. However, we note that this would only reduce the categorisation of the site from “functional floodplain” (3b) to “high probability of flooding” (3a) rather than protect the site from flooding at all.

In addition, CPRE Sussex has commissioned its own independent Flood Risk Assessment of the three proposed key strategic sites at New Monks Farm, West Sompting and Shoreham Airport. A copy of this Assessment is submitted together with these representations, but the conclusions of the Assessment include:

- *The EA Floodmap shows the sites to be located within Flood Zone 3b, 3a, 2 and 1, and the sites do not appear to benefit directly from the presence of defences to the required standard for planning.*
- *The Worthing and Adur SFRA shows:*
 - *Shoreham Airport: sewer flooding event on site.*
- *Modelled surface water flooding shows all of the sites to be affected by predicted surface water ponding.*
- *With significant surface water flooding predicted in the north of the New Monks Farm site and along Old Shoreham Road and around the numerous drains and tributaries across all three sites.*
- *The Worthing and Adur SFRA shows areas of Intermediate Susceptibility to surface water flooding across all three sites.*
- *Numerous anecdotal records of flooding have been provided, including photographic evidence and anecdotal evidence suggests the following combined flood mechanisms occur:*
 - *surface water flooding occurs in these areas as surface water cannot drain into the ground because of very high groundwater levels;*
 - *surface waters cannot discharge into ditches and tributaries that ultimately drain in the River Adur when tidal levels are high (i.e. tide locking occurs).*

- *Given the underlying geology, it is clear that most if not all of the allocated areas are going to be unsuitable for infiltration SUDS and all developments will need to be connected to mains drainage. The sustainability of the infrastructure requirements of draining potentially hundreds of new homes, plus commercial space and associated roads and car parking into mains drainage may be questionable.*
- *In addition, further investigation will be required into any built construction or land re-profiling which could affect overland flow routes or surface water flood conveyance routes across the sites.*
- *Further investigation is also recommended into the access and egress arrangements for the sites given the historical flooding records and potential for surface water flooding of the site access routes and adjacent roads.*
- *The SFRA has highlighted 'significant' risks of groundwater flooding in the allocation areas.*
- *There is a spring line at the base of the South Downs, where the Chalk aquifer dips below a cover of low permeability superficial deposits. There is firm evidence of groundwater emergence along this geological boundary (which is also, roughly, along the route of the A27). Emergence of groundwater here already causes local flooding issues. In addition, the superficial deposits can be seen to communicate tidal and river levels inland.*
- *To date the modelling and strategic flood risk assessments take into account each flood mechanism as an isolated event. Convergence of several flood drivers (e.g. high groundwater levels plus high rainfall) may combine to cause unanticipated levels of flooding.*

It is clear from this Assessment that there is still significant uncertainty over the ability to develop the strategic site at New Monks Farm (and the strategic sites at West Sompting and Shoreham Airport) without encountering substantive flooding problems and quite possibly, exacerbating flooding problems elsewhere (flooding is not constrained to the proposed development area: whatever is developed in the north of the Lancing-Shoreham Gap will impact the drainage for the whole flood plain area – upstream and downstream, particularly West Beach, which will be at further risk of flooding from displaced surface water).

CPRE Sussex is aware that West Sussex County Council has commissioned CM2MHill (Halcrow) to undertake a complete study of the surface and groundwater flows across the Lancing Gap with flow and capacity measurements. We understand that this report will not be available until the Spring of 2015 and that it will propose solutions to stabilise and improve the drainage of the area for conditions which currently exist, taking no account of future developments arising from allocations in the Adur Local Plan.

CPRE Sussex considers that the submission of the Local Plan would be premature until this report is available and its conclusions can be used to inform the Plan's policies and proposals, particularly the allocations of strategic sites at New Monks Farm and Shoreham Airport.

CPRE Sussex further considers that in the absence of this report and any further work undertaken by the District Council, and with the conclusions of the CPRE Sussex Assessment, the Council has failed to demonstrate that development at New Monks Farm would achieve clause V9 of the Local Plan's Vision – that *'flood risk will have been greatly reduced through..... the careful consideration of the location of new development'* – and, critically as regards the soundness of the Plan, that it would not be contrary to paragraph 100 of the National Planning Policy Framework, which states *"Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere"* and that Part 2 of the Exception Test can be met according to paragraph 102 of the NPPF.

Accordingly, CPRE Sussex does not consider the allocation of land at Shoreham Airport, at this time at least, to be sound.

5. Please explain in the box below what change(s) you consider necessary to make the Adur Local Plan legally compliant and sound having regard to the reason you identified above.

(You will need to say why this change will make the Plan legally compliant or sound. It will be helpful if you are able to put forward your suggested or revised wording of any policy or supporting text. Please be as precise as possible).

CPRE Sussex believes that the correct procedure would be not to submit the Local Plan until the conclusions and recommendations of the CM2MHill Report are published (and publicly available) with, if necessary revisions to the Plan to take account of these conclusions and recommendations.

If the Council nevertheless proposes to submit the Plan before the CM2MHill Report is published, Policy 7 and its supporting text should be revised to make it clear that the development of the Shoreham Airport strategic site will only be acceptable if this Report demonstrates that viable attenuation is possible to avoid ground/surface water flood risk to existing and new build properties (i.e., if this Report demonstrates that viable attenuation is not possible, the development of the site will not be acceptable. It should then be deleted from the Plan as a main modification).

We suggest the following amendment to Policy 7:

If it can be demonstrated that viable attenuation is possible to avoid ground/surface water flood risk to existing and new buildings, land at Shoreham

Airport.....”

6. If your representation concerns soundness or legal compliance and is seeking a change, do you consider it necessary to attend and give evidence at the hearing part of the examination? (tick as appropriate)

No, I wish to communicate through written representations

Yes, I wish to speak to the Inspector at the hearing sessions **YES**

Please note: The Inspector will determine the most appropriate procedure to hear those who have indicated that they wish to participate at the hearing part of the examination.

7. If you wish to participate at the hearing part of the examination, please outline why you consider this to be necessary.

CPRE Sussex wishes to submit evidence to the Inspector of flood risk, and the sustainability and deliverability of the sites referred to above.

8. Please tick if you do not wish to be informed of the following:

When the Plan has been submitted for Examination

When the recommendations from the Examination have been Published

When the Local Plan has been adopted



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Flood Risk Assessment

PREPARED FOR: CPRE Sussex Countryside
Trust

REFERENCE #: 2146

DATE: November 2014



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PROJECT: FLOOD RISK ASSESSMENT

**LOCATION: KEY STRATEGIC SITES AT NEW MONKS FARM, LAND WEST OF SOMPTING, AND
SHOREHAM AIRPORT**

PREPARED FOR: CPRE SUSSEX COUNTRYSIDE TRUST

**KEY STRATEGIC SITES AT NEW MONKS FARM
LAND WEST OF SOMPTING
AND SHOREHAM AIRPORT**

PROJECT #: 2146

	<i>Name</i>	<i>Date</i>	<i>Signature</i>
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1. SUMMARY

This report presents the findings of a Flood Risk Assessment Report focusing on pluvial flood risk (surface water) and groundwater flood risk, which has been carried out for three major site allocations in the consultation draft of the Adur Local Plan. This report has been carried out using current best practices, including the criteria set out in the National Planning Policy Framework (NPPF).

The EA Floodmap shows the sites to be located within Flood Zone 3b, 3a, 2 and 1, and the sites do not appear to benefit directly from the presence of defences to the required standard for planning.

The Worthing and Adur SFRA shows:

- New Monks Farm: surface water flooding event close to east of the site, numerous sewer, groundwater and fluvial flooding events in north west of site.
- Land to the west of Sompting: fluvial flooding event in north east corner of site, groundwater flooding events in north west corner of site, surface water event in south eastern corner of site.
- Shoreham Airport: sewer flooding event on site.

Modelled surface water flooding shows all of the sites to be affected by predicted surface water ponding.

With significant surface water flooding predicted in the north of the New Monks Farm site and along Old Shoreham Road and around the numerous drains and tributaries across all three sites.

The Worthing and Adur SFRA shows areas of Intermediate Susceptibility to surface water flooding across all three sites.

Numerous anecdotal records of flooding have been provided, including photographic evidence and anecdotal evidence suggests the following combined flood mechanisms occur:

- surface water flooding occurs in these areas as surface water cannot drain into the ground because of very high groundwater levels;
- surface waters cannot discharge into ditches and tributaries that ultimately drain in the River Adur when tidal levels are high (i.e. tide locking occurs).

Given the underlying geology, it is clear that most if not all of the allocated areas are going to be unsuitable for infiltration SUDS and all developments will need to be connected to mains drainage. The sustainability of the infrastructure requirements of draining potentially hundreds of new homes, plus commercial space and associated roads and car parking into mains drainage may be questionable.

In addition, further investigation will be required into any built construction or land re-profiling which could affect overland flow routes or surface water flood conveyance routes across the sites.

Further investigation is also recommended into the access and egress arrangements for the sites given the historical flooding records and potential for surface water flooding of the site access routes and adjacent roads.

The councils Sequential and Exception Test document states that:

'...this site [New Monks Farm] suffers from significant surface water and groundwater flooding issues. These issues have been investigated further by the developer and the draft interim conclusions indicate that these issues can be mitigated. These draft conclusions have also been agreed by West Sussex County Council as the Local Lead Flood Authority'.

This investigation has not been seen by Ambiental in the preparation of this review report.

The SFRA has highlighted 'significant' risks of groundwater flooding in the allocation areas.

There is a spring line at the base of the South Downs, where the Chalk aquifer dips below a cover of low permeability superficial deposits. There is firm evidence of groundwater emergence along this geological boundary (which is also, roughly, along the route of the A27). Emergence of groundwater here already causes local flooding issues. In addition, the superficial deposits can be seen to communicate tidal and river levels inland.

To date the modelling and strategic flood risk assessments take into account each flood mechanism as an isolated event. Convergence of several flood drivers (e.g. high groundwater levels plus high rainfall) may combine to cause unanticipated levels of flooding.

Review of the developer's investigation on surface water and groundwater flooding at New Monks Farm site would be appreciated to better understand the work that has already been done.

A glossary of acronyms used within this report has been provided in Appendix E for quick reference.

2. INTRODUCTION

3.1 Site Location

This report presents the findings of a Flood Risk Assessment Report focusing on pluvial flood risk (surface water) and groundwater flood risk, which has been carried out for three major site allocations in the consultation draft of the Adur Local Plan. The Adur Local Plan was published for public comment on 20 October 2014. It identifies three Greenfield sites for development:

1. Land West of Sompting
2. New Monks Farm
3. Shoreham Airport

The location of these sites can be seen below in Figure 1. A more detailed view of each of the three sites can be seen in Figures 2 to 4.

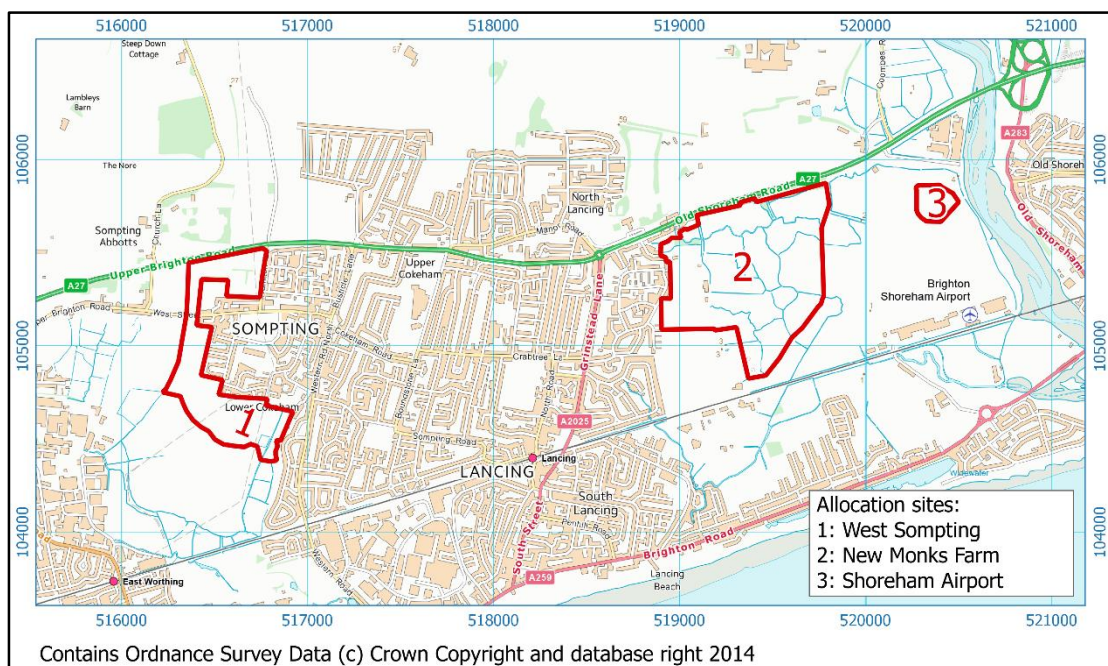


Figure 1: Site locations and context (Source: Proposed Submission Adur Local Plan 2014)

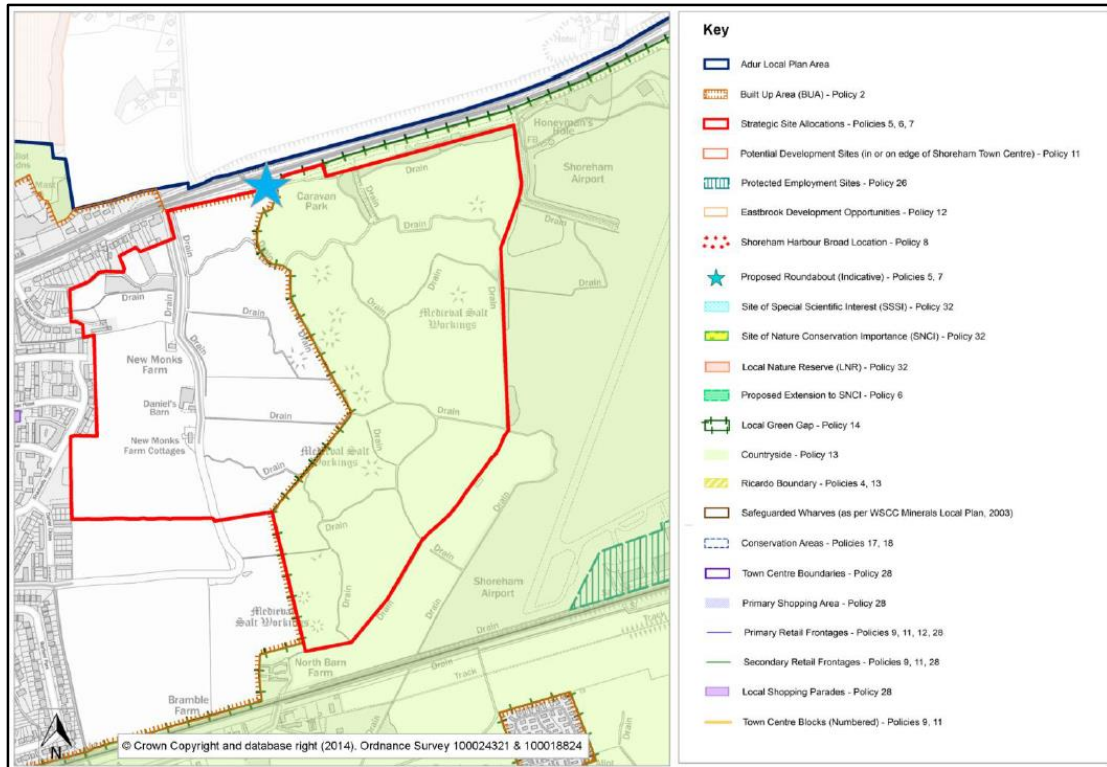


Figure 2: New Monks Farm site allocation (Source: Proposed Submission Adur Local Plan 2014)

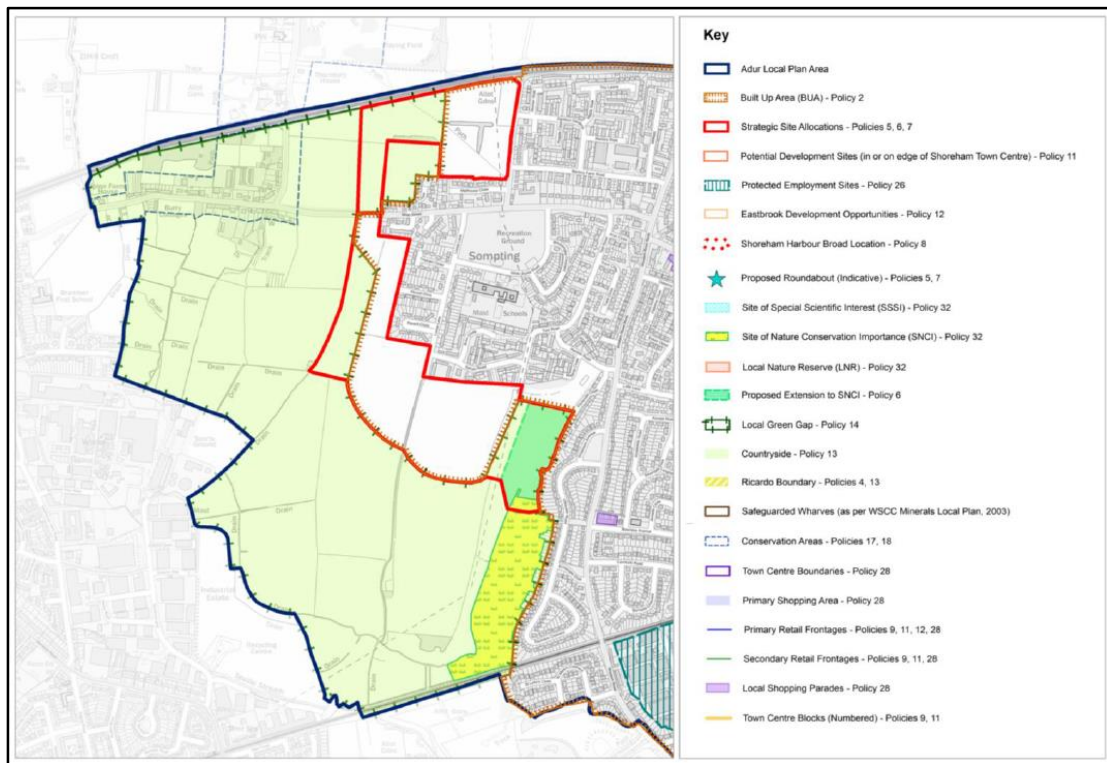


Figure 3: Land west of Sompting site allocation (Source: Proposed Submission Adur Local Plan 2014)

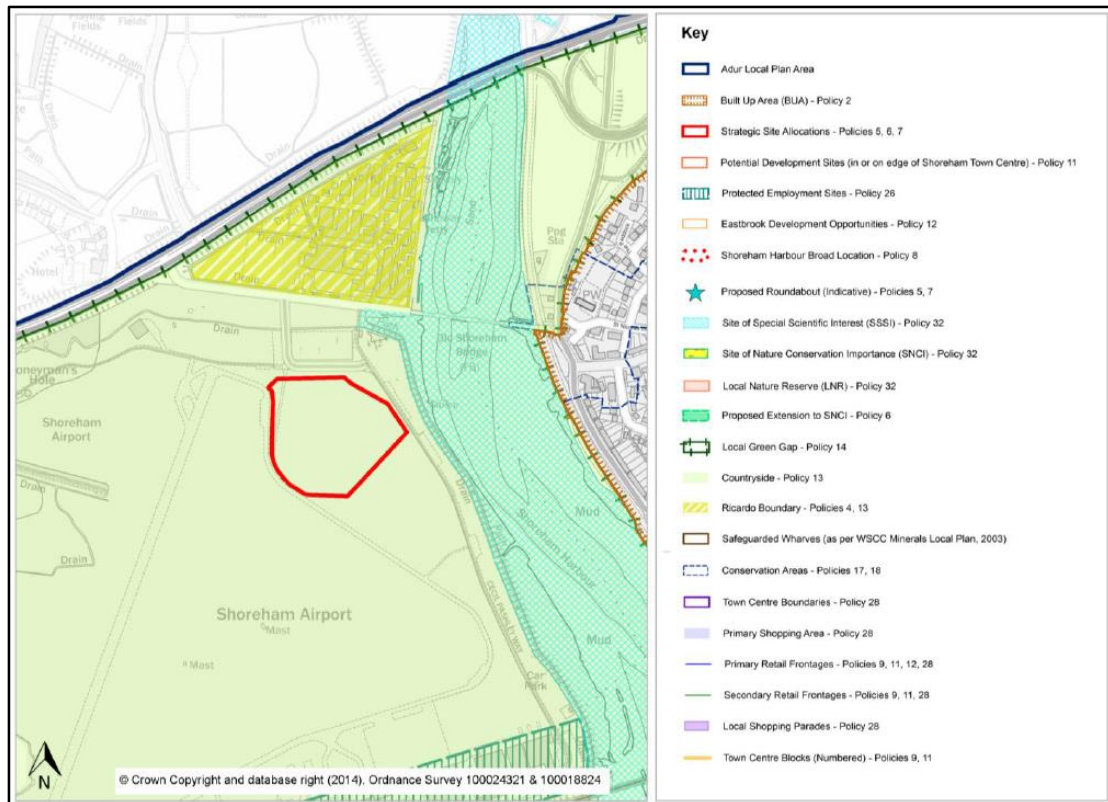


Figure 4: Shoreham Airport site allocation (Source: Proposed Submission Adur Local Plan 2014)

3.2 Site Topography

Topographic information for the sites and wider area was obtained in the form of a LiDAR derived Digital Terrain Model (DTM). Investigation of LiDAR data coverage revealed that 2m horizontal resolution data was available for the entire site areas. The LiDAR acquired has a vertical accuracy of approximately 12-15cm root-mean-square error (RMSE).

Topographic levels across the sites vary between approximately:

1. New Monks Farm: 1.4mAOD and 8.4mAOD. The land is characterised by higher banks of land (understood to be associated with golf course usage), crossed by numerous drainage channels.
2. Land west of Sompting: 1.7mAOD and 20.4mAOD. The land generally slopes down from north to south.
3. Shoreham Airport: 1.8mAOD and 2.0mAOD. The land is generally flat and relatively low lying.

3. FLUVIAL / TIDAL FLOOD RISK

4.1 Source(s) of Risk

Potential sources of fluvial/tidal risk in close proximity to the sites include:

- **River Adur and its drains and tributaries (including the Willow Brook)**
- **Teville Stream and its drains and tributaries**

4.2 EA Flood Zone(s)

According to the EA Flood Map, all three sites are located partially within Flood Zone's 3 and 2. Flood zoning for each site is discussed in Part Two of the Local Plan, and is dealt with in more detail in the SFRA (Strategic Flood Risk Assessment) update of 2012 and in the Sequential and Exception Test document. Each of the sites include areas in all flood zones:

1. New Monks Farm is predominantly located within Flood Zone 3a with some of the raised banks in the eastern portion of the site shown to be within Flood Zone's 2 and 1. A small portion of land near the western site boundary is also shown to be located partially within Flood Zone's 2 and 1.
2. Land west of Sompting is predominantly Flood Zone 1, with lower land in the south eastern corner of the site (in proximity to a drain / tributary of the Teville Stream) within Flood Zone's 3b, 3a and 2.
3. Shoreham Airport is predominantly within Flood Zone 3b and is in close proximity to the River Adur.

For reference, the EA Flood Zones are defined below:

	Description
Zone 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%).
Zone 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.
Zone 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.
Zone 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 Environment Agency, including water conveyance routes).

Table 2: Definition of EA Flood Zones as per the NPPF (Source: NPPF)

These flood zones are defined in part using JFLOW - a relatively coarse, national-scale flood modelling strategy (see Appendix C). It is important to note that only the *potential* fluvial/tidal floodplain is shown; the mitigating effects of any flood defences currently in place are not considered.

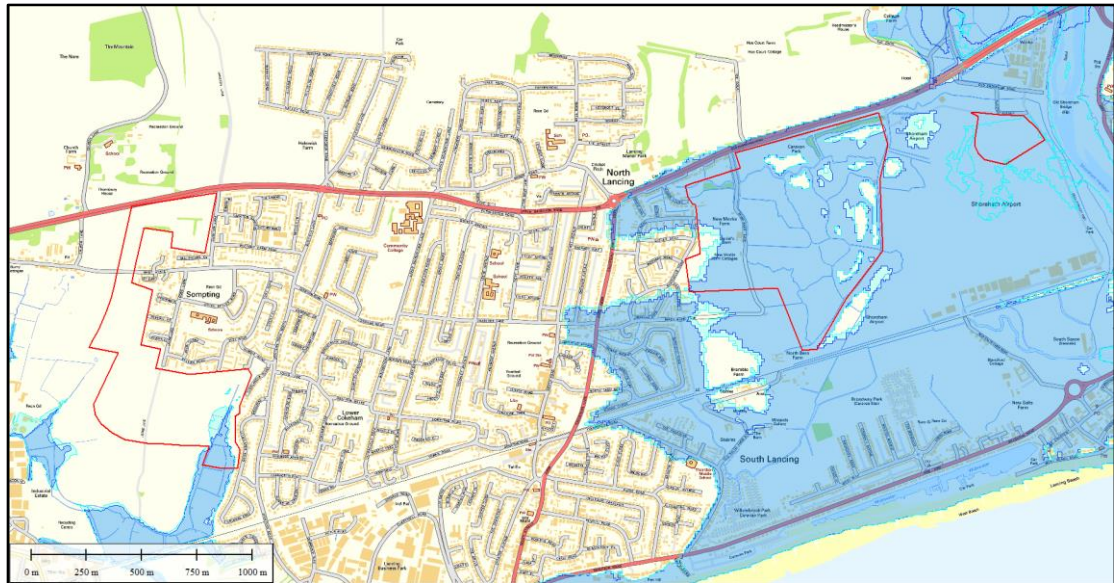


Figure 5: EA Floodmap. Light and dark blue areas represent EA Flood Zones 2 & 3a respectively (Source: EA)

The sites do not appear to benefit directly from the presence of flood defences that would protect to an adequate standard for planning.

4.3 Historic Flood Events

4.3.1 Environment Agency historic flood records

Communication with the EA has revealed that there are historic records of flooding in the local area of Lancing in 1960 (figure 6). The north west corner of the New Monks Farm site is shown to have been affected by these historic events.

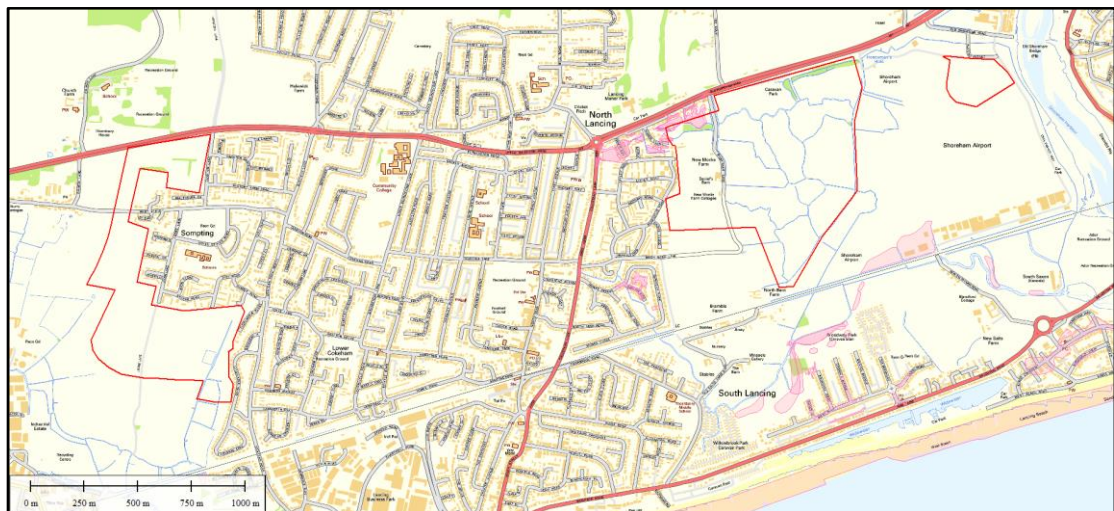


Figure 6: EA historic flood map (Source: EA)

4.3.2 Strategic Flood Risk Assessment records

The Worthing Borough Council and Adur District Council Strategic Flood Risk Assessment (SFRA) shows the following historic flooding records in the vicinity of the site allocations:

1. New Monks Farm: surface water flooding event close to east of the site, numerous sewer, groundwater and fluvial flooding events in north west of site.

2. Land to the west of Sompting: fluvial flooding event in north east corner of site, groundwater flooding events in north west corner of site, surface water event in south eastern corner of site.
3. Shoreham Airport: sewer flooding event on site.

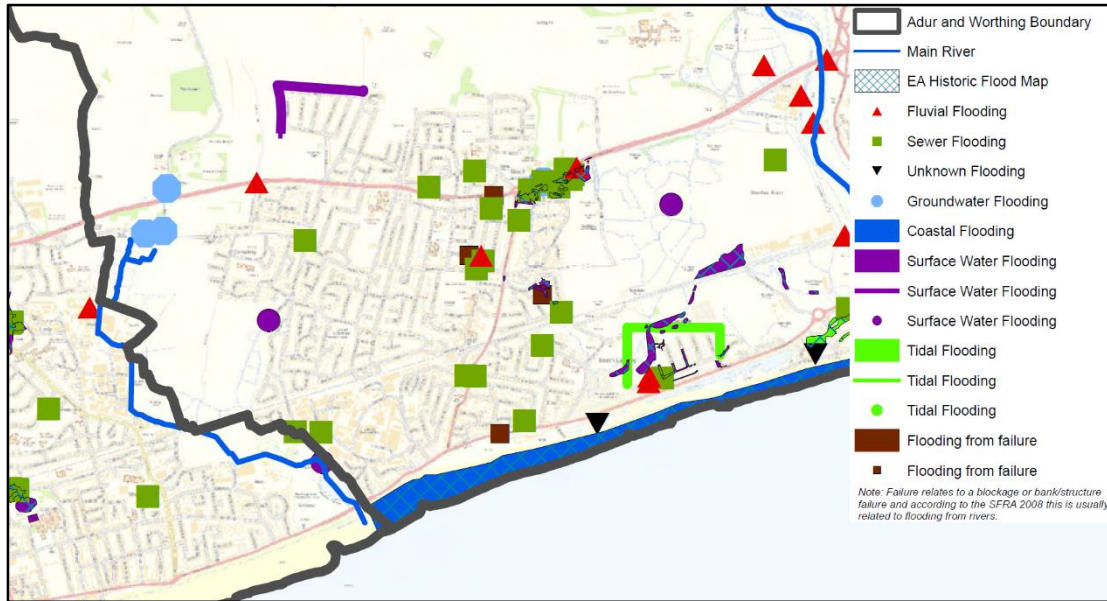


Figure 7: Historical flooding map (Source: Worthing Borough Council and Adur District Council Strategic Flood Risk Assessment)

4.3.3 Anecdotal and local resident records

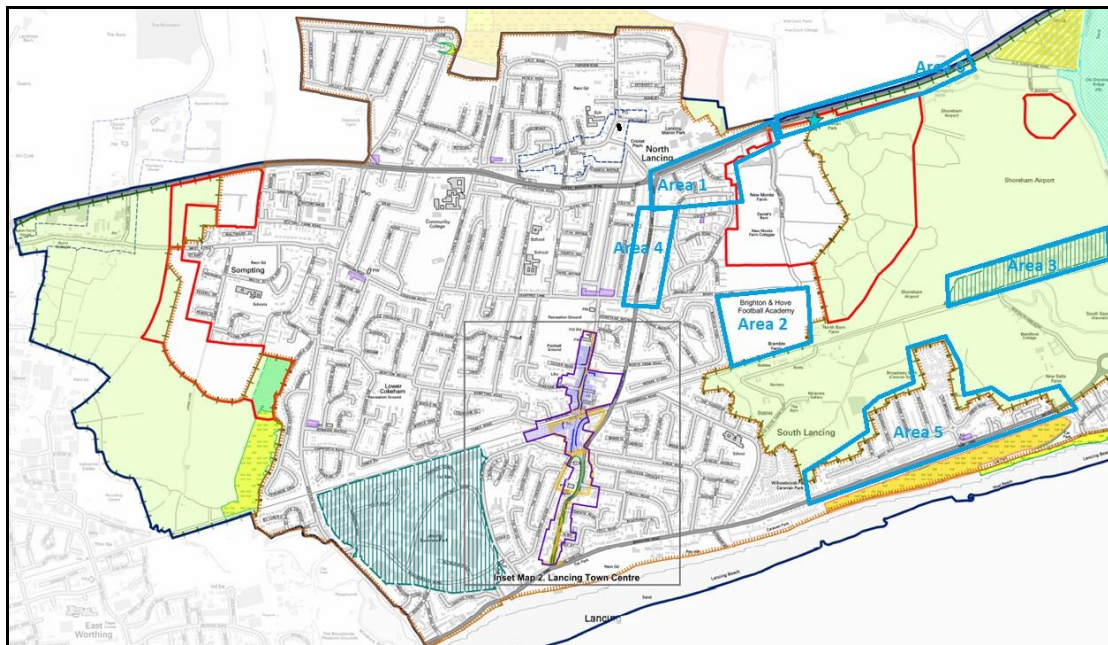


Figure 8: Map showing areas identified as having anecdotal historical flooding records (outlined and annotated in blue) (Source: anecdotal records of flooding)

The anecdotal records of flooding will be discussed further under the surface water and groundwater sections.

4.4 *Flood Defences*

The sites are not shown to be within the 'area benefitting from defences' on the EA floodmap, and as such it is assumed that the sites are not defended to the required 1:100 year fluvial and 1:200 year tidal standard for planning.

Shoreham does however benefit from coastal defences in the form of a shingle beach, with a new tidal defence scheme on the River Adur which is understood to be due to complete construction in 2014.

4. PLUVIAL FLOOD RISK (SURFACE WATER RUN-OFF)

5.1 Definition (NPPF)

The NPPF defines surface water flooding as:

“Intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems and that can run quickly off land and result in local flooding. In developed areas, this flood water can be polluted with domestic sewage where foul sewers surcharge and overflow. Local topography and built form can have a strong influence on the direction and depth of flow. The design of development down to a micro-level can influence or exacerbate this. Overland flow paths should be taken into account in spatial planning for urban developments. Flooding can be exacerbated if development increases the percentage of impervious area.”

New or re-developments must therefore incorporate management of surface water, as an essential element of reducing future flood risk to both the site and its surroundings.

5.2 Existing Risk

Ambiental has undertaken 2-dimensional surface water modelling for the purposes of this Flood Risk Assessment for the following return periods: 20 year, 50 year, 100 year, 100 year (with an allowance for climate change), 200 year and 1000 year. The technical modelling write-up can be found in the Appendix.

Modelled surface water flooding is shown to affect all three of the sites. For clarity the 1:100 year (with allowance for climate change) event is discussed here, as this is considered to be the key return period for planning.

1. New Monks Farm: surface water flooding is shown around the drainage network on site. Significant ponding is also shown in the north of the site (east of Manor Close) and either side of the northern section of Marsh Barn Lane. Surface water ponding is also shown along Old Shoreham Road.
2. Land west of Sompting: surface water flooding is shown around the drains and tributaries of the Teville Stream on site. In addition, a surface water flow path is shown from the Sompting-By-Pass / Upper Brighton Road to the south along Busticle Lane and south to reach the drains on site. The rest of the site is shown to be predominantly outside of modelled surface water flooding areas.
3. Shoreham Airport: surface water flooding flowpaths are shown crossing the site from north to south from Almond Avenue south towards Shoreham Airport, and southeast towards Cecil Pashley Way.

The Worthing and Adur SFRA also maps Areas Susceptible to Surface Water Flooding (figure 9). This surface water modelling shows the following for the three sites:

1. New Monks Farm: the majority of the site is shown to be at Intermediate Susceptibility to Surface Water Flooding. The northern section of the entire site (from north of Manor Close) is entirely within the Intermediate Susceptibility area.
2. Land west of Sompting: the south eastern corner of the site is shown to be within an Intermediate Susceptibility area. There are also Low Susceptibility in the north of the site.
3. Shoreham Airport: the majority of the site is shown to be at Intermediate and Less susceptibility to surface water flooding.

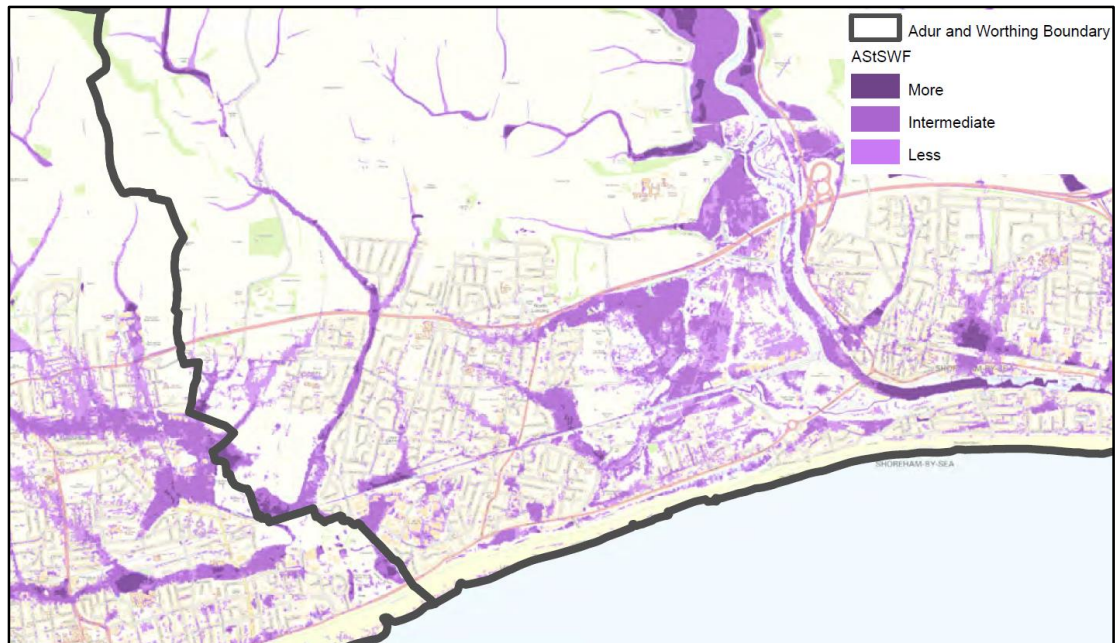


Figure 9: Areas Susceptible to Surface Water Flooding (Source: Worthing Borough Council and Adur District Council Strategic Flood Risk Assessment).

The Worthing and Adur SFRA has identified historic records of surface water flooding at the upstream extent of the drains (tributaries of Teville Stream) within the Land west of Sompting site. Surface water flooding records are also shown in the north west of New Monks Farm, however it is considered likely that the numerous sewer flooding events in this area are attributable in part to surface water sources – either surcharging of surface water sewers, or surface water ingress into sewers. A sewer flooding record is also identified within the Shoreham Airport site, which could well be attributable to surface water sources.

The anecdotal records and photographs of historic flooding events are discussed in the Groundwater flooding section. It should be noted that anecdotal evidence suggests the following combined flood mechanisms occur:

- surface water flooding occurs in these areas as surface water cannot drain into the ground because of very high groundwater levels;
- surface waters cannot discharge into ditches and tributaries that ultimately drain in the River Adur when tidal levels are high (i.e. tide locking occurs).

5.3 Planning Considerations

New developments generally reduce the ground permeability of the wider site. This can significantly change the site's response to rainfall and, without attenuation, the volume of water that runs off the site; thereby likely increasing the peak run-off rate. As such, substantial surface water drainage techniques should be applied to developments so that the risk to the development itself and the surrounding area is not increased.

The NPPF states:

“The surface water drainage arrangements for any development site should be such that the volumes and peak flow rates of surface water leaving a developed site are no greater than the rates prior to the proposed development, unless specific off-site arrangements are made and result in the same net effect.”

Therefore, any re-development on-site should incorporate effective measures to prevent an increase in surface water generation, by attenuating runoff to the existing site runoff rate.

Techniques to improve surface water management are often referred to as Sustainable Urban Drainage Systems (SUDS). The NPPF describes a range of SUDS techniques which vary in suitability from site to site.

These techniques are summarised below:

- Source control measures including rainwater recycling and drainage;
- Infiltration devices to allow water to soak into the ground, that can include individual soakaways and communal facilities;
- Filter strips and swales, which are vegetated features that hold and drain water downhill mimicking natural drainage patterns;
- Filter drains and porous pavements to allow rainwater and run-off to infiltrate into permeable material below ground and provide storage if needed; and
- Basins and ponds to hold excess water after rain and allow controlled discharge that avoids flooding.

Given the underlying geology however, it is clear that most if not all of the allocated areas are going to be unsuitable for infiltration SUDS and all developments will need to be connected to mains drainage. The sustainability of the infrastructure requirements of draining potentially hundreds of new homes into mains drainage may be questionable.

In addition, further investigation will be required into any built construction or land re-profiling which could affect overland flow routes or surface water flood conveyance routes across the sites. Further investigation is also recommended into the access and egress arrangements for the sites given the historical flooding records and potential for surface water flooding of the site access routes and adjacent roads.

5. GROUNDWATER FLOOD RISK

6.1 Introduction

This section presents an overview of the sensitivity of the location with respect to groundwater flooding, and aims to identify any omissions from the Adur Local Plan and its supporting documents.

This groundwater section has been prepared by Dr Stephen Buss MA MSc CGeol. Dr Buss is a UK-based independent hydrogeologist with more than 15 years' consulting experience in solving groundwater issues for the Environment Agency, water companies and other private sector organisations.



6.2 The Adur Local Plan

In the 2012 update of the SFRA the risk of groundwater flooding is dealt with partly by reference to historical groundwater flood events and partly to the Environment Agency's dataset of Areas Susceptible to Groundwater Flooding (AStGWF). AStGWF is a strategic scale map showing areas that might be prone to groundwater flooding on a 1km square grid.

Historical groundwater flooding events are mapped in the Map 3 of the SFRA¹. A handful of events are mapped around the headwaters of the Teville Stream (c. TQ 1592 0519), just outside of the West Sompting allocated area.

However there is more information on groundwater flooding in the New Monks Farm area, in the Sequential and Exception Test document. This states that,

'...this site suffers from significant surface water and groundwater flooding issues. These issues have been investigated further by the developer and the draft interim conclusions indicate that these issues can be mitigated. These draft conclusions have also been agreed by West Sussex County Council as the Local Lead Flood Authority.'

This investigation has not been seen by Ambiental in the preparation of this review report.

From examination of the AStGWF map the SFRA concludes that,

'The majority of Adur District is susceptible to groundwater flooding. The only areas that don't appear to be susceptible to groundwater flooding are the north west and north east parts of the district which are mainly rural. The central area of the district between the A27 and to Shoreham-by-Sea is more susceptible to groundwater flooding with a high-risk category ($\geq 75\%$); the rest of the area is covered by a range of risk categories ($< 25\%$ to $< 75\%$).'

6.3 This Report

The SFRA has highlighted 'significant' risks of groundwater flooding in the allocation areas. On the basis of the available information from the Council (i.e. not including the developer's study of surface and groundwater flooding), this report aims to:

- Refine the understanding of groundwater flooding in the area.

- Identify if groundwater flooding is likely to occur over the development sites to an extent greater than the anticipated river flood risk, and to highlight areas of concern that might not be dealt with in the SFRA.
- Identify whether the hydraulic modelling adequately takes into account potential groundwater contributions to flooding.

6.4 *Physical Background*

6.4.1 *Overview*

All three sites lie on the coastal plain south of the South Downs, either side of the town of Sompting. The plain is low lying and, other than a small area of the West Sompting site, the elevation of the sites is less than 10mAOD.

Local hydrology is dominated by the tidal River Adur, to the east of the sites. Shoreham Airport is in the functional floodplain of the River Adur. New Monks Farm is also within the flood plain area of the River Adur but actually comprises the extensively-drained catchment of the Willow Brook which flows through South Lancing (depth of the drains is indicated well in the terrain map). West Sompting is in the upper catchment of the Teville Stream, which separates East Worthing and Lancing.

6.4.2 *Geology and Hydrogeology*

Bedrock geology at all three sites comprises Chalk (Newhaven Chalk Formation beneath the sites east of Lancing and Tarrant Chalk Formation west of Lancing). Chalk is a very permeable rock and forms an excellent aquifer; Chalk aquifers provide the principal groundwater supply for Southern and South East England.

West of Sompting the Chalk is overlain by Head, which is a superficial deposit comprising mixed sand, silt and clay that develops from sub-aerial weathering of the hills that form the South Downs. Local borehole records are not very descriptive in terms of lithology or thickness of the Head, but one borehole² about 250 m to the north west of the West Sompting allocation area shows 1 m of gravel, followed by 4 m of yellow clay, above chalk strata.

East of Lancing the Chalk is overlain by alluvium. This is, again, a mixed sand, silt and clay deposit, which forms by deposition from rivers. Extensive drainage in the Willow Brook catchment suggests that the alluvium has in places rather low permeability. There are more boreholes in this area³ (from the site investigation for Shoreham airport). These show layers of silty and sandy clay, clayey sand and fine sand so the spatial and vertical heterogeneity of hydraulic conductivity within the deposits will be significant.

There are no licensed groundwater abstractions⁴ within any of the allocation areas. There is one moderate agricultural abstraction to the south of New Monks Farm, at the edge of South Lancing and a small agricultural abstraction to the North of Lancing College. Neither are of a sufficient size to significantly change groundwater levels within the allocation areas.

² http://scans.bgs.ac.uk/sobi_scans/boreholes/577505/

³ http://scans.bgs.ac.uk/sobi_scans/boreholes/18141050, http://scans.bgs.ac.uk/sobi_scans/boreholes/577582, http://scans.bgs.ac.uk/sobi_scans/boreholes/577580, http://scans.bgs.ac.uk/sobi_scans/boreholes/578008, http://scans.bgs.ac.uk/sobi_scans/boreholes/577581

⁴ <http://apps.environment-agency.gov.uk/wiyby/default.aspx>

The conceptual model presented for the Lancing Surface Water Management Plan by CH2MHill in October 2014 is a good cross-section of the site geology (Figure 10). This shows groundwater moving southwards from the topographic high of the South Downs, underneath the low permeability sediments of the coastal plain. Springs emerge at the position where the chalk outcrop dips under the superficial sediments (Honeymans Hole Spring here) and at any location where there is a permeable pathway out to the coast.

Whilst acknowledging that it is only meant as a cartoon explanation of the groundwater system, there is misrepresentation of the magnitude of groundwater flow in Figure 10. Large groundwater flows (big blue arrows) do come down from the South Downs. However the small arrows at Honeymans Hole Spring and through the raised beach deposits suggest that these are small discharges. Fresh groundwater cannot go past the saline intrusion so it has to go somewhere: it has to go upwards through the cover of low permeability sediments. Or – if there is no escape route, more flows will emerge at the spring locations at the base of the Downs.

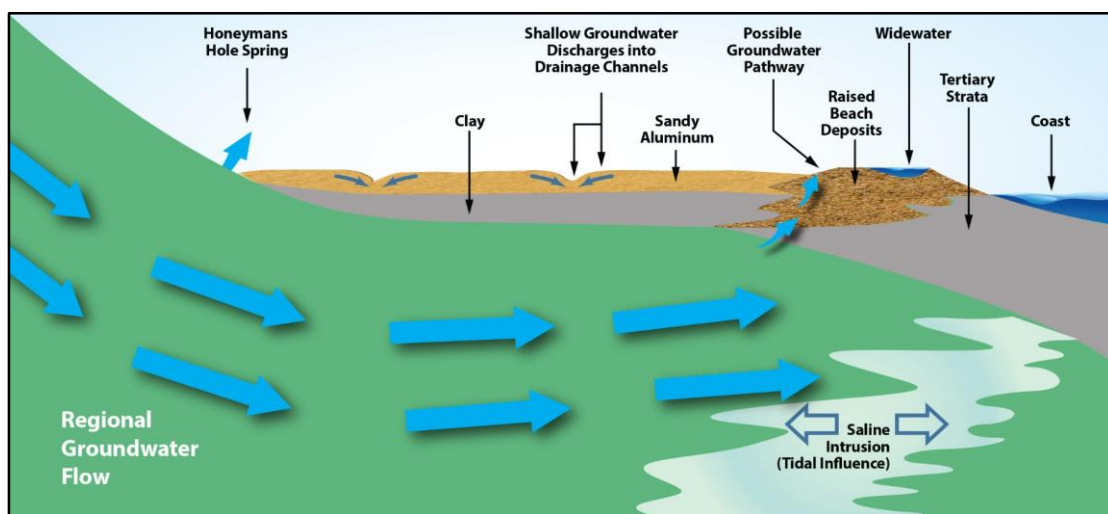


Figure 10: Cross-section of site geology (Source: Lancing Surface Water Management Plan by CH2MHill in October 2014)

6.4.3 Groundwater Levels

A considerable number of historical wells are recorded along the feather edge of the Head, west of the West Sompting area⁸. All appear to penetrate down to the Chalk, and some were artesian (i.e. groundwater head was above ground surface) when drilled. These locations are coincident with the springs in the headwaters of the Teville Stream and the reports of groundwater flooding mentioned in the SFRA 2012 update.

In the boreholes drilled for the Shoreham airport site investigation¹⁰ in May 1987, groundwater was struck within 2 m of the ground surface and the water level rose to within 1 m of the ground surface.

6.5 Groundwater Flood Risk

6.5.1 Introduction

Groundwater flooding may arise from a number of sources:

Bedrock groundwater flooding

Bedrock groundwater flooding may arise as a result of groundwater discharge from permeable aquifers after prolonged extreme rainfall. This type of flooding has occurred elsewhere in the South Downs, in the Berkshire Downs, North Downs, Hampshire, Wiltshire, and Dorset this previous winter. Almost all of these locations flooded because of the special hydrogeological characteristics of the Chalk aquifer⁵. The main local areas where this is a concern are in the dry valleys of the South Downs, not on the coastal plain.

Nevertheless spring flows may emerge at the break of slope where aquifers dip beneath impermeable superficial deposits, and this is most likely to have been the source of groundwater flooding incidents west of Sompting. Groundwater under artesian pressures can escape upwards through low permeability deposits either through naturally-formed spring conduits; or through wells and boreholes that were not backfilled properly.

Locations west of Sompting may be prone to groundwater flooding via this mechanism.

Alluvial groundwater flooding

Alluvial groundwater flooding (or permeable superficial deposits [PSD] groundwater flooding) occurs during periods of high local river or tidal stage, when groundwater levels rise as a result of raised river or tidal levels. Groundwater moves through permeable bankside sediments and rises into hollows in the ground surface that are separated from the main river or tidal flood by higher land.

With relatively flat topography, shallow groundwater levels and a river prone to flooding from fluvial and coastal influences the sites east of Lancing may be prone to this form of groundwater flooding.

6.5.2 Groundwater Flooding Susceptibility

The SFRA used the Environment Agency AStGWF map⁶ to give a strategic overview of the likelihood of groundwater flooding in the area. Using this dataset the SFRA concluded that much of the allocation areas were prone to groundwater flooding.

The AStGWF map was derived from the finer resolution map of groundwater flooding susceptibility, released by the British Geological Survey. This uses geological mapping and known high groundwater levels to map at 50x50 m resolution the susceptibility of groundwater flooding; this is reproduced in Figure 11. This classification for all three sites indicates that there are areas that might be prone to groundwater flooding, especially those east of Lancing.

⁵ Bradford and Croker, 2007. <http://qj.egh.lyellcollection.org/content/40/1/67>

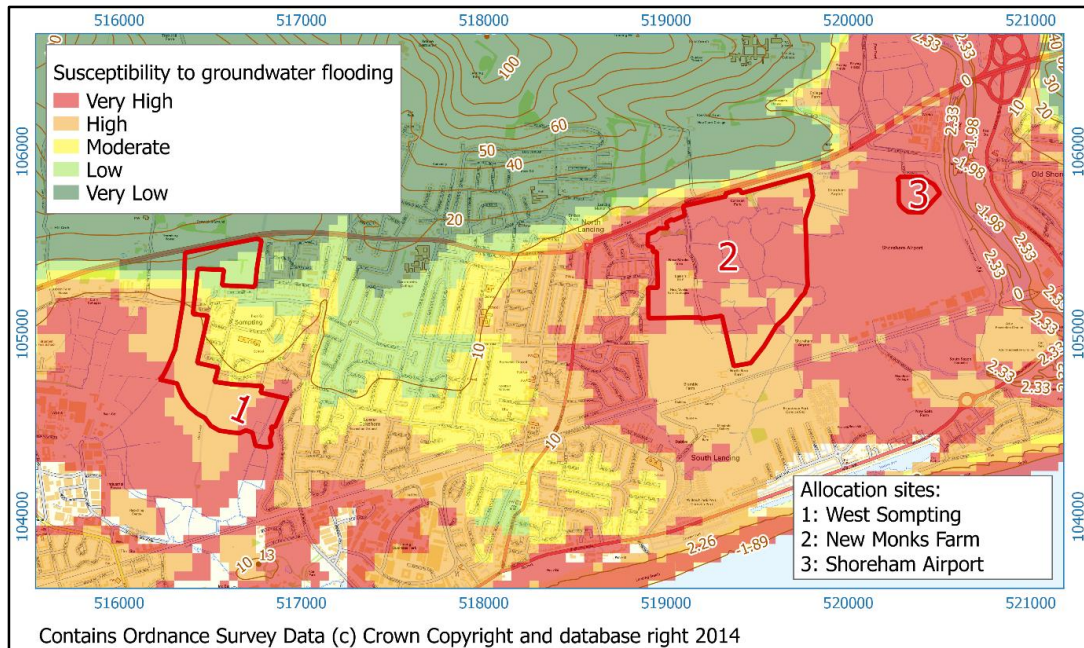


Figure 11: Groundwater flooding susceptibility (Source: BGS)

6.5.3 Local Evidence of Groundwater Issues

There are a number of known groundwater issues within the allocated areas, especially in the New Monks Farm area. An index of the locations referred to in the following sub-sections is presented in Figure 12.

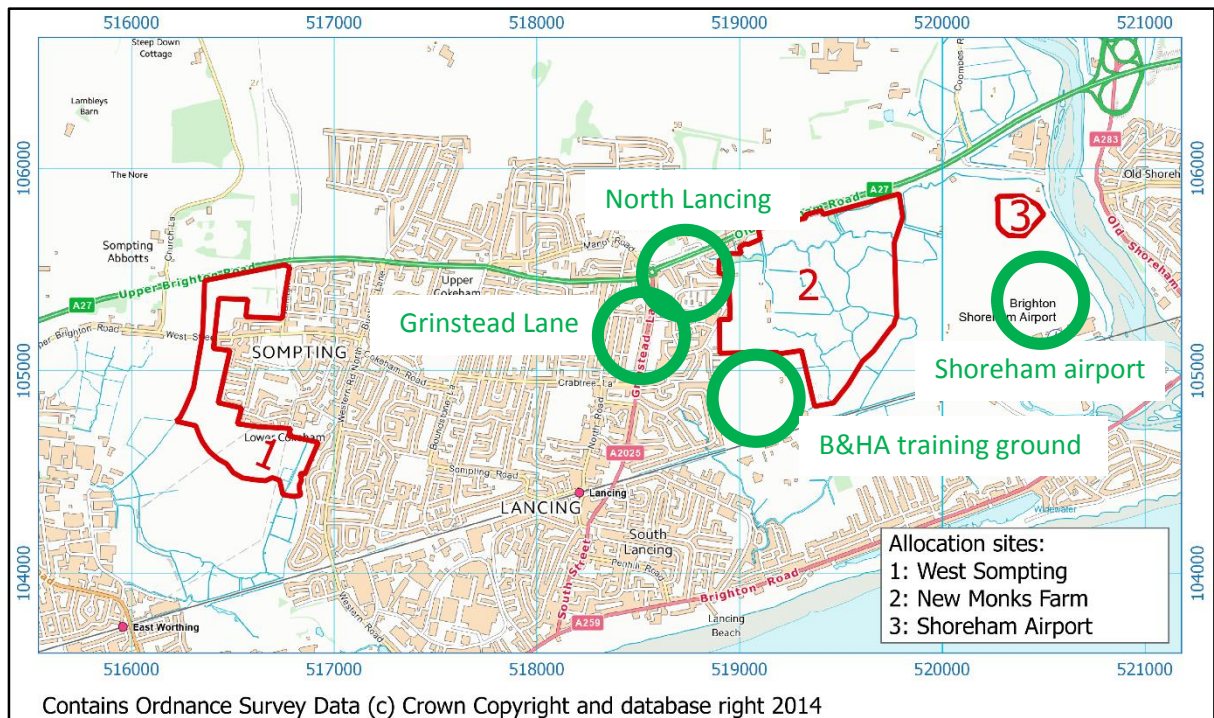


Figure 12: Local evidence of groundwater issues (labels in green)

6.5.3.1 *Brighton and Hove Albion Training Ground – groundwater level monitoring*

The new Brighton and Hove Albion Training Ground is being built on an adjacent plot to New Monks Farm, just to the south west of the area. Groundwater level monitoring was undertaken in eleven boreholes in 2012 and 2013 (reported in a letter dated 5 July 2013 from Soils Limited – Appendix A). Groundwater levels in several of the boreholes show some control from both rainfall and tides. In summary, long-term data for the boreholes show a range in groundwater level fluctuation of around 50cm, although some had a rather lower range.

When monitoring at a very fine time period, a response to individual rainfall events of 10-15mm was noted in some boreholes, which gave rise to a 10-20cm change in groundwater level. This appears to be a disproportionate increase in level (a rise of perhaps 3-5cm might be expected from infiltration alone) so this seems (in our opinion) to be an indication of a linkage between Willow Brook (in which water levels might easily have risen by tens of centimetres) and the groundwater.

The influence of tidal signals was small but clear in some boreholes: up to a 15cm range in groundwater level was observed as a result of a 6m tidal range. These boreholes are about 900m away from the shore.

(Borehole logs or locations have not been seen in preparation of this report so it is not clear what the proximity to water features is, or the depth of the piezometers used in monitoring. Borehole datums are also unknown so it is not clear what depth to groundwater these data give.)

No evidence has been seen that indicates that the flooding of Winter 13/14 at the construction site was related to groundwater emergence or to high groundwater levels. However if the monitoring data indicates near-surface groundwater levels and the adjacent drains were full to the banks then there is likely to have been a groundwater component.

6.5.3.2 *North Lancing - photographic evidence*

Photographs of flooding across North Lancing have been provided (Appendix B). These were taken over the previous few winters in the streets west of, and adjacent to, the New Monks Farm area. A notable feature of many of the photographs is that the water is very clear – this is typical of groundwater flooding. This observation alone does not make it a definitive identification.

The geological environment of this area (and of the northern part of the New Monks Farm area) is broadly the same as that west of Sompting. That is, chalk with a southward thickening layer of low permeability superficial deposits on it. Groundwater flooding, and springs, and shallow artesian wells, are seen in this environment west of Sompting. There is no geological reason to suggest that the case may not be the same in this area. The network of drains (were these historically spring-fed streams?) around Manor Close suggests that there may have historically been groundwater that needed draining.

6.5.3.3 *Shoreham Airport - photographic evidence*

Again the photographs of Shoreham Airport flooding show clear water (Appendix C). Shoreham Airport is, however, rather farther away from the boundary between the chalk outcrop and the overlying sediments.

In this instance the River Adur may have been very high and the flood waters moved laterally through the permeable alluvial sediments to emerge in shallow hollows at the ground surface. (Clarity of the water would have been caused by filtration through the sediments.) Alternatively this may be surface water flooding that cannot drain into the ground because of very high groundwater levels.

6.5.3.4 *Grinstead Lane - photographic evidence*

Photographs of Grinstead Lane show clear water emerging from a manhole to flood the road (Appendix D). This may be surface water flooding but, given the geological environment at the spring line at the foot of the South Downs it would be surprising if there was no groundwater component.

6.6 *Conclusions*

This report reviews available evidence for groundwater contributions to flooding in the areas east of Lancing and west of Sompting. There is a spring line at the base of the South Downs, where the Chalk aquifer dips below a cover of low permeability superficial deposits. There is firm evidence of groundwater emergence along this geological boundary (which is also, roughly, along the route of the A27). Emergence of groundwater here already causes local flooding issues. In addition, the superficial deposits can be seen to communicate tidal and river levels inland.

In this environment, where river, coastal, surface water and groundwater flooding interact it is essential to develop a firm understanding of the inter-dependencies. To date the modelling and strategic flood risk assessments take into account each flood mechanism as an isolated event. Convergence of several flood drivers (e.g. high groundwater levels plus high rainfall) may combine to cause unanticipated levels of flooding. (For example in the Windsor area earlier this year two unexceptional storms caused considerable flooding next to the River Thames because the river was already full of groundwater from the exceptionally wet winter.)

Review of the developer's investigation on surface water and groundwater flooding at New Monks Farm site would be appreciated to better understand the work that has already been done.

It is clear that most if not all of the allocated areas are going to be unsuitable for infiltration SUDS and all developments will need to be connected to mains drainage.

6. CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER WORK

- The EA Floodmap shows the sites to be located within Flood Zone 3b, 3a, 2 and 1, and the sites do not appear to benefit directly from the presence of defences to the required standard for planning.
- The Worthing and Adur SFRA shows:
 - New Monks Farm: surface water flooding event close to east of the site, numerous sewer, groundwater and fluvial flooding events in north west of site.
 - Land to the west of Sompting: fluvial flooding event in north east corner of site, groundwater flooding events in north west corner of site, surface water event in south eastern corner of site.
 - Shoreham Airport: sewer flooding event on site.
- Modelled surface water flooding shows all of the sites to be affected by predicted surface water ponding.
- With significant surface water flooding predicted in the north of the New Monks Farm site and along Old Shoreham Road and around the numerous drains and tributaries across all three sites.
- The Worthing and Adur SFRA shows areas of Intermediate Susceptibility to surface water flooding across all three sites.
- Numerous anecdotal records of flooding have been provided, including photographic evidence and anecdotal evidence suggests the following combined flood mechanisms occur:
 - surface water flooding occurs in these areas as surface water cannot drain into the ground because of very high groundwater levels;
 - surface waters cannot discharge into ditches and tributaries that ultimately drain in the River Adur when tidal levels are high (i.e. tide locking occurs).
- Given the underlying geology, it is clear that most if not all of the allocated areas are going to be unsuitable for infiltration SUDS and all developments will need to be connected to mains drainage. The sustainability of the infrastructure requirements of draining potentially hundreds of new homes, plus commercial space and associated roads and car parking into mains drainage may be questionable.
- In addition, further investigation will be required into any built construction or land re-profiling which could affect overland flow routes or surface water flood conveyance routes across the sites.
- Further investigation is also recommended into the access and egress arrangements for the sites given the historical flooding records and potential for surface water flooding of the site access routes and adjacent roads.
- The councils Sequential and Exception Test document states that:

'...this site [New Monks Farm] suffers from significant surface water and groundwater flooding issues. These issues have been investigated further by the developer and the draft interim conclusions indicate that these issues can be mitigated. These draft conclusions have also been agreed by West Sussex County Council as the Local Lead Flood Authority'.
- This investigation has not been seen by Ambiental in the preparation of this review report.

- The SFRA has highlighted 'significant' risks of groundwater flooding in the allocation areas.
- There is a spring line at the base of the South Downs, where the Chalk aquifer dips below a cover of low permeability superficial deposits. There is firm evidence of groundwater emergence along this geological boundary (which is also, roughly, along the route of the A27). Emergence of groundwater here already causes local flooding issues. In addition, the superficial deposits can be seen to communicate tidal and river levels inland.
- To date the modelling and strategic flood risk assessments take into account each flood mechanism as an isolated event. Convergence of several flood drivers (e.g. high groundwater levels plus high rainfall) may combine to cause unanticipated levels of flooding.
- Review of the developer's investigation on surface water and groundwater flooding at New Monks Farm site would be appreciated to better understand the work that has already been done.

For more information on our flood risk products and services including detailed reports and site investigations, please contact Ambiental Technical Solutions on:

Tel: 01273 704441

Fax: 01273 704499

Email: fra@ambiental.co.uk

Or visit our website at:

www.ambiental.co.uk

7. DISCLAIMER AND LIMITATIONS

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Ambiental have performed the services previously specified in a manner consistent with the high level of skill and care ordinarily exercised by members of the flood modelling profession. We do not warrant nor guarantee that acquisition, compilation, and analysis of topographic and hydrological data will enable identification of all potential flood risks within a study area.

The advice and opinions in this report should be read and relied on only in the context of the report as a whole. As with any environmental appraisal or investigation, the conclusions and observations are based on limited data. The risk of undiscovered environmental impairment of the property cannot be ruled out. Ambiental cannot therefore warrant the actual conditions at the site and advice given is limited to those conditions for which information is held by Ambiental at the time. The findings are based on the information made available to Ambiental at the date of the report (and will have been assumed to be correct) and on current UK standards, codes, technology and practices as at that time.

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APPENDIX A: BRIGHTON AND HOVE ALBION TRAINING GROUND

Letter dated 5 July 2013 from Soils Limited

Civil Engineering Practice

Via email only: gerry@civil.co.uk

5th July 2013

FAO: Gerry Waller

Our Ref: **J13124/GWLR/Rev1.03**

Dear Gerry,

RE: B & HA Training Ground - Groundwater monitoring with respect to rainfall and tidal influence.

We are writing with regard to the recent groundwater monitoring undertaken at the above named site.

Background

Site works were undertaken in December 2011 and comprised the installation of eleven boreholes using Cable Percussive drilling techniques to a maximum depth of 30.00m bgl with groundwater monitoring wells installed within all trial holes. The location of the trial holes was determined through discussion between the Soils Limited Engineer and the Client.

A borehole location plan is presented in Figure 1.

Groundwater Monitoring

Groundwater monitoring was undertaken within BH1-BH11 between 15th June 2012 and 1st February 2013. The data is presented in Tables 1-3 below.

Table 1					
13124 Lancing Groundwater Levels (m AOD)					
Borehole	15.06.12	19.07.12	02.08.12	28.08.12	10.09.12
BH1	Not located	Not located	0.98	Not located	Not located
BH2	0.97	1.09	0.88	0.73	0.63
BH3	0.85	1.08	0.71	0.63	0.53
BH4	1.84	2.22	0.62	1.34	1.17
BH5	2.09	2.41	2.27	1.47	1.28
BH6	1.62	2.28	2.10	Not located	0.95
BH7	1.94	2.18	1.66	1.31	1.24
BH8	1.77	2.28	1.93	1.24	1.11
BH9	1.90	2.19	1.87	1.32	1.15
BH10	-	-	8.52	8.30	8.16
BH11	-	-	0.74	1.30	1.17

Table 2 Lancing Groundwater Levels (m AOD)				
Borehole	28.9.12	12.10.12	26.10.12	15.11.12
BH1	Not located	Not located	Not located	Not located
BH2	0.86	0.87	0.86	0.85
BH3	0.68	0.67	0.77	0.79
BH4	1.23	1.30	1.47	1.57
BH5	1.41	1.45	1.57	1.67
BH6	1.09	1.11	1.25	1.31
BH7	1.23	1.37	1.51	1.60
BH8	1.20	1.26	1.41	1.49
BH9	1.28	1.32	1.45	1.57
BH10	3.22	8.30	8.42	8.55
BH11	1.18	1.37	1.60	1.74

Table 3 Lancing Groundwater Levels (m AOD)				
Borehole	3.12.12	19.12.12	04.01.13	01.02.13
BH1	0.78	0.85	0.82	2.69
BH2	0.96	1.10	1.04	1.49
BH3	0.88	1.04	0.97	1.45
BH4	1.83	2.01	1.88	2.83
BH5	1.97	2.17	2.14	3.14
BH6	1.58	1.83	1.79	2.63
BH7	1.90	2.09	2.03	2.96
BH8	1.76	2.01	1.96	Flooded
BH9	1.85	2.06	2.00	2.99
BH10	8.77	8.89	8.85	Destroyed
BH11	1.96	2.15	2.04	Destroyed

Following the initial monitoring period it was requested that a further six weeks of monitoring were carried out within five of the boreholes (BH1-BH5) in order to determine whether groundwater levels across the site were tidally influenced. In addition the data was to be used to establish whether there was any further correlation between rainfall events and the levels of groundwater within the boreholes.

Groundwater monitoring was undertaken for a period of six weeks from 8th March 2013 until 17th April 2013 to identify any correlation between groundwater level and Met Office rainfall data and/or tidal data.

Groundwater data loggers were installed within BH1-BH5 to facilitate continuous groundwater depth monitoring within each borehole. A barometric data logger was installed within the contractor's compound to monitor barometric pressure and temperature during the monitoring period (this is used to compensate groundwater data variations).

Data loggers were recovered halfway through the six week period to allow data retrieval for interim examination. On final recovery, the data logger from BH2 was compromised. As a result there is only a three week data-set for D2.

A summary of the dataset is given in the table below.

Table 4 Data Loggers		
Data logger	Location	Monitoring period
Diver 1 (D1)	BH1	Six weeks
Diver 2 (D2)	BH2	Three weeks
Diver 3 (D3)	BH3	Six weeks
Diver 4 (D4)	BH4	Six weeks
Diver 5 (D5)	BH5	Six weeks
Barometer (Baro)	Contractors Compound	Six weeks

Results

Logger data was compensated using Barometric data to establish the depth to the surface of the groundwater (cm) with respect to top of casing within each borehole. The compensated data was then translated to Above Ordnance Datum (AOD), and graphed to highlight trends and correlations when compared to rainfall and tidal data for the area.

Rainfall

Groundwater data indicates a slight correlation between rainfall and increases of water head (cm) in the boreholes. Data was compared against rainfall peaks noted on 22nd March, 10th April, and 13th to 14th April 2013 to highlight correlations. A weak trend was noted within D1 and D2 of high rainfall corresponding with a 1 day lag-time and a peak water head of approximately 10-20cm. A very faint correlation was also noted within D3 and D5 of 1-2day lag-time and a peak water head of approximately 20cm. No correlation was noted with rainfall and water head within D4.

Graphed Met Office rainfall data and diver data is presented in Appendix A and Appendix B.

A summary of the rainfall/groundwater depth is given in Table 5.

Table 5 Rainfall And Trial Hole Head Correlation			
Diver	Daily Rainfall (cm)	Lag-time	Water Head Response (m)
D1	1.0 - 1.5	Approximately 1 day	0.20
D2	1.0 - 1.5	Approximately 1 day	0.10
D3	1.0 - 1.5	Approximately 1-2 days	0.20
D4		No correlation noted	
D5	1.0 - 1.5	Approximately 1-2 days	0.20

Tidal influence

Groundwater data indicated a tidal influence in some of the trial holes. Graphs showing the daily groundwater variation compared to the Shoreham Tide Data are presented in Appendix C and Appendix D.

A date, 13th March 2013, was selected from the data-set which coincided with no rainfall in order to show the tidal influences on groundwater. Data from 13th March 2013, was used to graph the diver data to compare against the Shoreham Tidal Data for the same date (presented in Appendix E). D2, and D3 showed a clear tidal influence with high and low tides and a tidal lag-time of +2.5hrs. D1, D3 and D5 did not show a tidal influence on water head within the trial hole. The results are present in Table 6.

Table 6 Tidal Influence On Groundwater		
Diver	Tidally Influenced	Tidal lag-time
D1	No	-
D2	Yes	2.5hrs+
D3	Yes	2.5hrs+
D4	No	-
D5	No	-

Conclusions

Table 7 shows a précis of the results.

Table 7 Tidal And Rainfall Influence On Groundwater						
Diver	Rainfall Response	Rainfall Lag (Days)	Rainfall Impact On Groundwater		Tidal Influence	Tidal lag
			Rainfall (cm)	Groundwater Response (m)		
D1	Yes	≈1	1.0-1.5	0.20	No	-
D2	Yes	≈1	1.0-1.5	0.10	Yes	2.5hrs
D3	Yes	≈1-2	1.0-1.5	0.20	Yes	2.5hrs
D4	No	-	None	None	No	-
D5	Yes	≈1-2	1.0-1.5	0.20	No	-

The results indicate that groundwater head levels recorded by D4 are not significantly influenced by rainfall or tide.

D2 and D3 show stronger correlations to tidal influences and rainfall. Data recorded at these locations proved the most variable out of all the monitoring points – possibly due to D2 and D3 being located closest to the sea.

The highest groundwater reading recorded during the six week monitoring period was 0.94m below top of casing (2.15m AOD) in D1 at 10.00pm on 8th March 2013. D2-D5 recorded groundwater head in excess of 1.50m below top of casing, throughout the six week monitoring period.

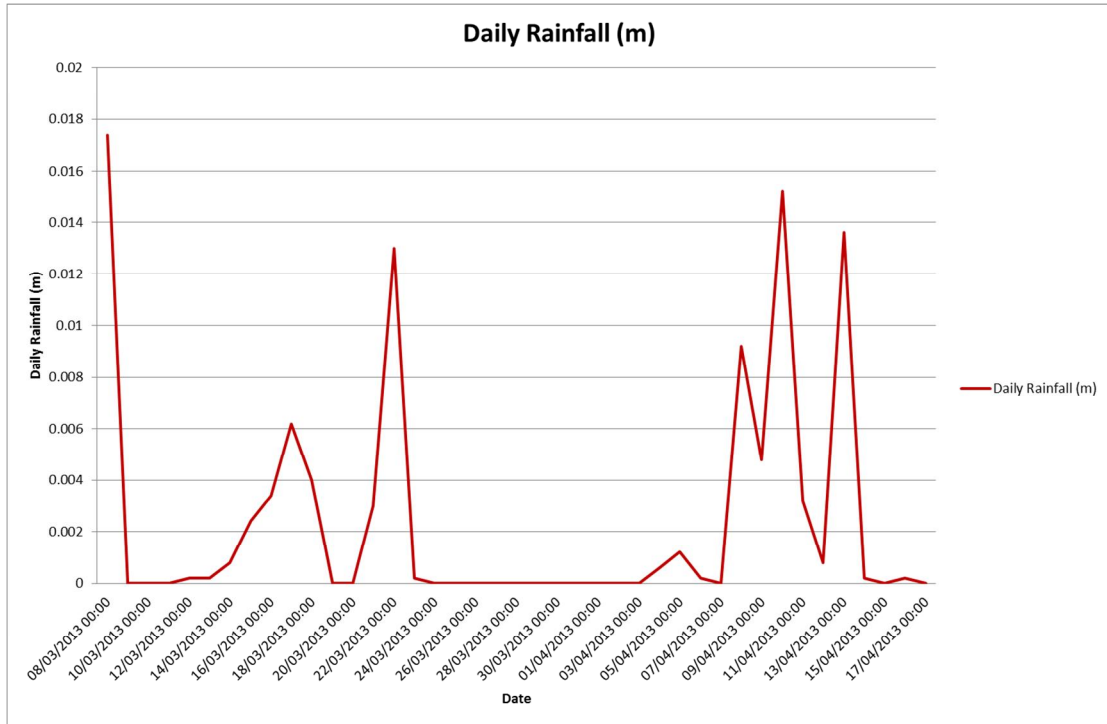
Should you have any questions then please do not hesitate to contact the undersigned.

Yours sincerely

L. Stockwell.

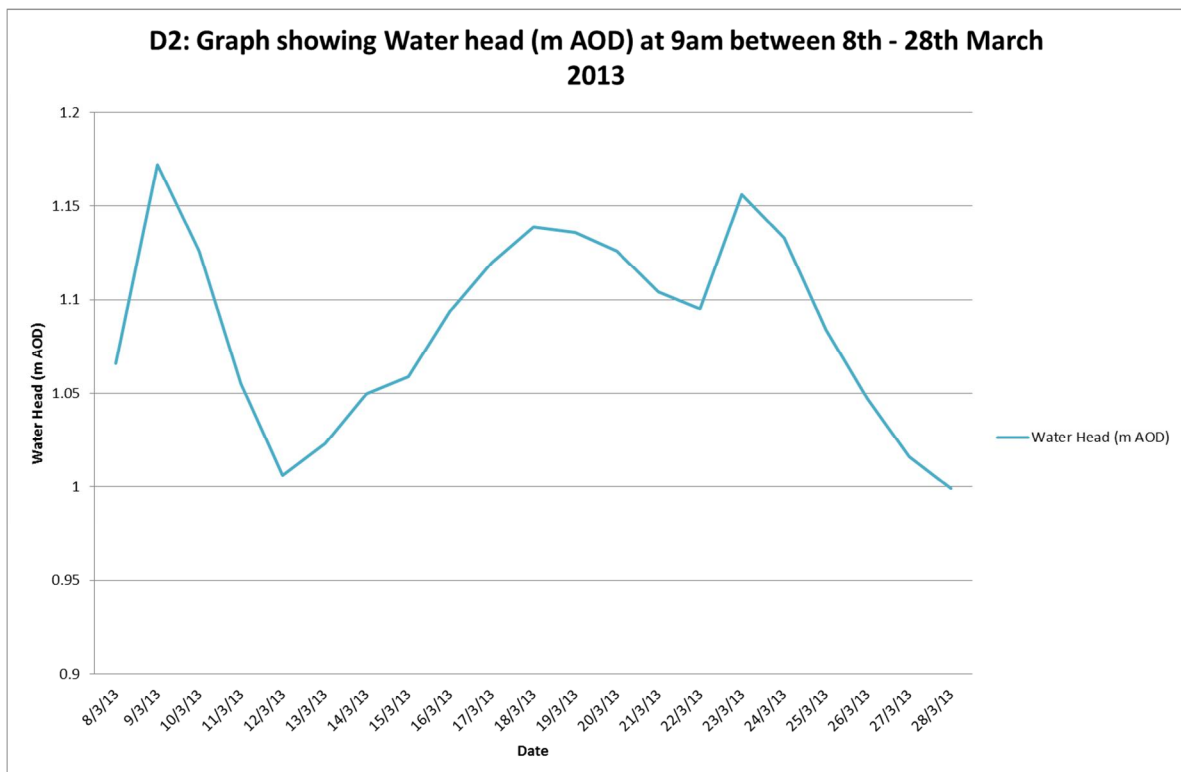
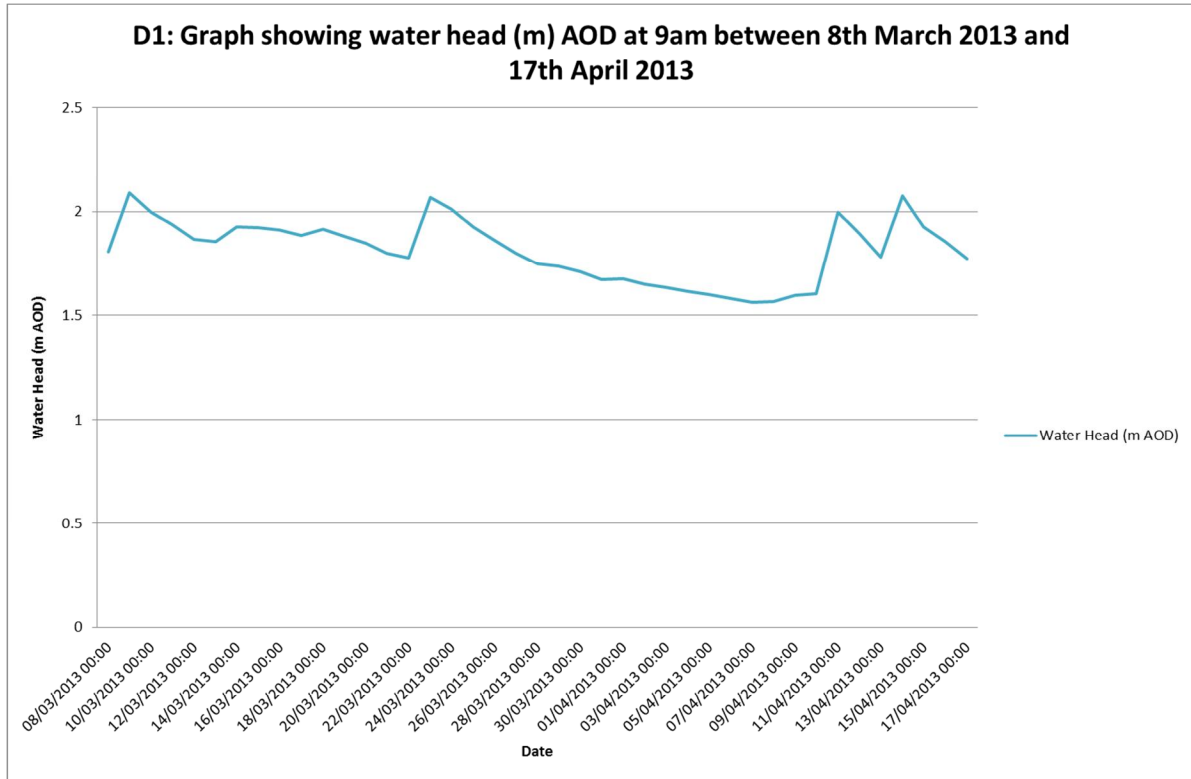
L. Howell BSc (Hons.) FGS
On behalf of Soils Limited

Appendix A
Met Office Total Daily Rainfall Graph

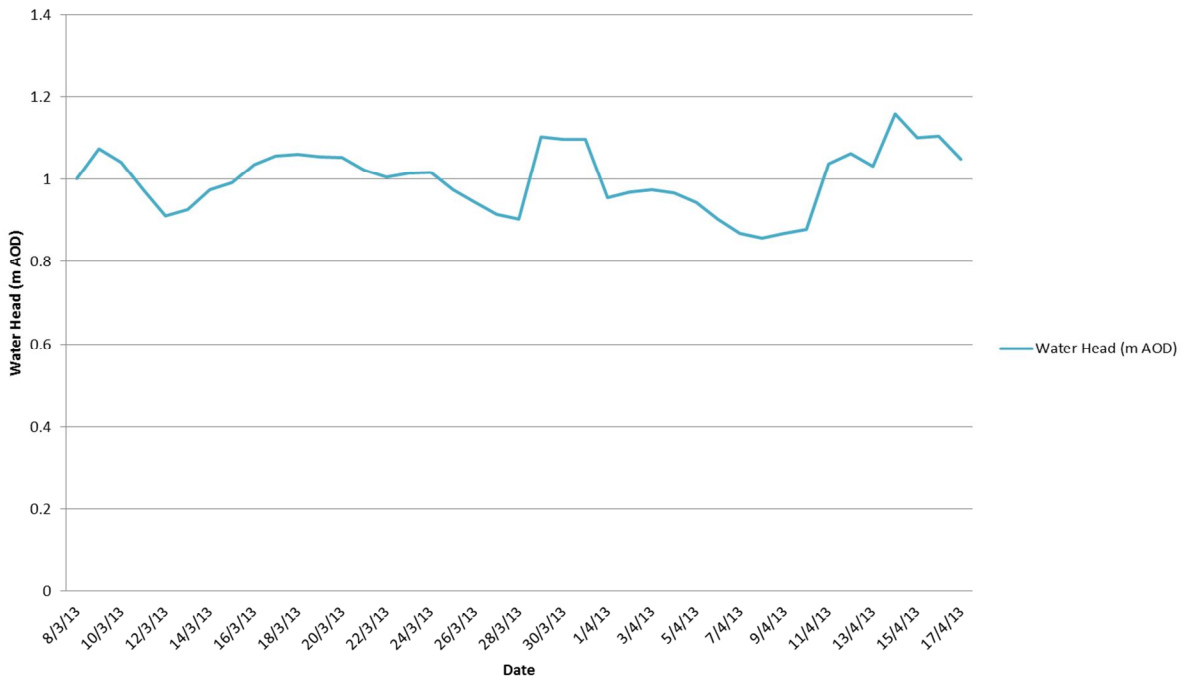


Appendix B

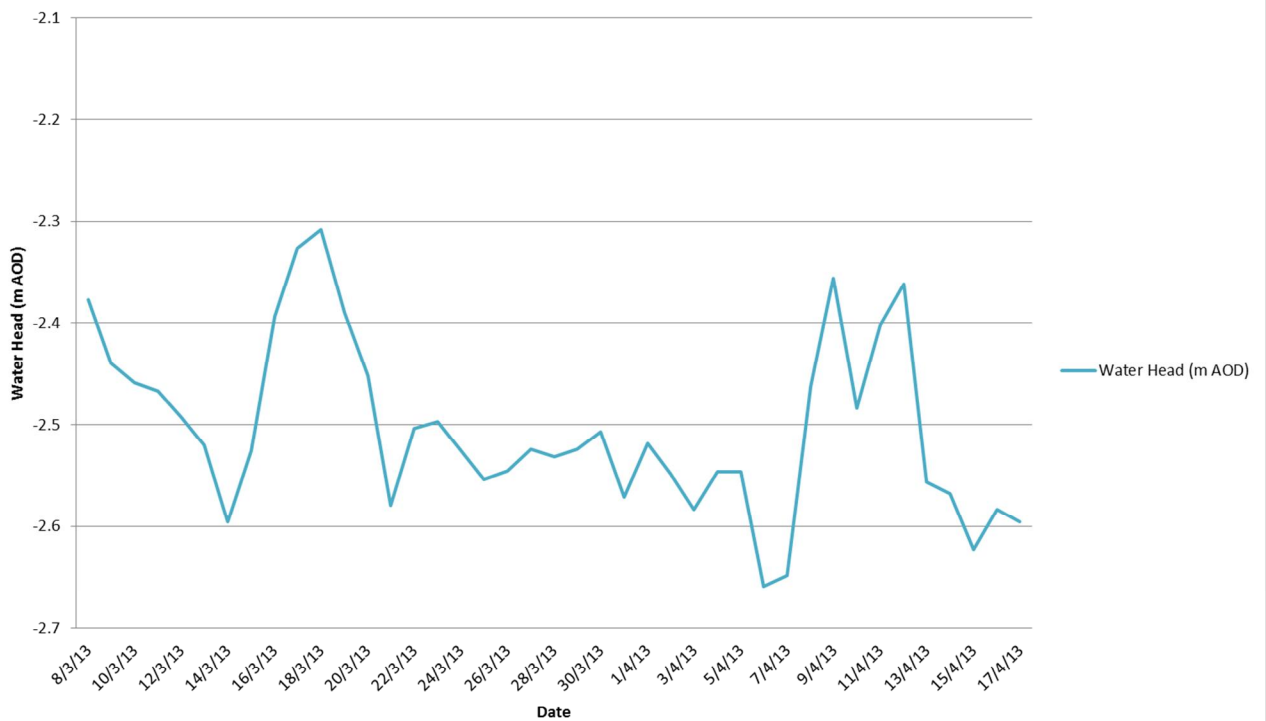
Graphs showing water head (m AOD) within trial holes at 9am
– for comparison with Met Office Rainfall Data



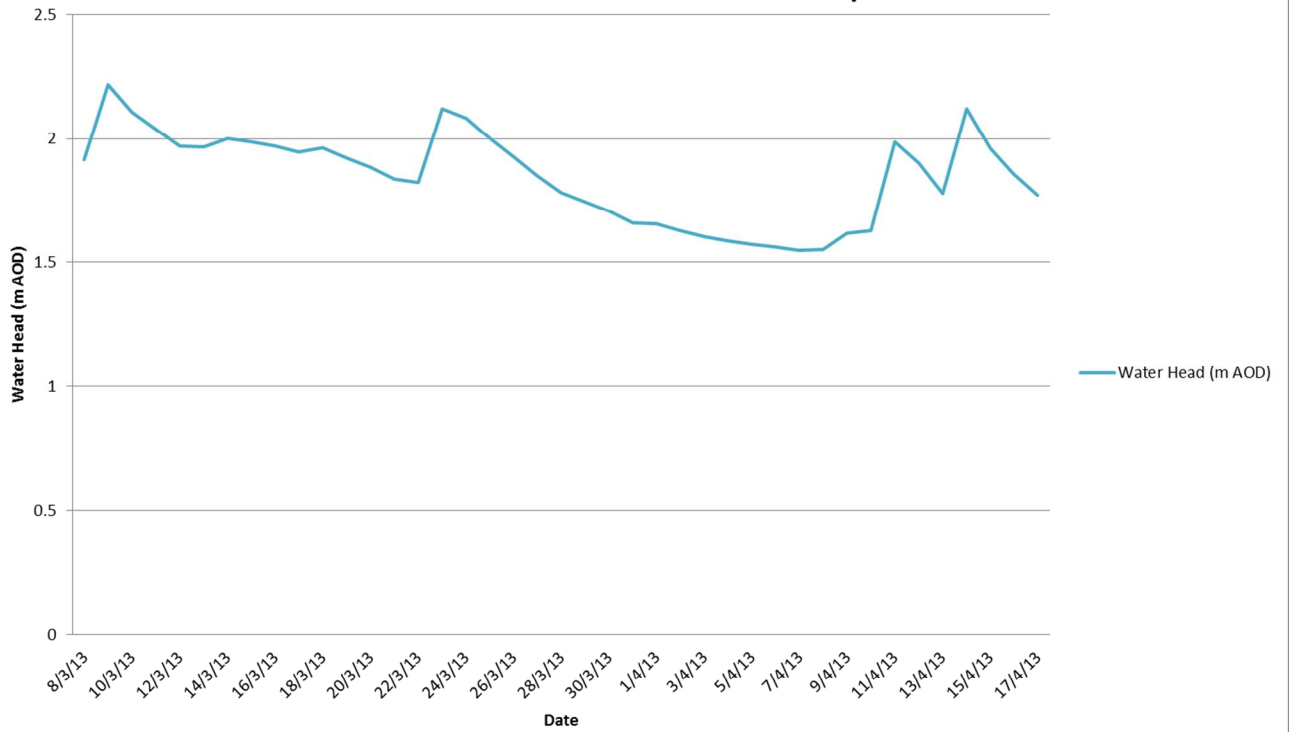
D3: Graph showing water head (m AOD) at 9am between 8th March 2013 and 17th April 2013



D4: Graph showing water head (m) AOD at 9am between 8th March 2013 and 17th April 2013

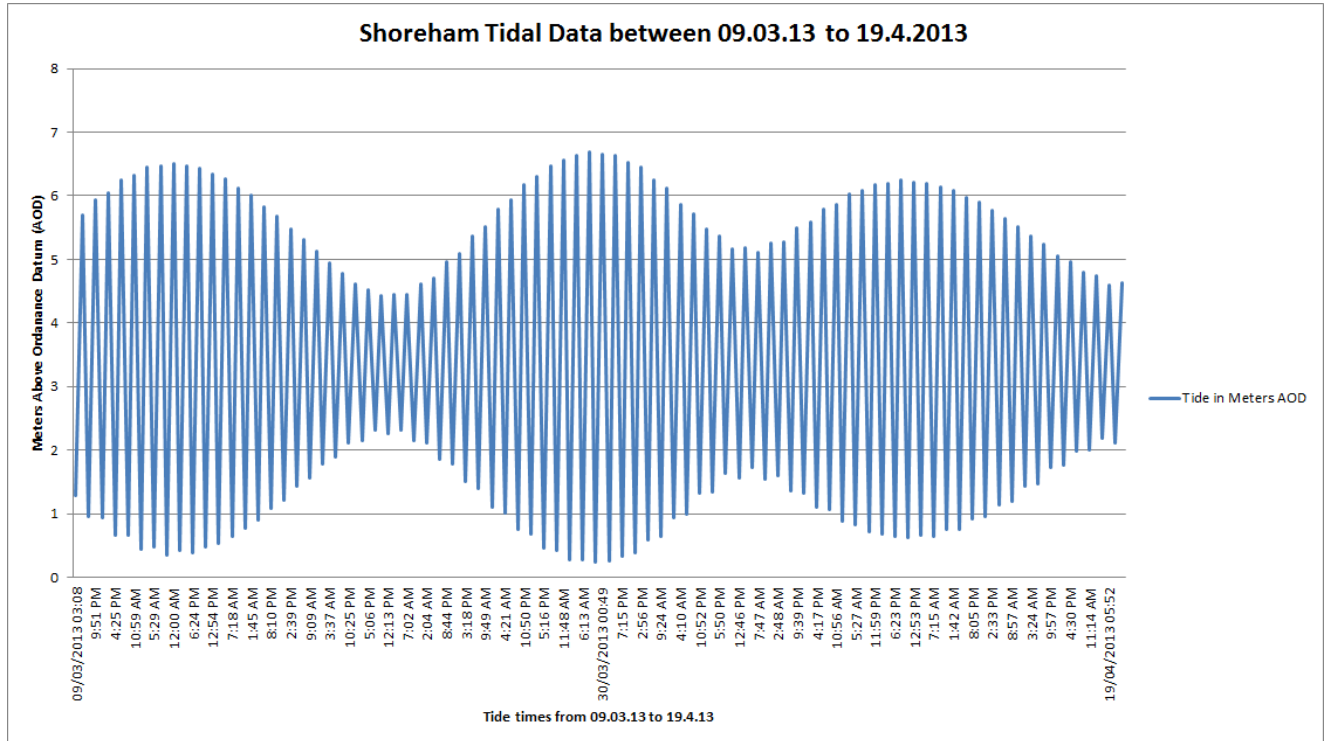


D5: Graph showing water head (m AOD) at 9am between 8th March 2013 and 17th April 2013



Appendix C

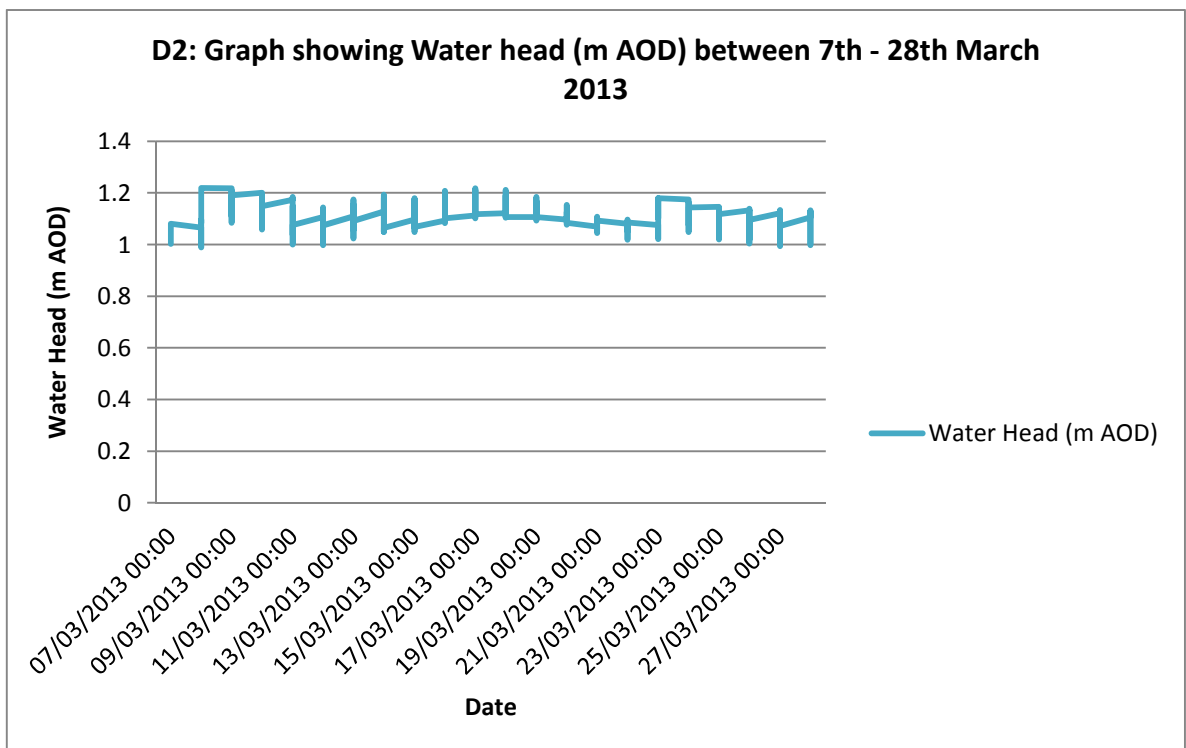
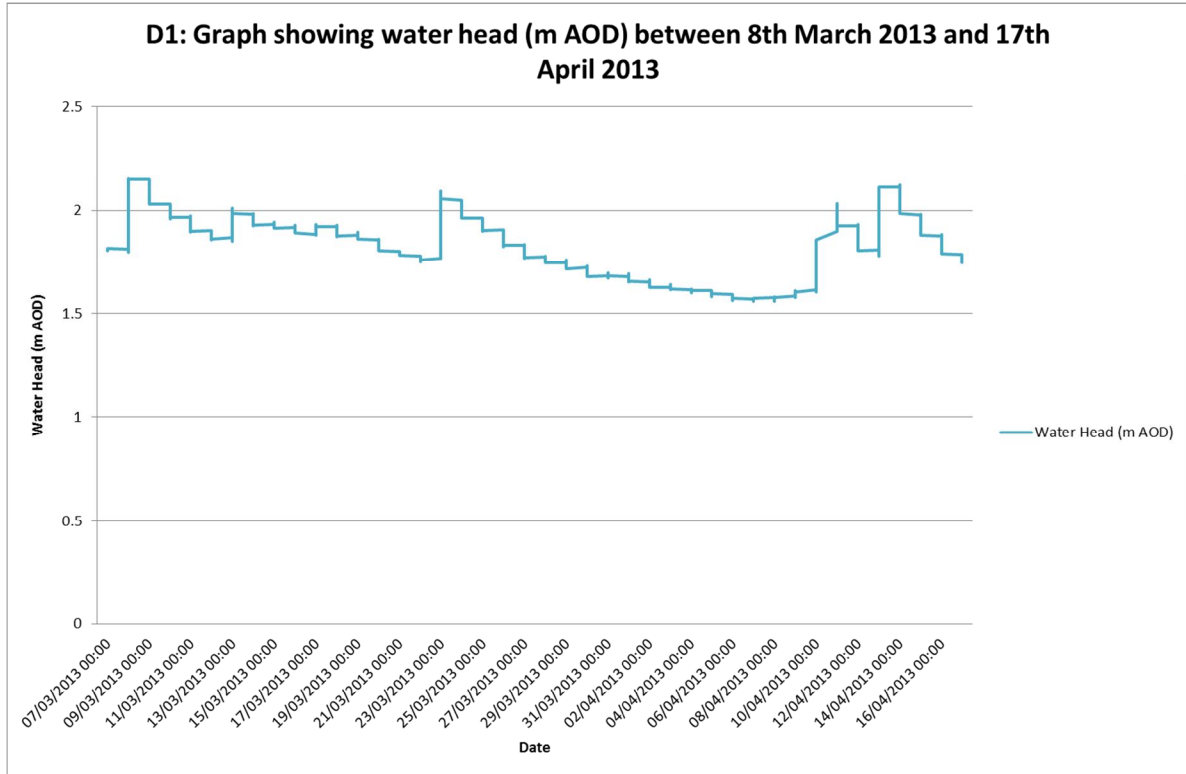
Graphs showing Shoreham Tidal Data

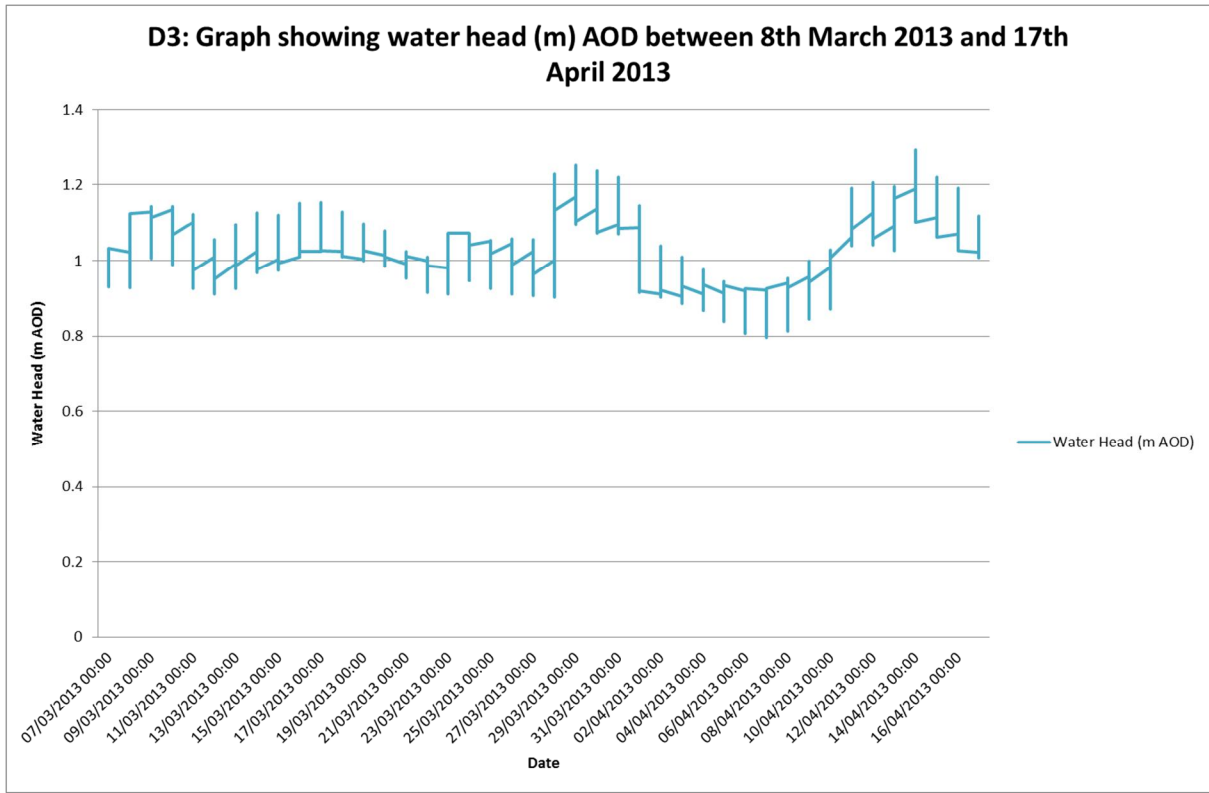


Appendix D

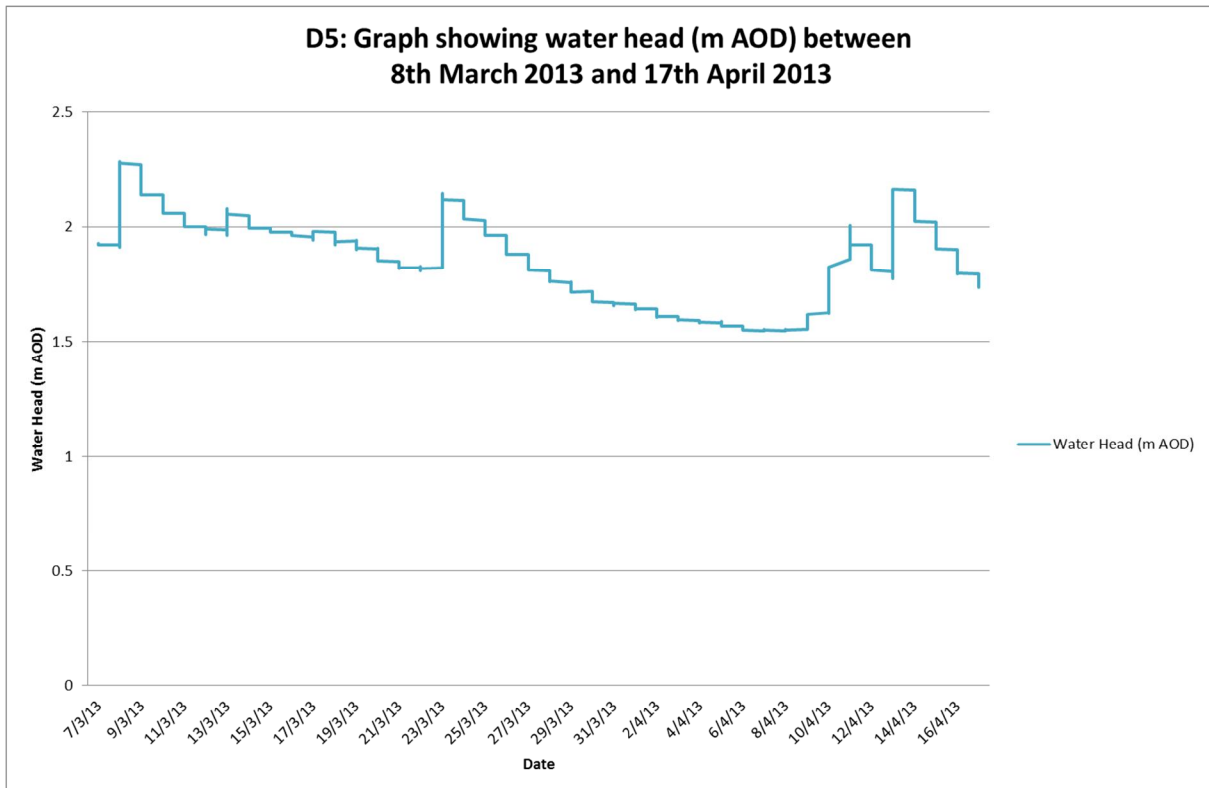
Graphs showing water head (m AOD) within trial holes

– for comparison with Shoreham Tidal Data

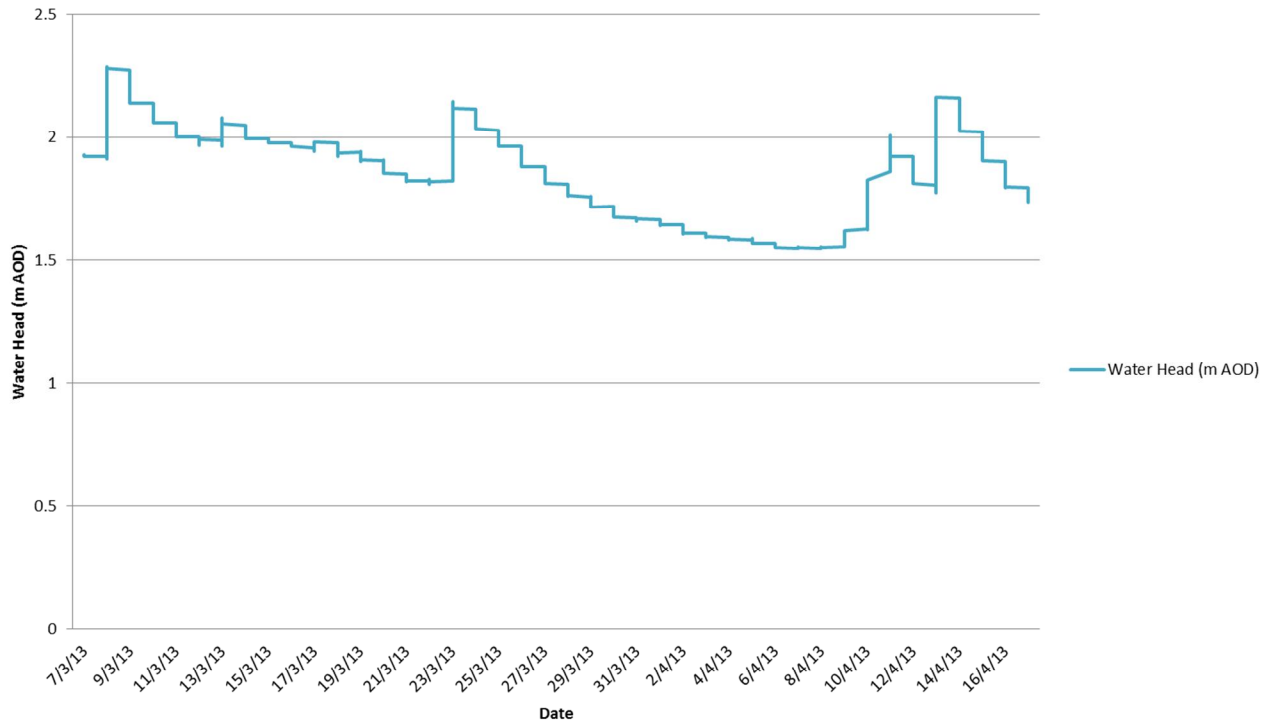




**An anomaly was noted within the data from D3 between 27.03.13 and 1.04.13, whereby data values increased by 500cm. This anomaly was not recorded by other data loggers and was understood to be a data recording error. The graph above shows the anomaly corrected by -500cm, which corresponds with trends recorded in the other trial holes.*



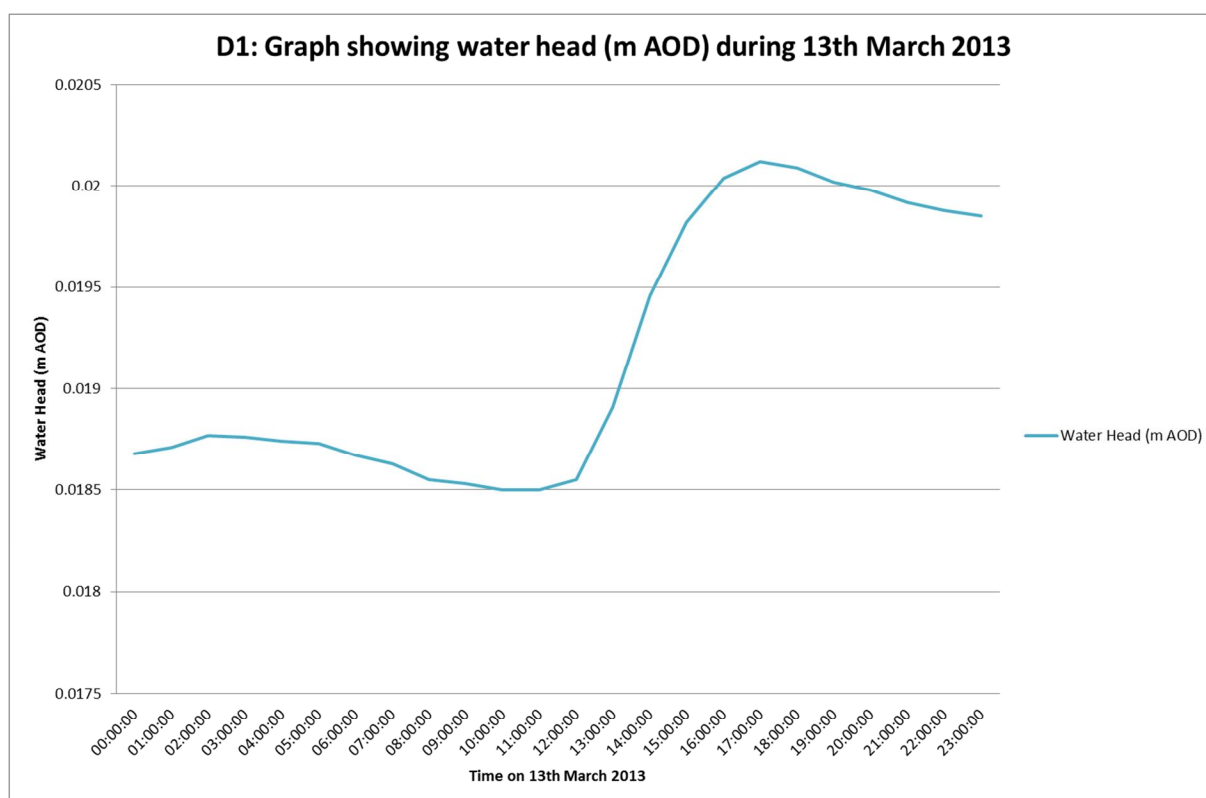
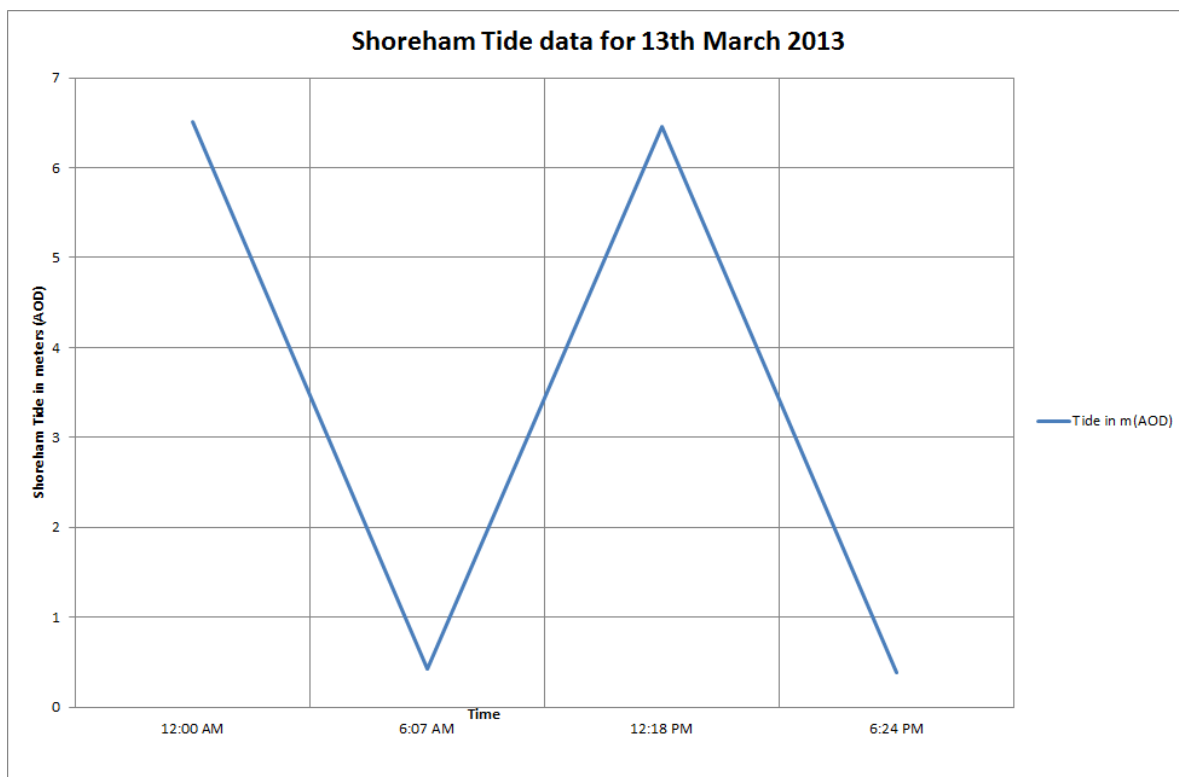
**D5: Graph showing water head (m AOD) between
8th March 2013 and 17th April 2013**



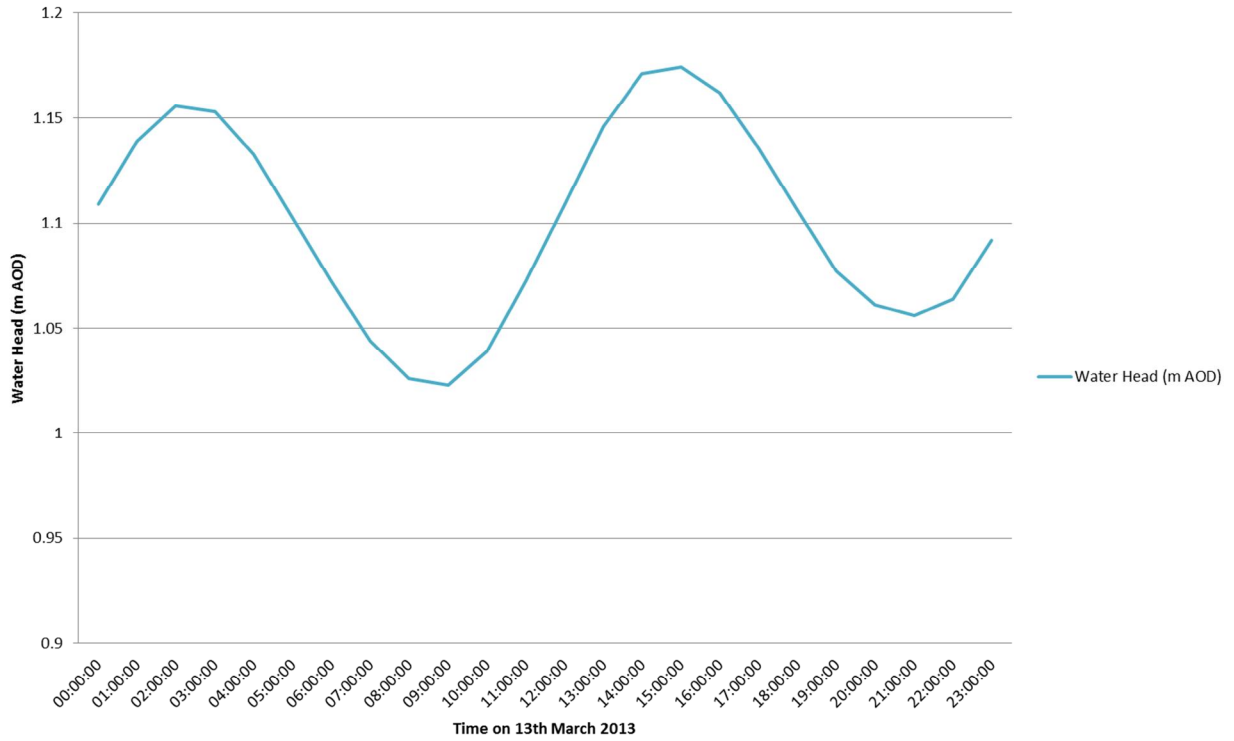
Appendix E

Graphs showing water head (m AOD) within trial holes on 13th March 2013

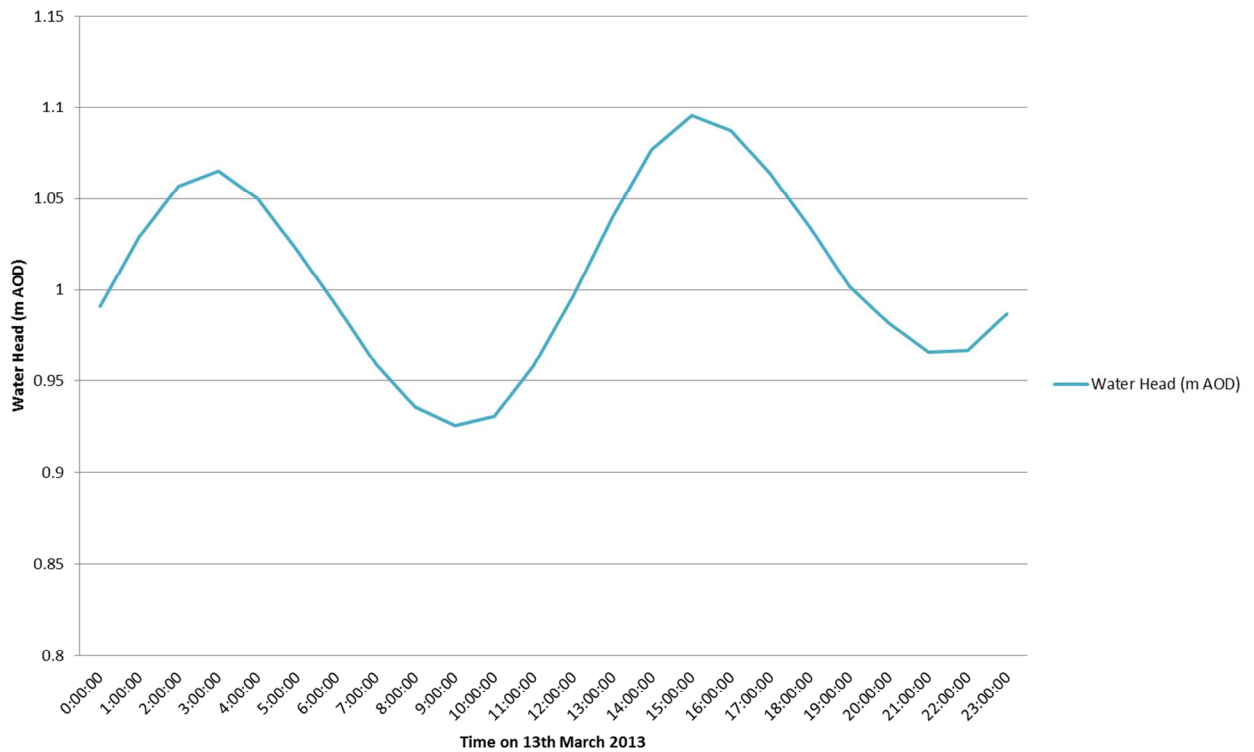
– for comparison with Shoreham Tidal Data for 13th March 2013



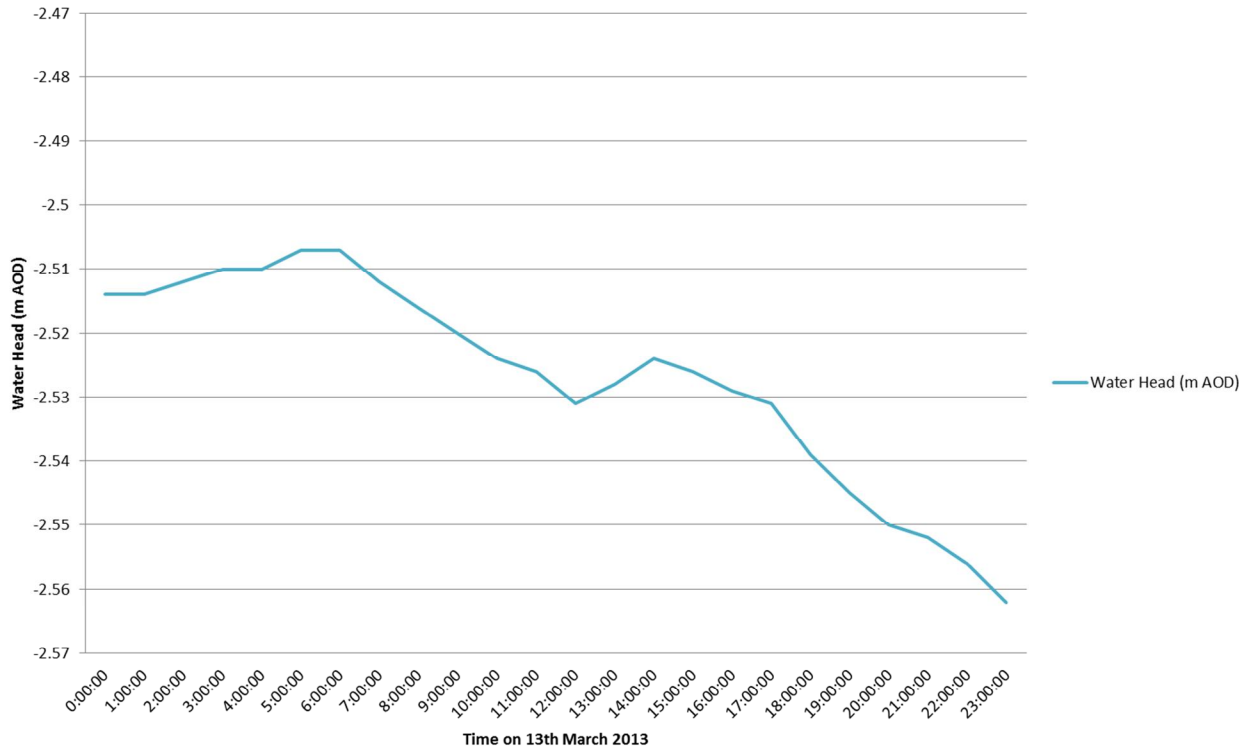
D2: Graph showing water head (m AOD) during 13th March 2013



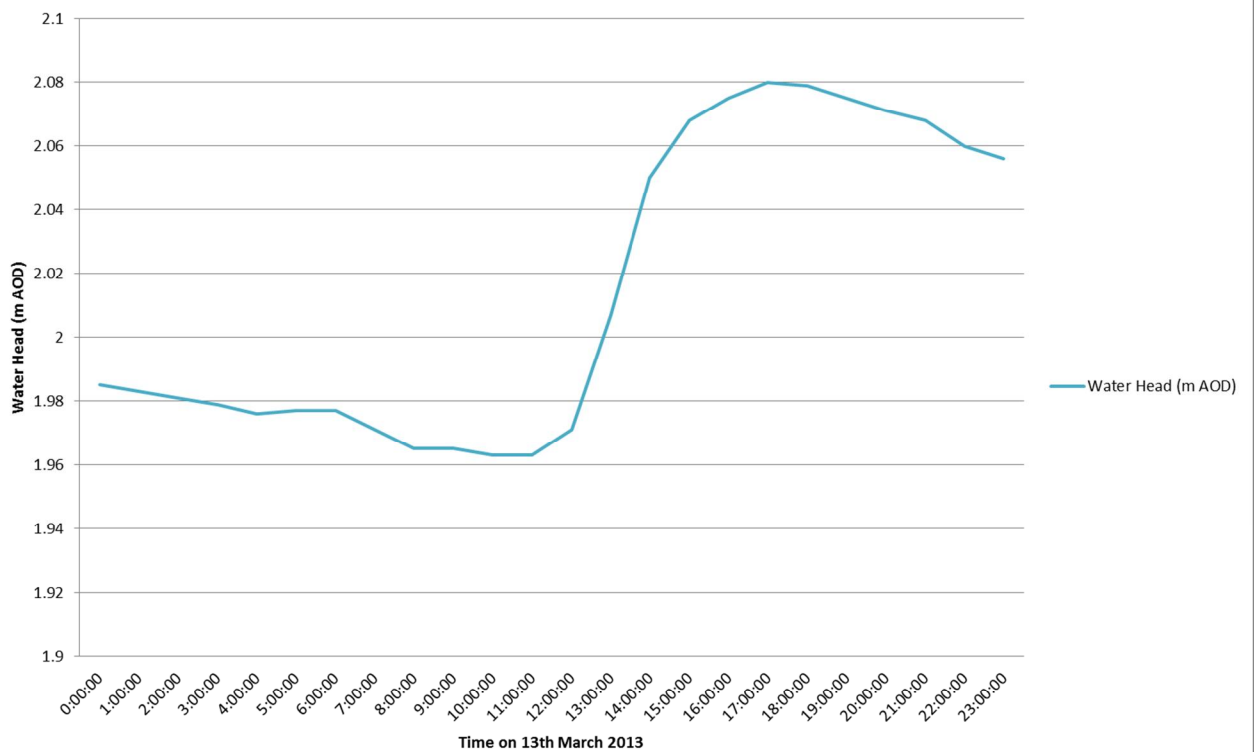
D3: Graph showing water head (m AOD) during 13th March 2013



D4: Graph showing water head (m AOD) on 13th March 2013



D5: graph showing water head (cm AOD) on 13th March 2013



APPENDIX B: PHOTOGRAPHIC EVIDENCE OF HISTORIC FLOODING

North Lancing



Manor Way, 26 December 2011



Flooded Ditch behind Old Shoreham Road, 1 January 2013

Shoreham Airport



Shoreham Airport terminal, 6 December 2012



Shoreham Airport terminal, 6 December 2012

Grinstead Lane



Grinstead Lane, 6 February 2014



Grinstead Lane, 6 February 2014

APPENDIX C: 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 1-2 years.
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.

APPENDIX D: QUICK REFERENCE – ACRONYMS

CC	C limate C hange
DEM	D igital E levation M odel
FRS	D esktop F lood R isk A ssessment
DPD	D evelopment P lan D ocument
EA	E nvironment A gency
FRA	F lood R isk A ssessment
LDD	L ocal D evelopment D ocuments
LPA	L ocal P lanning A uthority
mAOD	M etres A bove O rdnance D atum
NPPF	N ational P lanning P olicy F ramework
RFRA	R egional F lood R isk A ssessment
RMSE	R oot M ean S quare E rror
RPB	R egional P lanning B ody
RSS	R egional S patial S trategies
SFRA	S trategic F lood R isk A ssessment
SUDS	S ustainable U rban D rainage S ystems

APPENDIX E: SURFACE WATER MODELLING TECHNICAL MODELLING WRITE-UP

1 INTRODUCTION

- 1.1 This technical report write-up summarises the results of a 2-dimensional modelling exercise that has been undertaken at three sites in the area around Shoreham Airport.
- 1.2 It is understood that the results of this analysis will be used to inform a Flood Risk Assessment (FRA) report. This analysis has been carried out using current best practices, and against the criteria set out in National Planning Policy Framework (NPPF).



Figure 1: Site Locations in Red (Source: Ordnance Survey Mapping)

2 METHODOLOGY

2.1 The following methodology was applied for this study:

Design Scenario(s)

2.2 The following pluvial return periods scenarios were run (both 1 hour and 24 hour storms were simulated for each, with the maximum depth/velocity captured from each run):

- 20yr
- 50yr
- 100yr
- 100yr+CC (20% increase in 100yr total rainfall)
- 200yr
- 1000yr

2.3 All three sites fell within the catchment outlined in Figure 2 below. As such, the same rainfall parameterisation was used in each case. Industry standard Depth-Duration-Frequency (DDF) calculations were consulted from the Flood Estimation Handbook v3 (FEH) to ascertain the design rainfall (please see Figure 3).

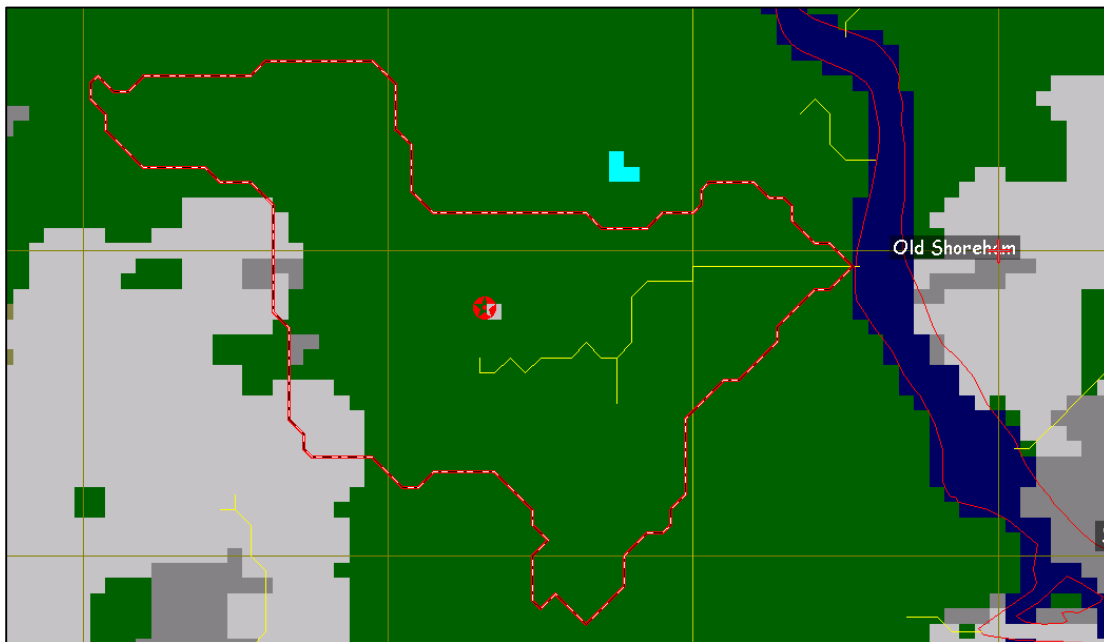


Figure 2: FEH catchment for subsequently derived data for Peak Rainfall

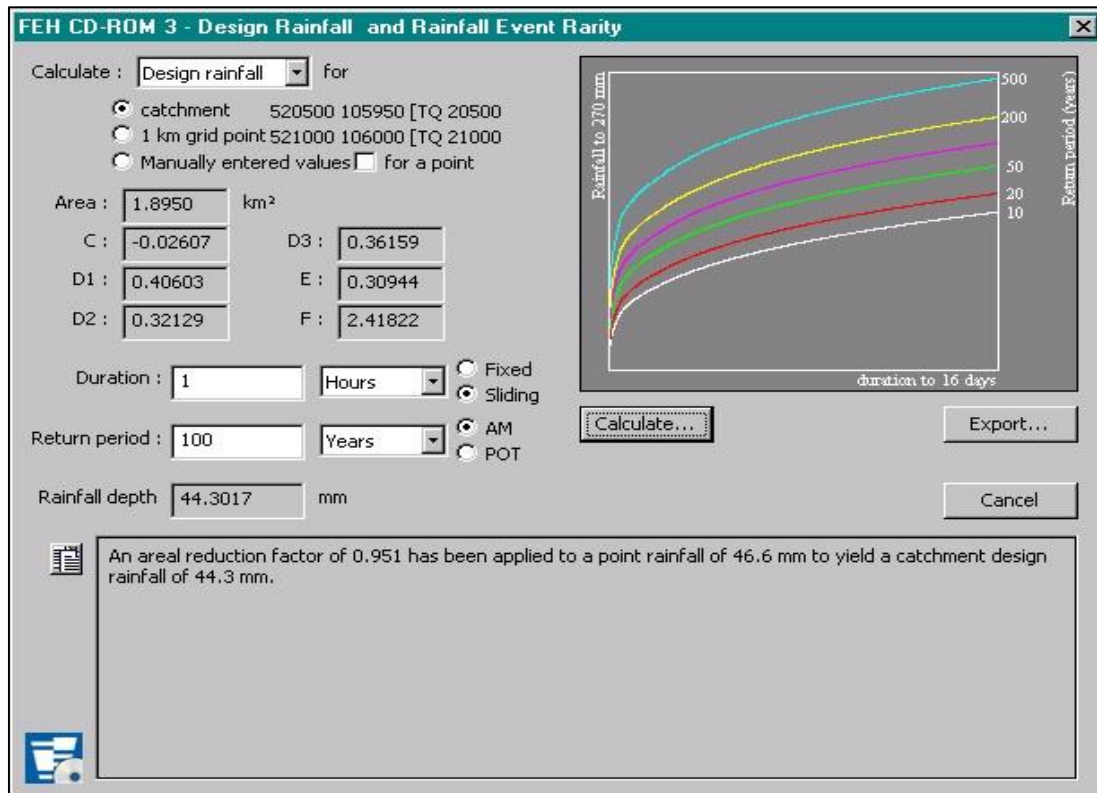


Figure 3: FEH DDF modelling from the catchment shown in Figure 2 – used to obtain design rainfall for each return period and storm duration

2.4 For this exercise, 2-d modelling has been undertaken, using a steady rainfall input (i.e. equal rainfall is applied over the entire storm duration), and simulation was run until reaching a terminal state. Maximum depth and velocity has been captured at each grid cell for each return period. Table 1 below presents the specified peak rainfall values, using a 1 hour and 24 hour duration events to get the maximum flood extent:

Duration	1 in 20yr	1 in 50yr	1 in 100yr	1 in 100yr +CC	1 in 200yr	1 in 1000yr
1 Hour (Total mm)	26.75	35.69	44.3	53.16	54.94	90.46
1 Hour (mm/hr)	26.75	35.69	44.3	53.16	54.94	90.46
24 Hour (Total mm)	74.16	91.68	107.52	128.88	125.76	181.2
24 Hour (mm/hr)	3.09	3.82	4.48	5.37	5.24	7.55

Table 1: Rainfall specified for each Pluvial Duration scenario

Flood Defences

2.5 No flood defences were parameterised within the 2-d model setup.

Topographic Data

- 2.6 A LiDAR Digital Terrain Model (DTM) was obtained for use within this project. The data was originally collected and processed by the EA and as such, represents the best available topographic information for this site.

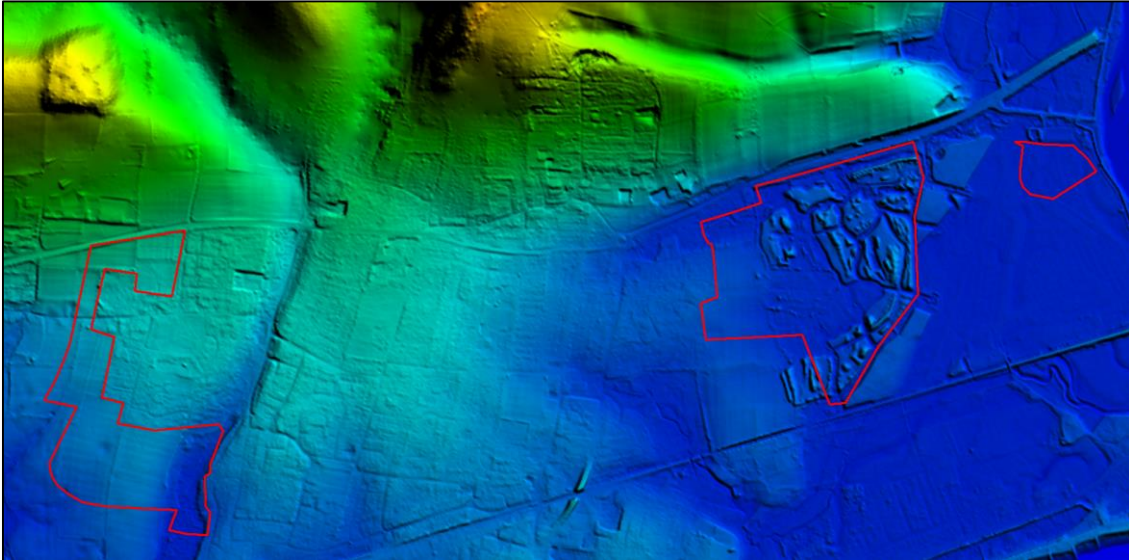


Figure 4: LiDAR-based digital terrain model (DTM) utilised within the model setup

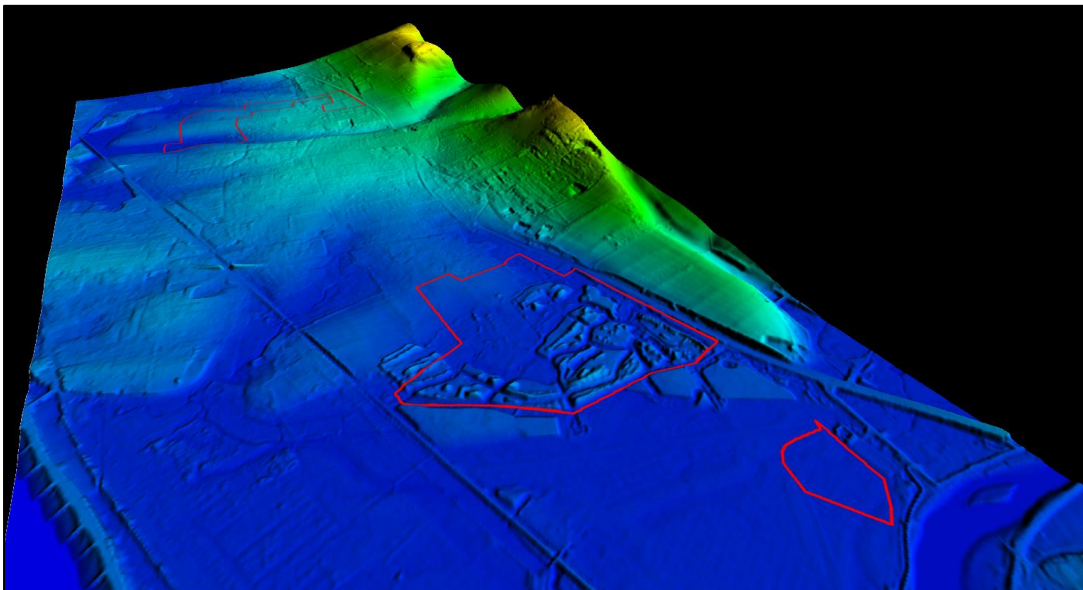


Figure 5: 3-d representation of the LiDAR-based DTM with vertical exaggeration of 2.50

Computational Flood Model

- 2.7 Infiltration and Drainage values were input into the model using Landuse data provided by the OS, taking into account the difference between rural and urban drainage systems. Figure 6 below shows Urban areas as Green and Rural areas as Blue.

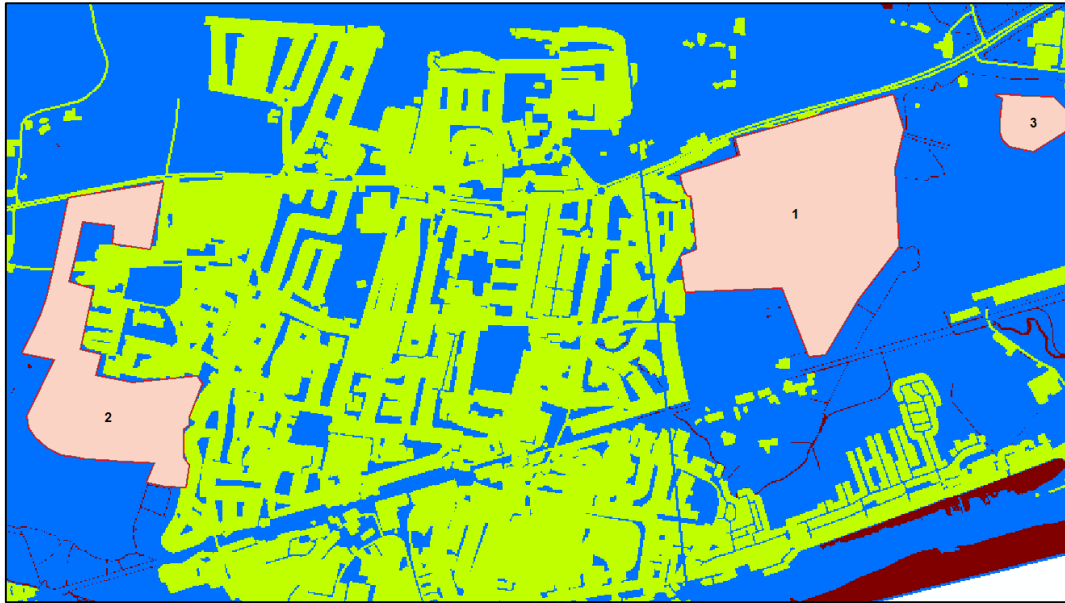


Figure 6: Landuse data (Source: Ordnance Survey)

- 2.8 Variable land use data provided by the OS made it possible to spatially parameterise urban and rural land cover. Urban drainage was assumed to be a constant 12mm/hr, whereas infiltration was set up as a run-off percentage. Urban runoff was set up as 70% (i.e. 30% of rainfall infiltrates into the ground) whereas rural runoff was set up as 39%.
- 2.9 The modelling software used for this project was the 2-d Flood Risk Modelling package Flowroute-i™. Flowroute-i™ is a raster-based hydrodynamic flood model which has been developed in collaboration with the University of Cambridge (which can be run in 1D, 2D and coupled 1D-2D modes). A technical summary is included in the Appendix.
- 2.10 The domain extent was delimited such that it incorporates the entire flood cell, however so as to maintain relative realism, 'out-flow' from the domain boundaries was allowed (i.e. water that flows out of the domain is removed from the simulation).
- 2.11 Post-processing of the model outputs was undertaken to remove flood depths <10cm so as to allow for reasonable interpretation of the results (pluvial simulations result in all areas being 'wet' to some degree, so a threshold must be set in order to generate a flood map).
- 2.12 It should also be noted that all simulations undertaken within this project successfully passed mass-balance checks.

3 RESULTS

3.1 The following results are presented in the attached Maps in full. Below is a summarised overview of the total flooded area across each of the 3 sites:

Site	Return Period	Flooded Area (%) above 10cm depth
Site 1 – New Monks Farm	20 Year	10.48769
	50 Year	13.18406
	100 Year	17.96084
	100 Year +CC	21.12224
	200 Year	21.05697
	1000 Year	30.378
Site 2 – Land west of Sompting	20 Year	9.48744
	50 Year	9.454703
	100 Year	11.20945
	100 Year +CC	11.92969
	200 Year	12.02135
	1000 Year	14.90884
Site 3 – Shoreham Airport	20 Year	8.460499
	50 Year	11.23287
	100 Year	13.57504
	100 Year +CC	18.73738
	200 Year	17.30339
	1000 Year	36.61436

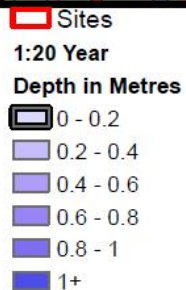
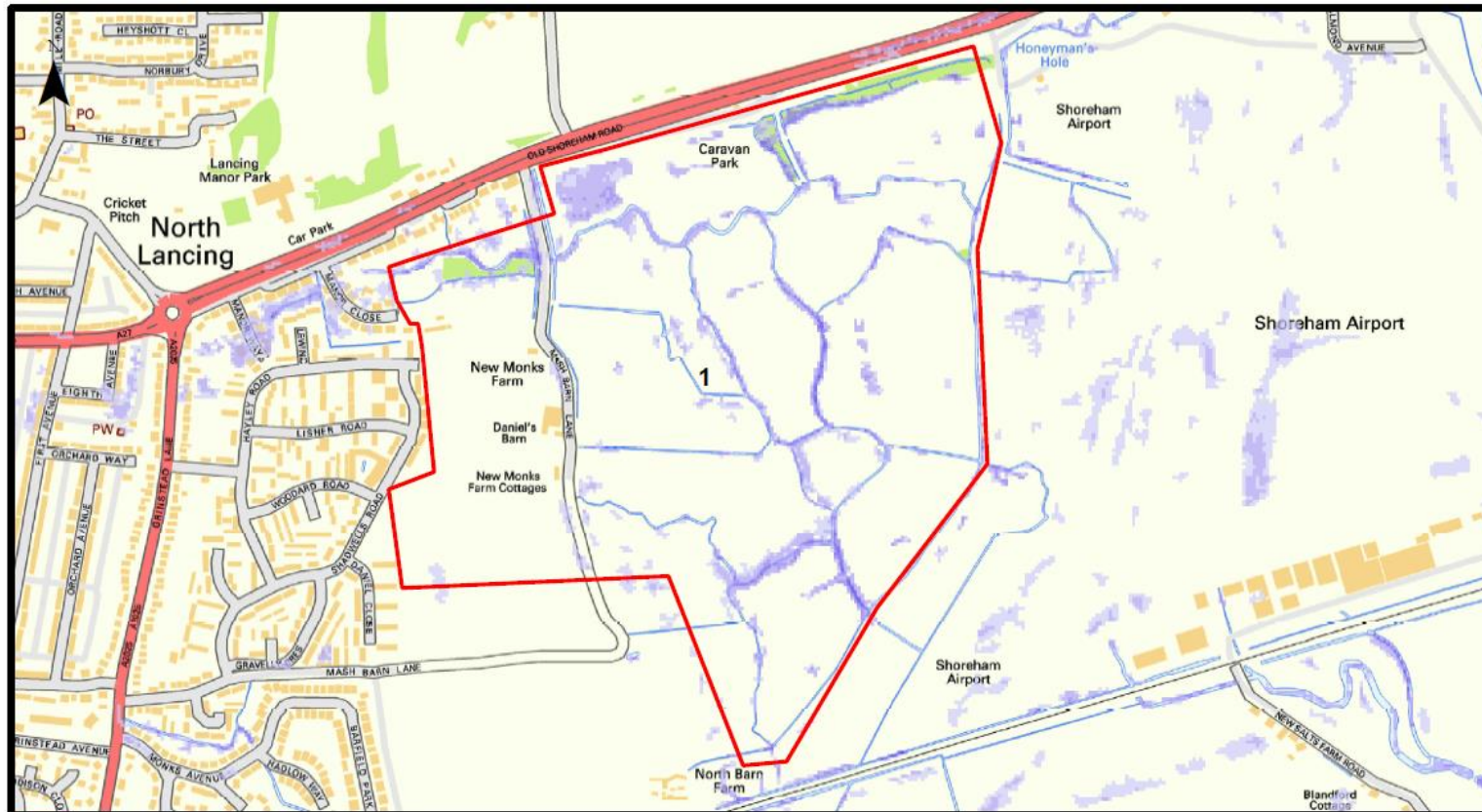
Table 2: Summary results of each pluvial simulation

4 APPENDIX

Pluvial Site Mapping for each site:

1. 20yr
2. 30yr
3. 100yr
4. 100yr + CC
5. 200yr
6. 1000yr

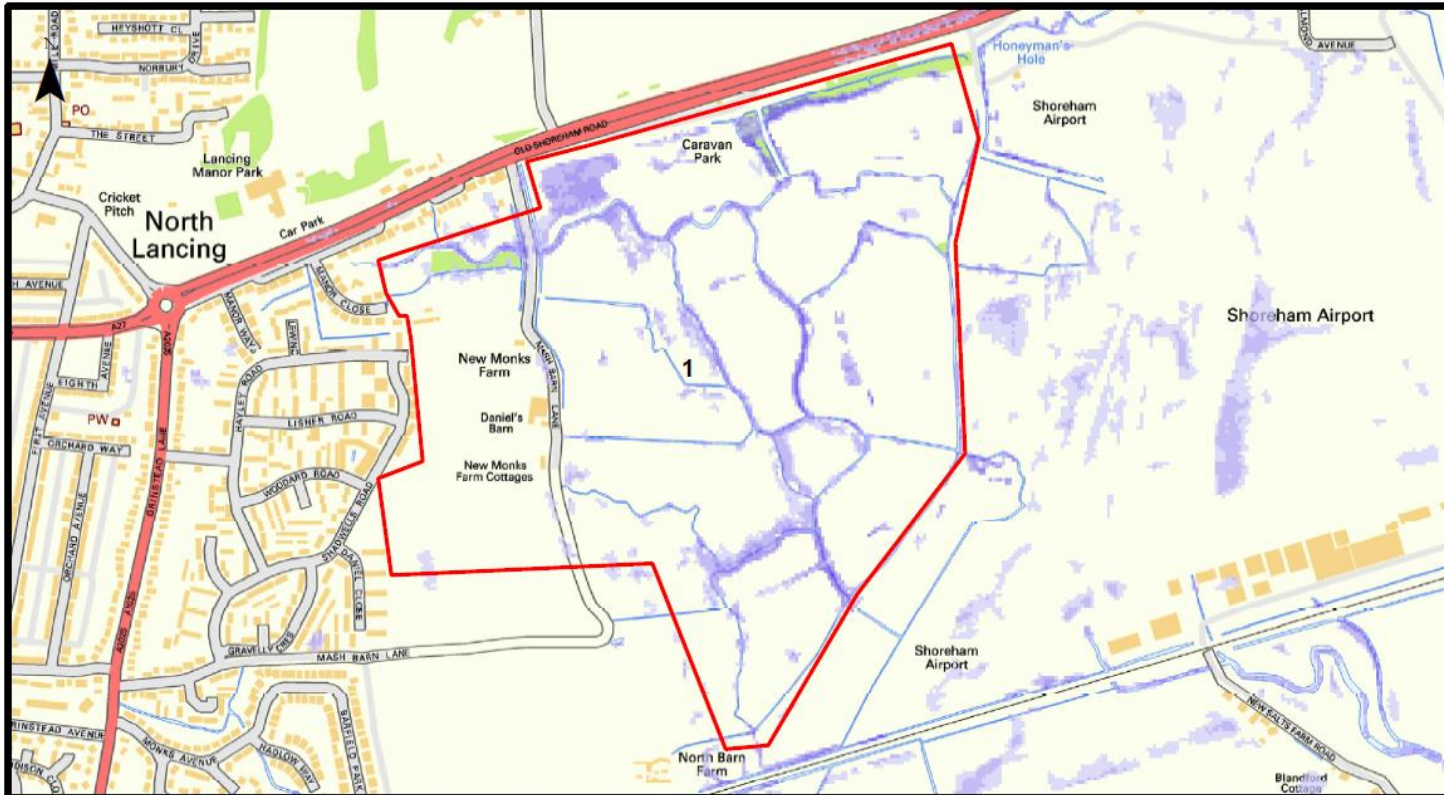
Adur Community FRA - Site 1 - 1:20 Year Pluvial Flood



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Adur Community FRA - Site 1 - 1:50 Year Pluvial Flood



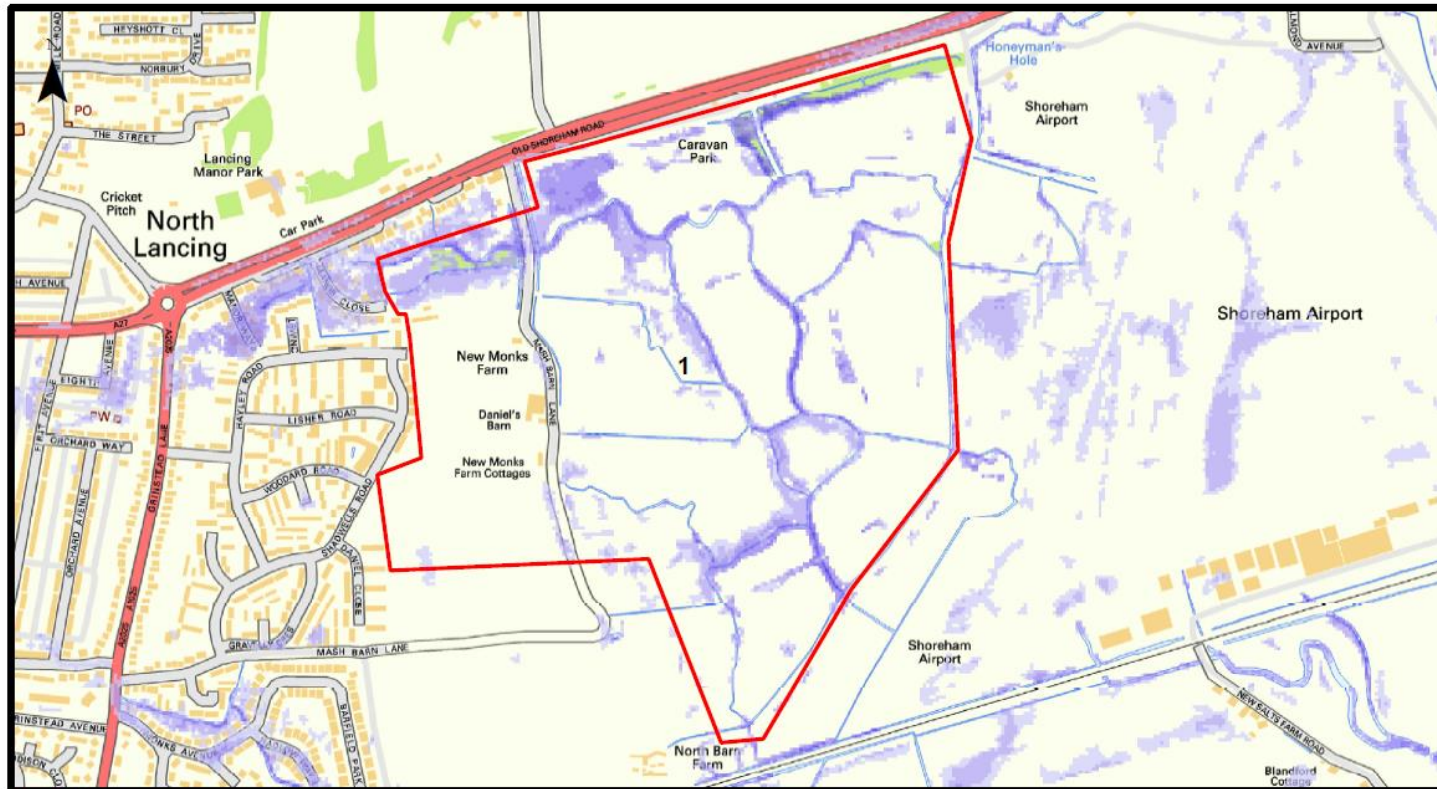
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- Depth in Metres**
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- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- 1+



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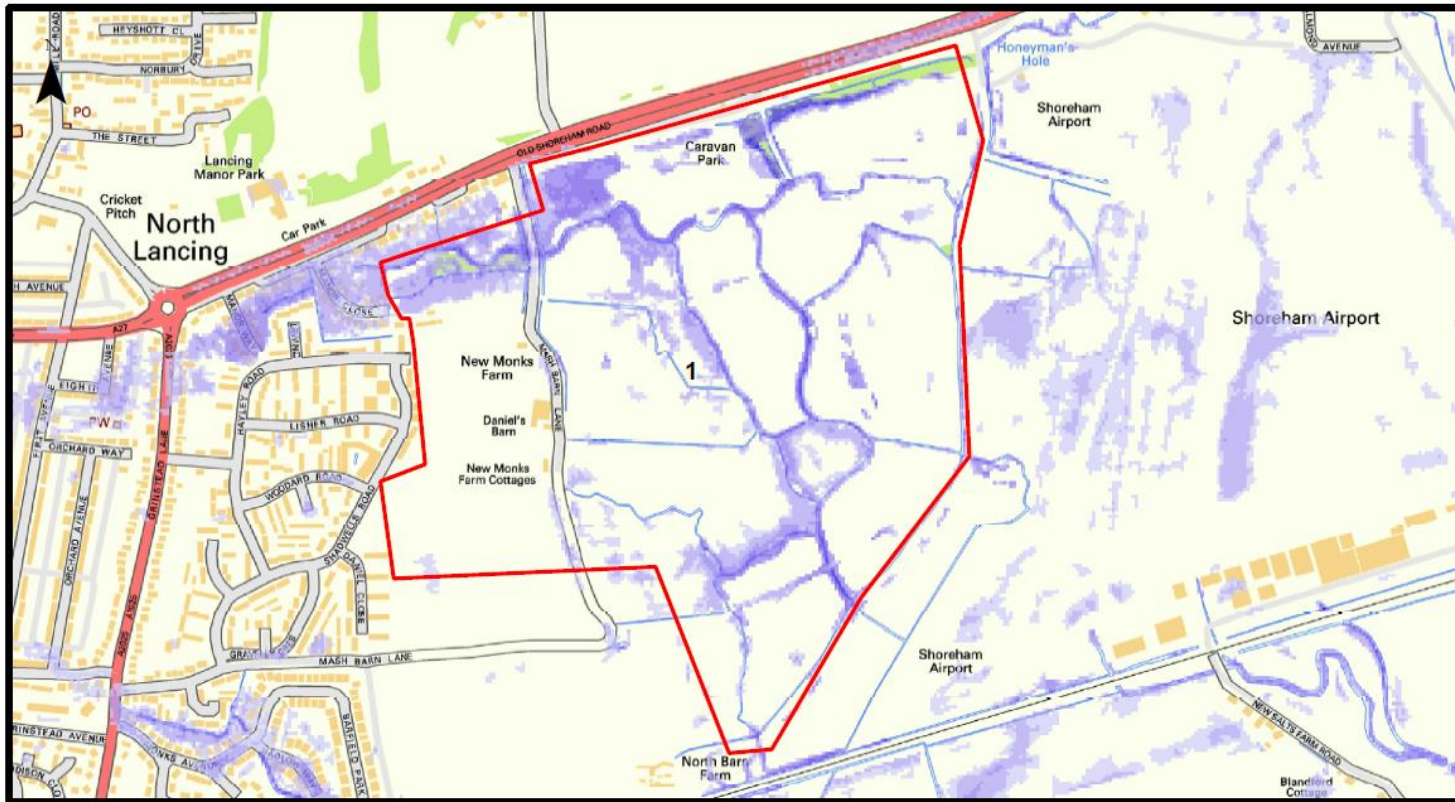
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- Depth in Metres**
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- 0.6 - 0.8
- 0.8 - 1
- 1+

0 100 200 400 Meters

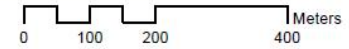
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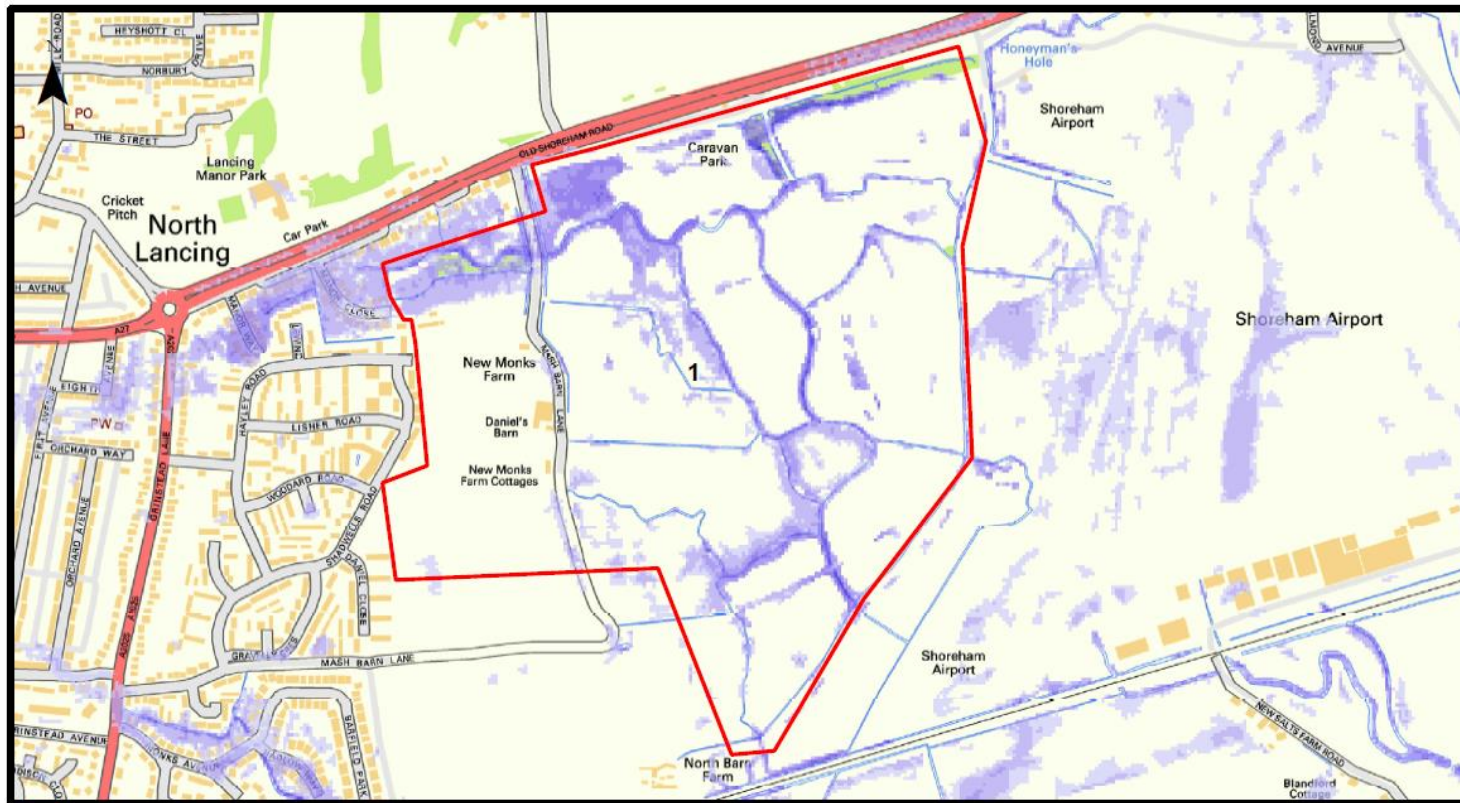
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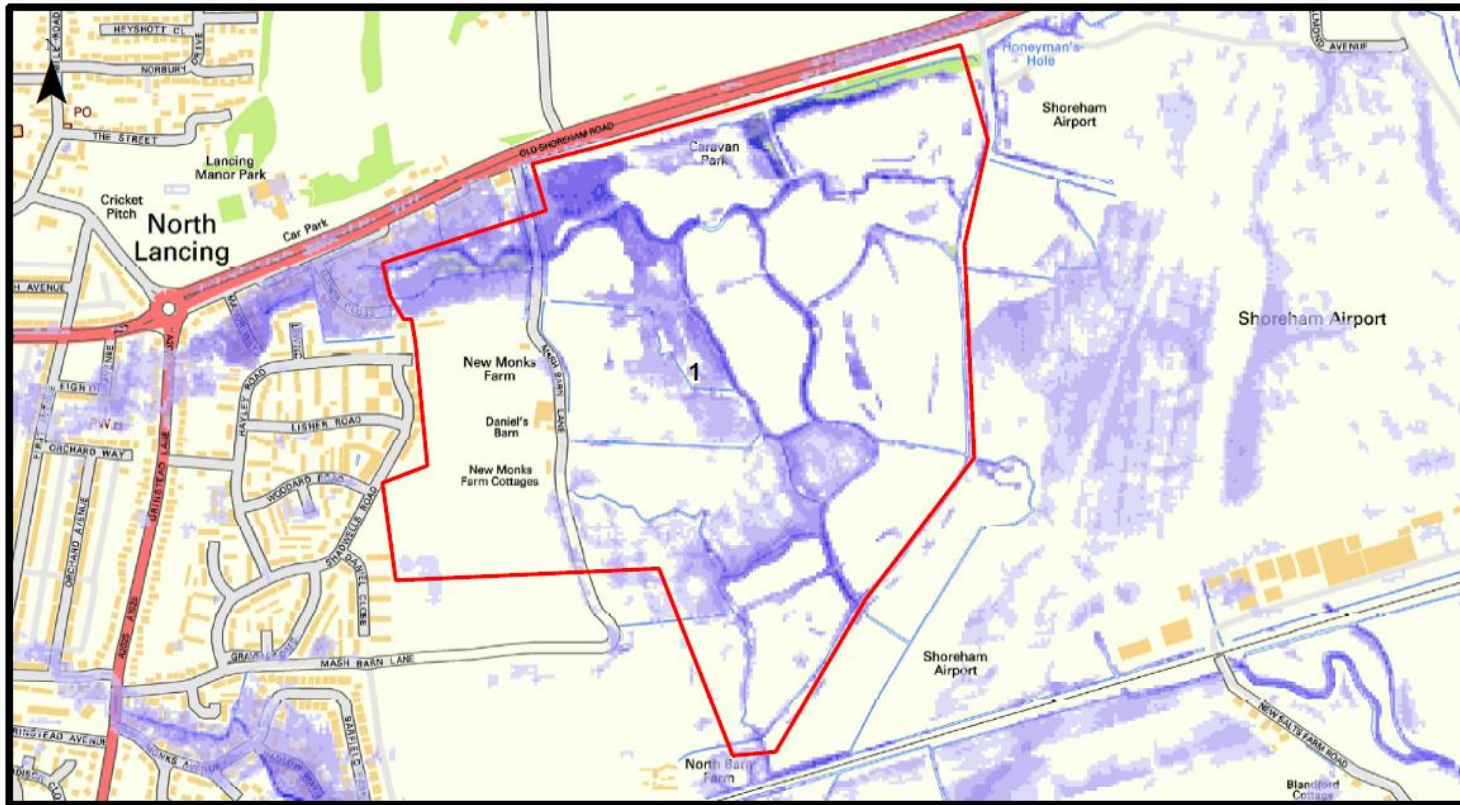
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- 0.8 - 1
- 1+



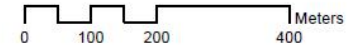
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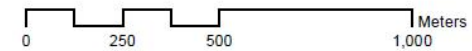
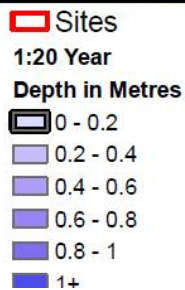
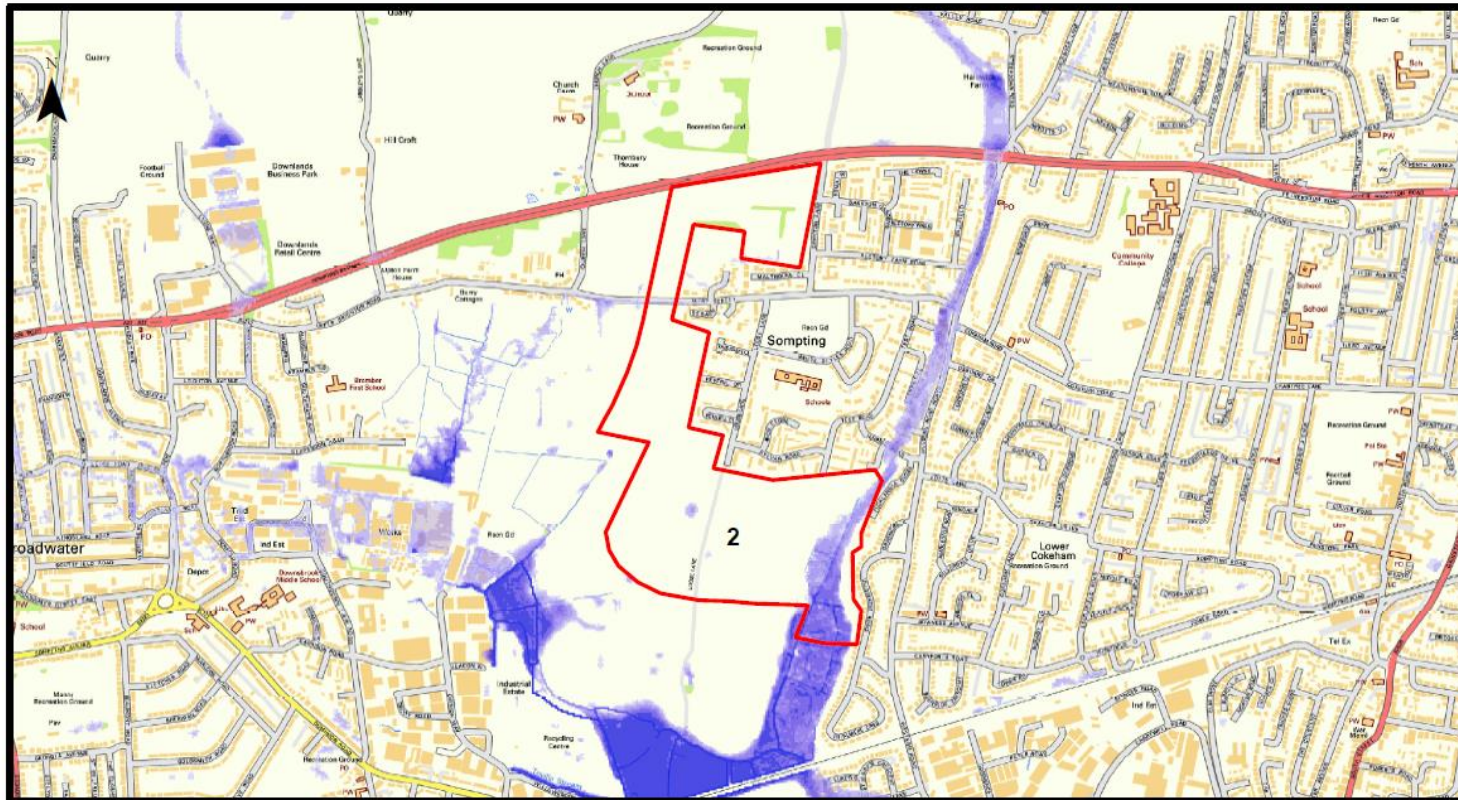
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- Depth in Metres**
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- 0.8 - 1
- 1+



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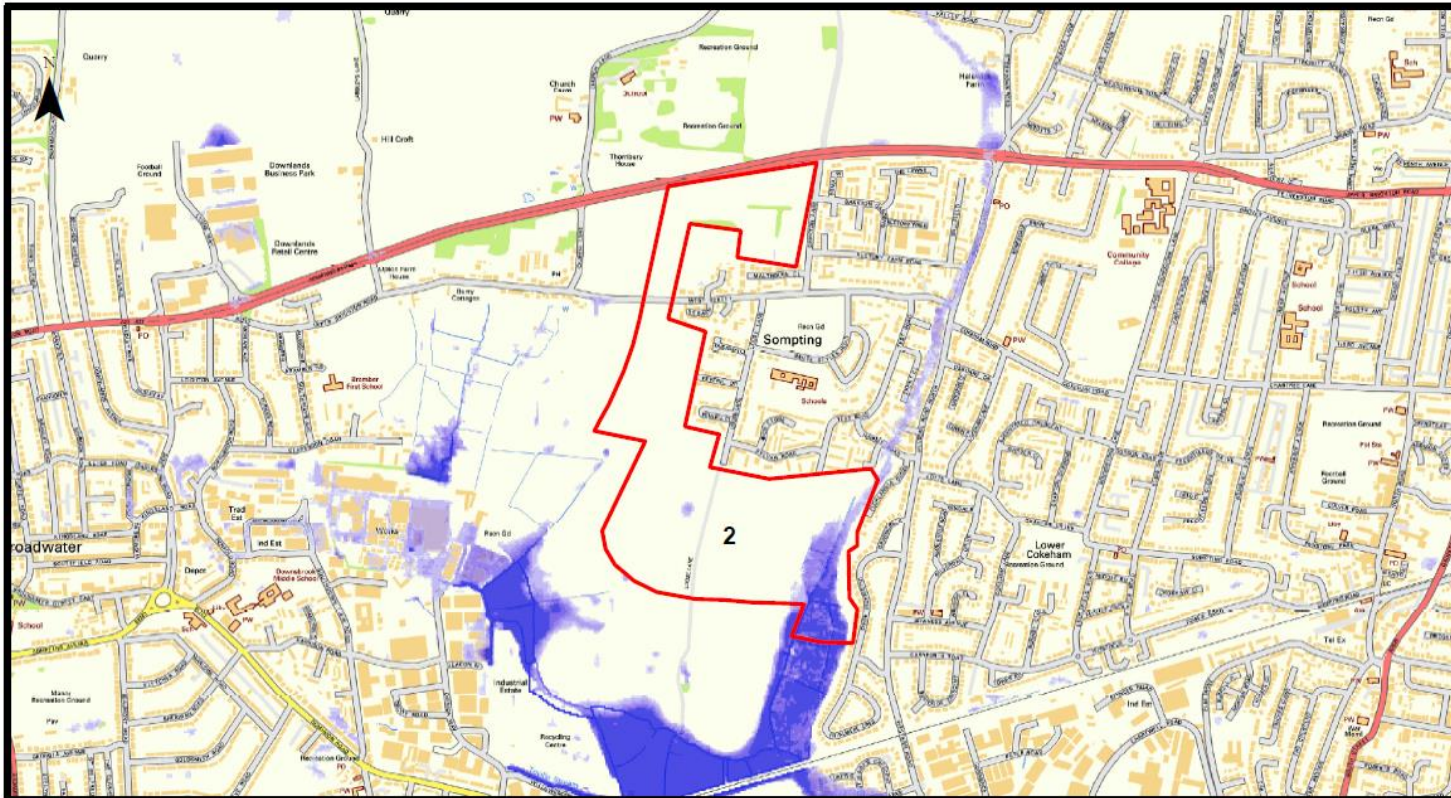
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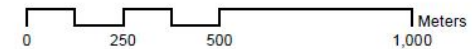
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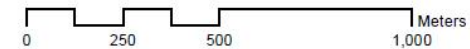
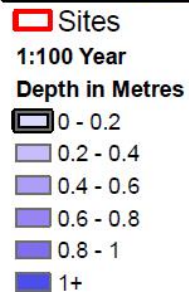
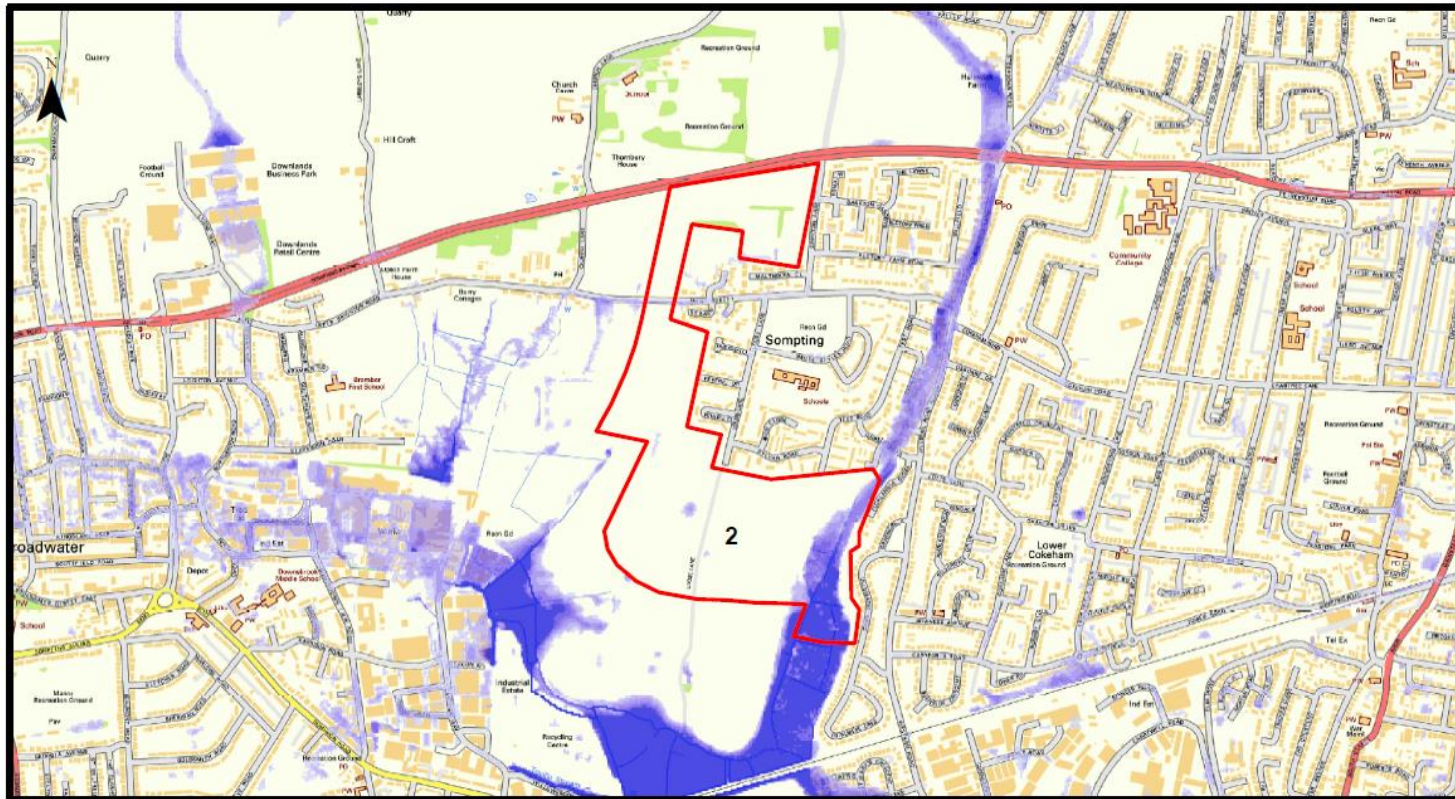
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- 1:50 Year
- Depth in Metres
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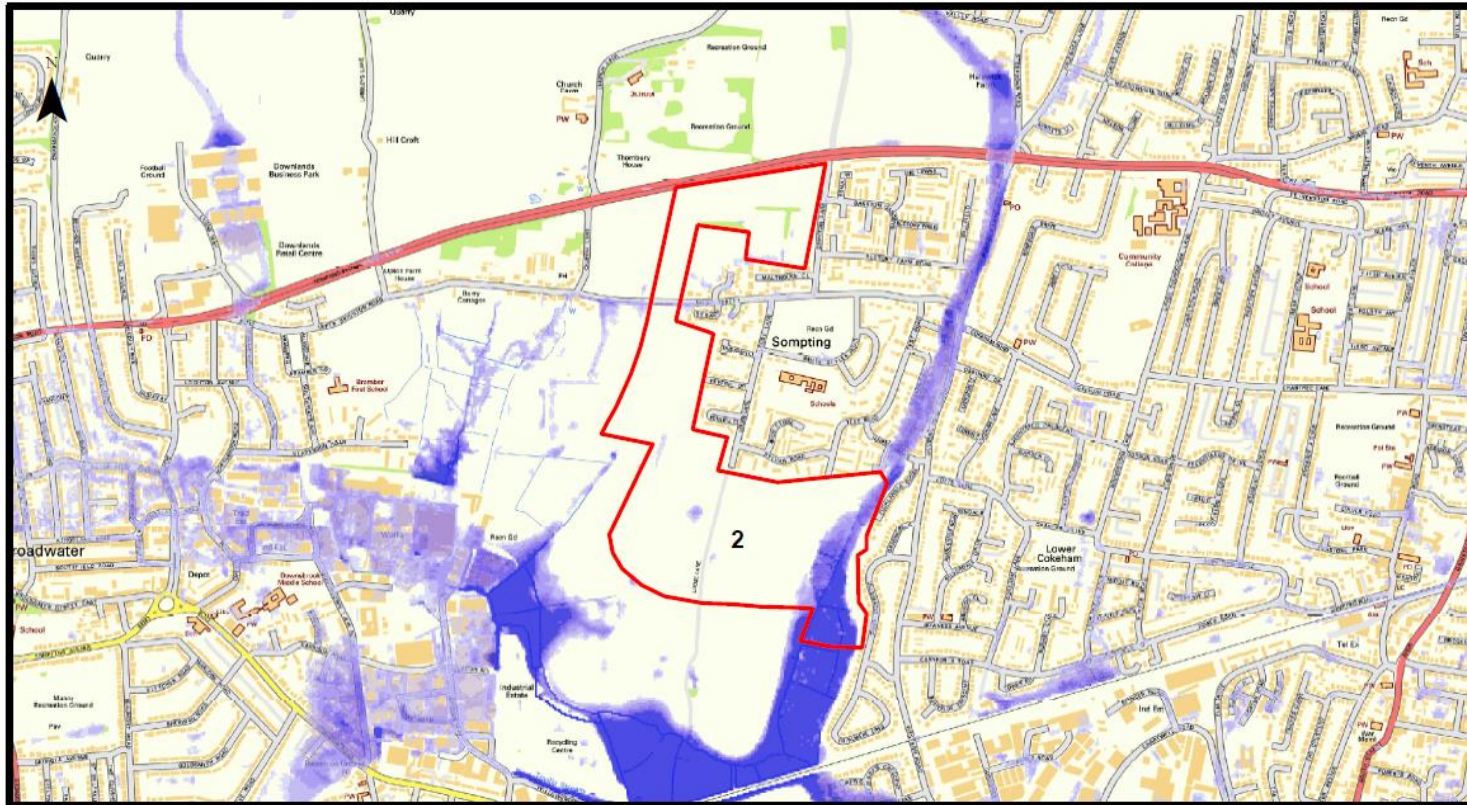
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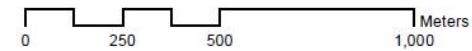
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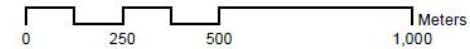
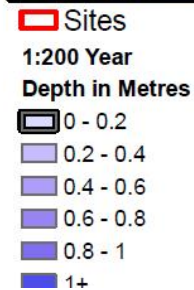
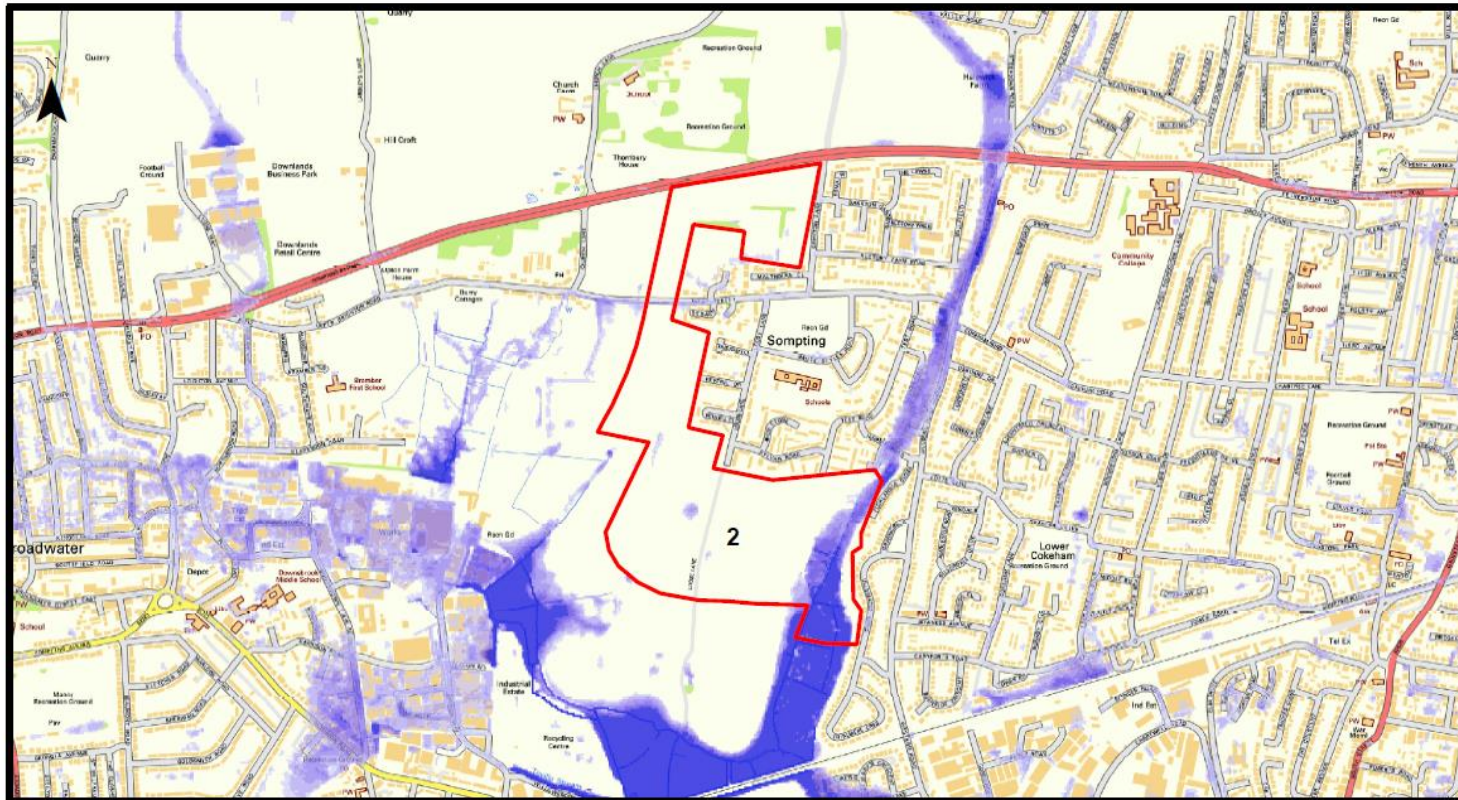
- Sites
- 1:100 Year+CC**
- Depth in Metres**
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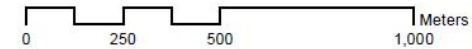
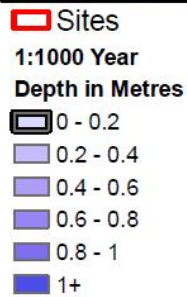
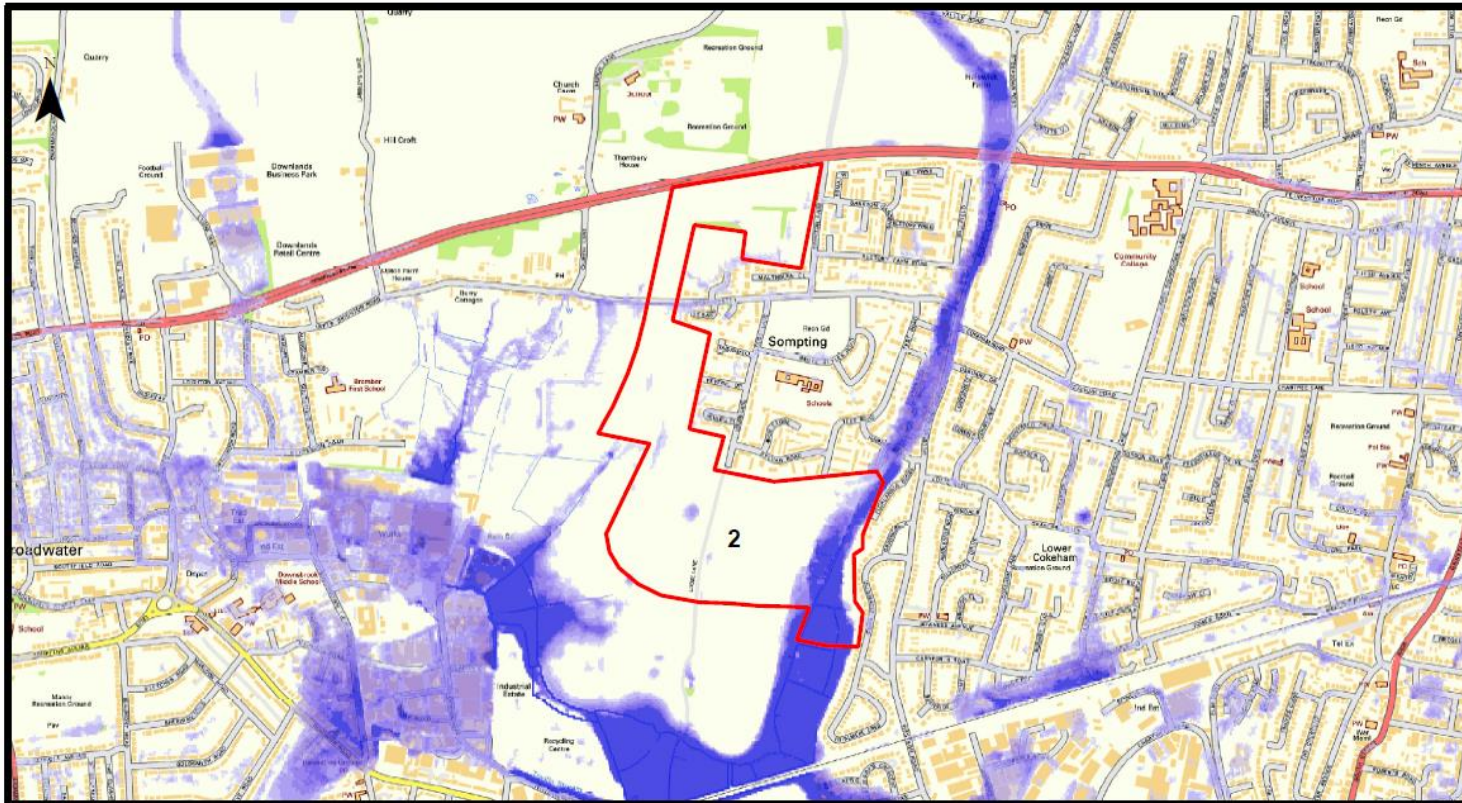
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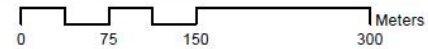
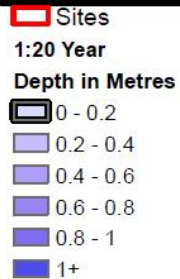
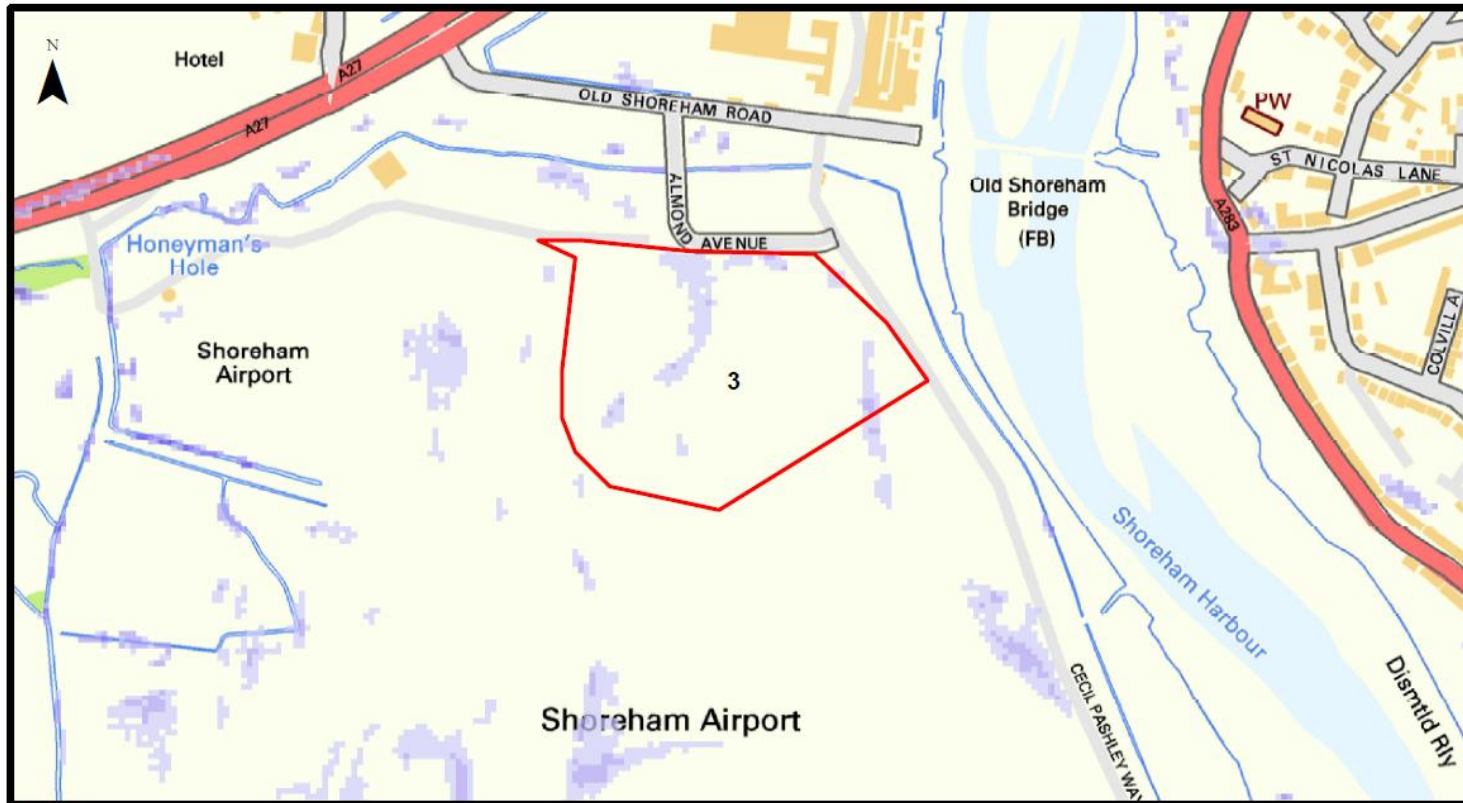
Adur Community FRA - Site 2 - 1:1000 Year Pluvial Flood



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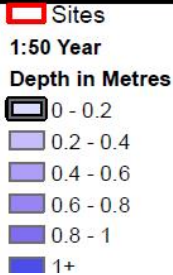
Adur Community FRA - Site 3 - 1:20 Year Pluvial Flood



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Adur Community FRA - Site 3 - 1:50 Year Pluvial Flood



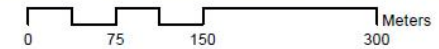
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Adur Community FRA - Site 3 - 1:100 Year Pluvial Flood



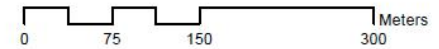
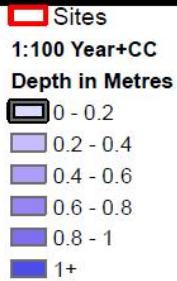
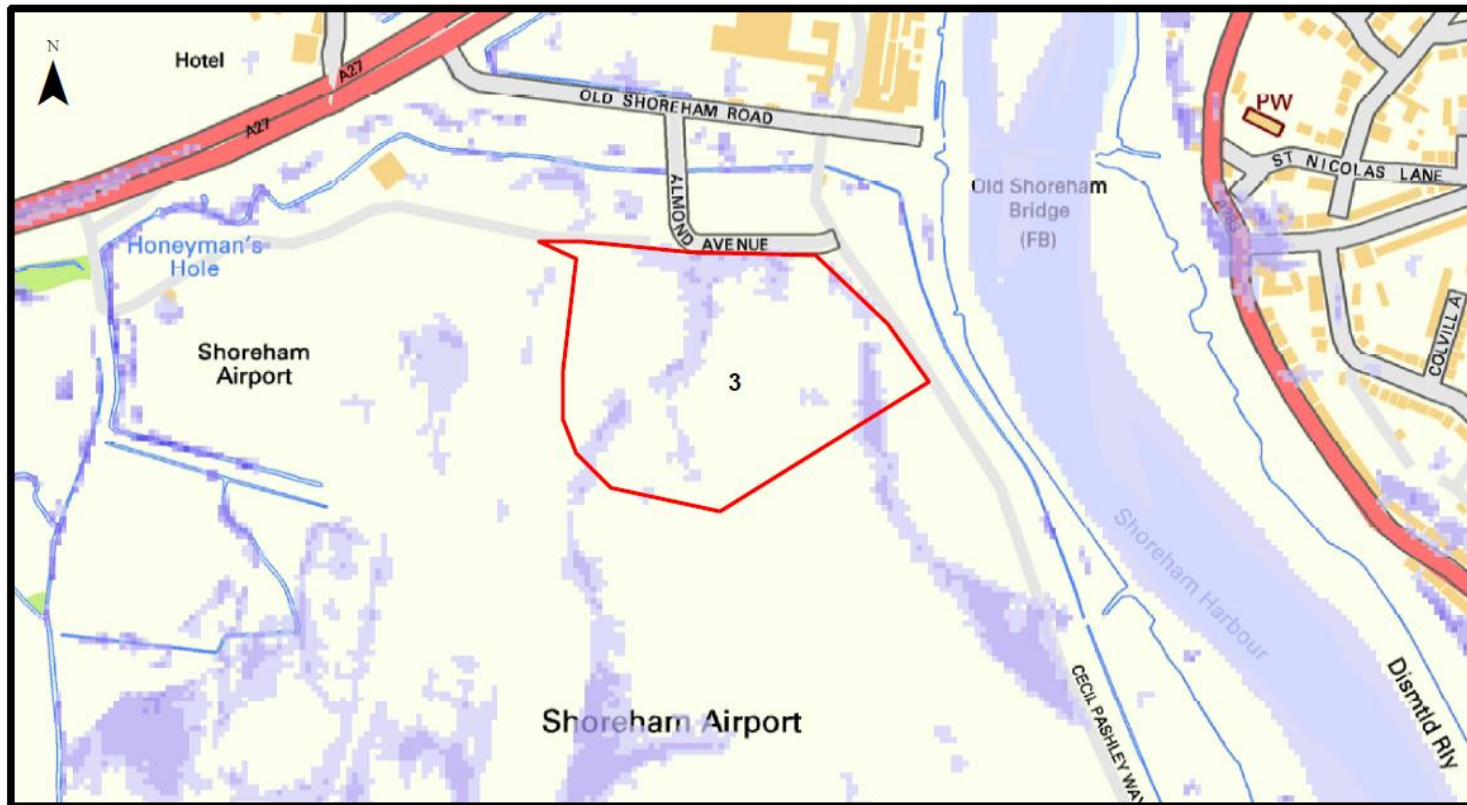
- Sites
- 1:100 Year**
- Depth in Metres**
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- 1+



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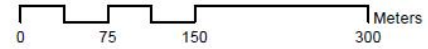
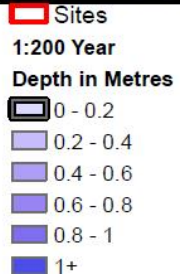
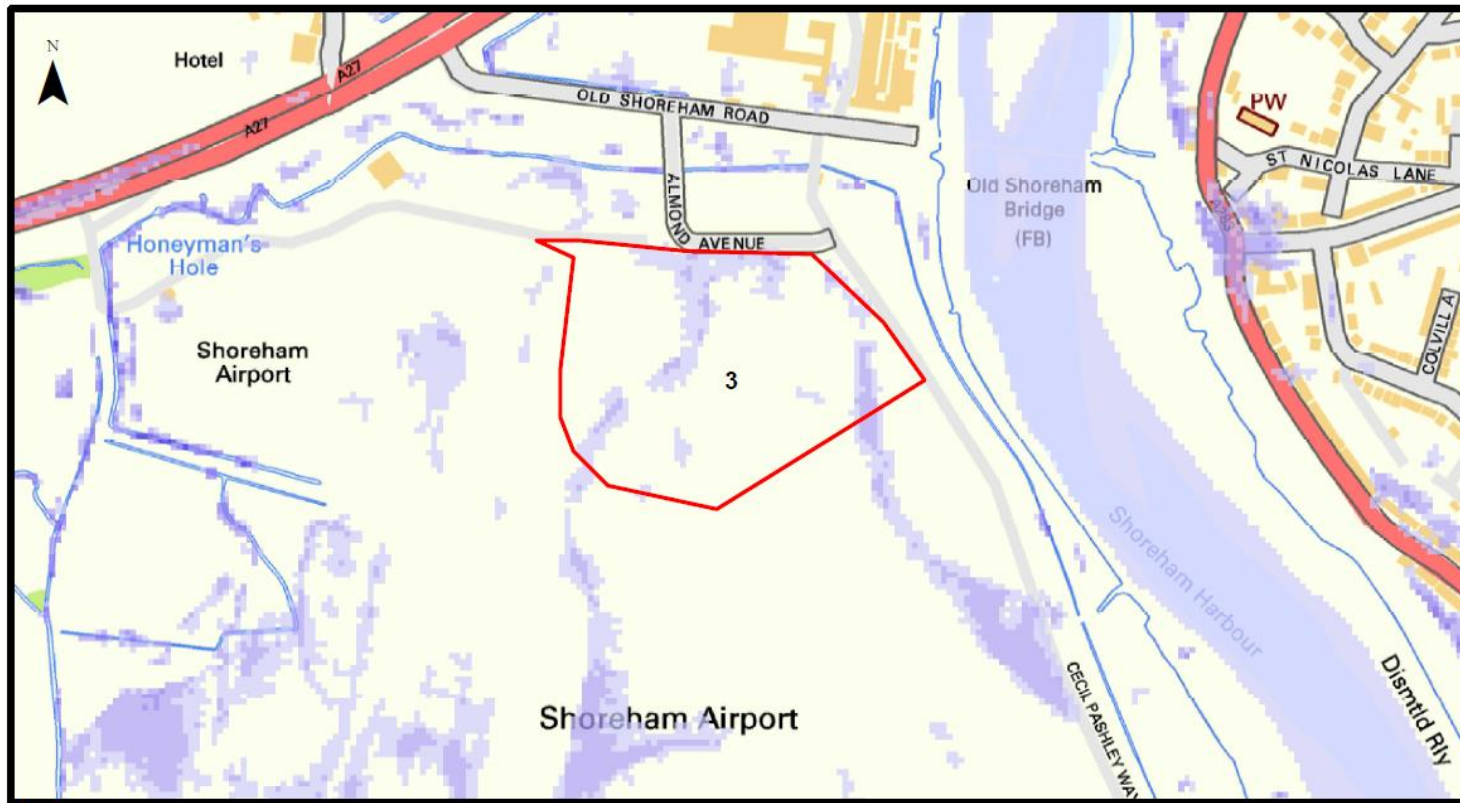
Adur Community FRA - Site 3 - 1:100 Year + CC Pluvial Flood



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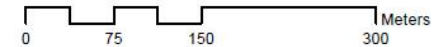
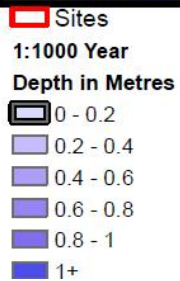
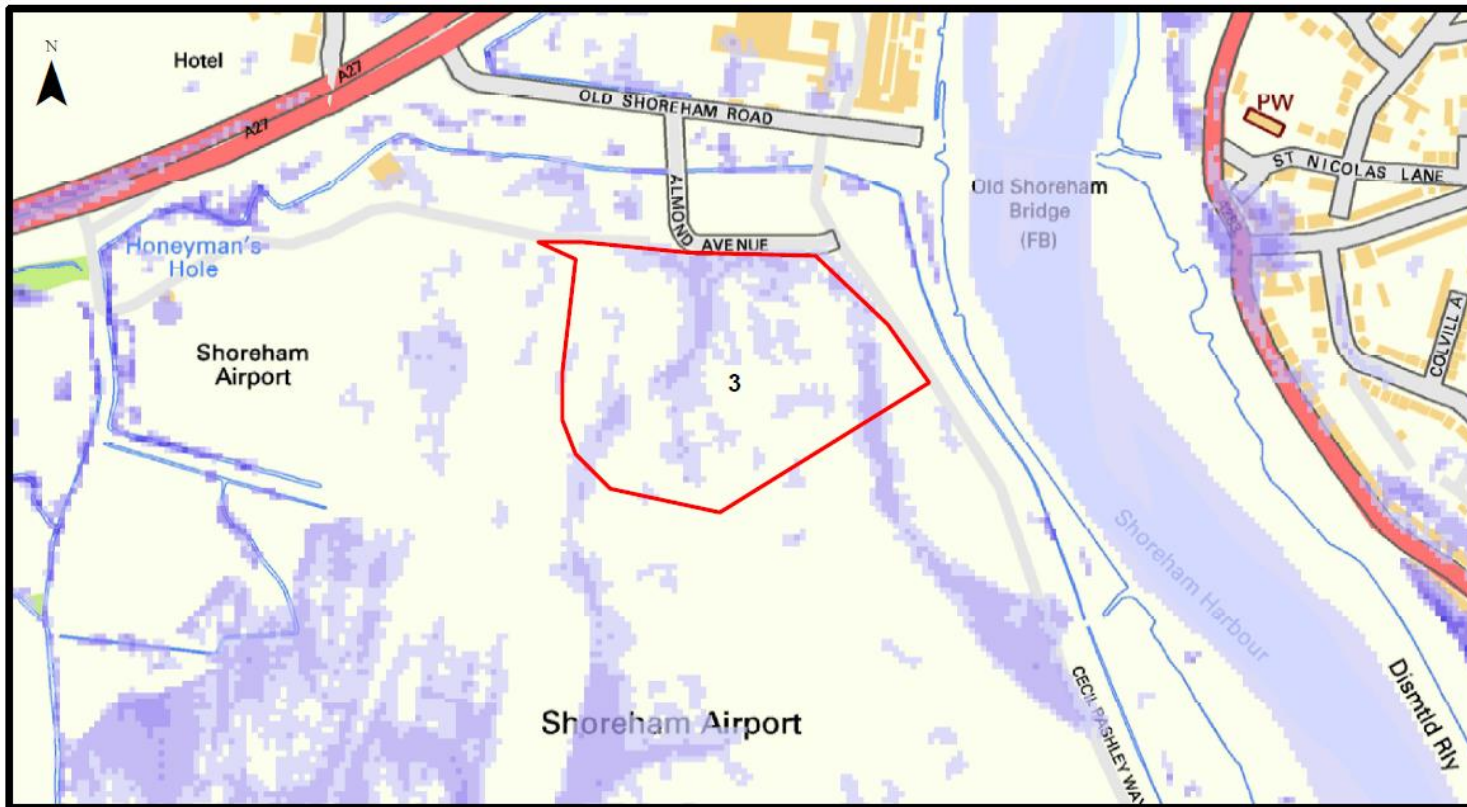
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Adur Community FRA - Site 3 - 1:200 Year Pluvial Flood



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Adur Community FRA - Site 3 - 1:1000 Year Pluvial Flood



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