

Hallam Land Management Limited

BOGNOR REGIS GOLF COURSE

Flood Risk Assessment





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REPORT RV1 PUBLIC

PROJECT NO. 70088068

OUR REF. NO. FRA

DATE: DECEMBER 2021

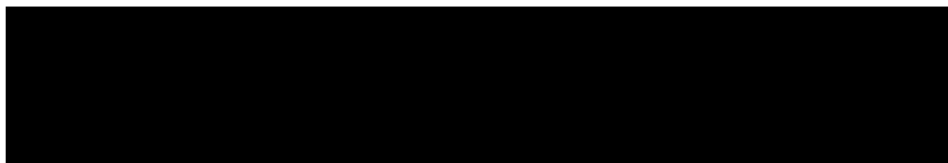
WSP

3RD Floor, Kings Orchard

1 Queen Street

Bristol

BS2 0HQ





QUALITY CONTROL

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Prepared by	Aidan Wilks Daly	Aidan Wilks Daly		
Signature				
Checked by		Rachel Ledger		
Signature				
Authorised by	Andy Smith	Andy Smith		
Signature				
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EXECUTIVE SUMMARY

This Flood Risk Assessment (FRA) has been undertaken to accompany the planning application for the proposed residential development at Bognor Regis Golf Course. This FRA has been prepared in accordance with the guidelines set out in the National Planning Policy Framework (NPPF) published in July 2021 and the National Planning Practice Guidance along with other relevant local and national guidance.

Item	Overview
Site Location	The Site is Bognor Regis Golf Club, Felpham in West Sussex, with nearest postcode PO22 8JD, at an approximate National Grid Reference 494990, 101210. The site has an area of approximately 40 hectares.
Development Proposals	Proposed residential development of up to 500 new homes.
Environment Agency Flood Zone(s)	The majority of the site, is located in Flood Zone 3, based upon the Environment Agency's Flood Map for Planning, with a small area in the southeast of the site located in Flood Zone 1.
Vulnerability Classification(s)	More Vulnerable
Tidal Flood Risk	The Environment Agency have confirmed that the coastal defences have a 1 in 200 year Standard of Protection and that this will keep pace with the impacts of climate change. The risk of tidal flooding to the site is assessed to be Low.
Fluvial Flood Risk	Hydraulic modelling has been undertaken for the Lidsey Rife which flows past the western boundary of the development. The baseline results show that the extents of Flood Zone 3 are not as extensive as that shown by the Environment Agency's Flood Map for Planning. The post development modelling shows that the site can be safely developed without having adverse impacts elsewhere. Therefore, the risk of fluvial flooding is Low.
Surface Water Flood Risk	The Environment Agency's Flood Risk from Surface Water map demonstrates that the risk of surface water flooding to the proposed development is Low. Additionally the site specific hydraulic modelling confirms that the development platforms are not at risk of surface water flooding and surface water flows on to the site can be safely routed through the development. Therefore, the risk of surface water flooding is Low.
Groundwater Flood Risk	Baseline – High, the nearest borehole log records a water strike at 1.6mbgl in a perched aquifer.

Item	Overview
	Post Development – Low , as mitigation measures will be included within the scheme design, these include a positive surface water drainage system and the residential units will be constructed on a raised platform with FFL raised 300mm above the platform levels.
Sewer Flood Risk	The West Sussex, Lidsey SWMP states that surface water and foul water sewer flooding has occurred at the golf course but no foul flooding has been reported to Southern Water Services due to hydraulic overload. This will however be mitigated by the drainage strategy and foul water strategy that will be implemented as part of the development.
Artificial Flood Risk	The site is located outside of the Environment Agency’s modelled reservoir flood extents and no artificial waterbodies are identified that could pose a significant flood risk to the site. Therefore, the risk of reservoir flooding is Low.
Sequential & Exception Test	Demonstration that the site passes the sequential test is provided in a standalone report. Demonstration that the Site passes the Exception Test is provided in Section 4.3.

1. INTRODUCTION

1.1. BACKGROUND

- 1.1.1. WSP UK Ltd (WSP) has been appointed by Hallam Land Management Limited (HLM) to prepare a Flood Risk Assessment (FRA) to support the application for redevelopment of Bognor Regis Golf Club to provide up to 480 dwellings and associated open space.
- 1.1.2. The objective of the study is to demonstrate that the site can be developed safely, without exposing the development to an unacceptable degree of flood risk or increasing the flood risk to third parties. The objectives are to:
- » Confirm the sources of flooding which may affect the site;
 - » Provide an appraisal of the availability and adequacy of existing information; and
 - » Undertake an appraisal of the flood risk posed to the site and potential impact of the development on flood risk elsewhere.

1.2. LIMITATIONS

- 1.2.1. WSP has prepared this report in accordance with the instructions of their client, HLM, for their sole and specific use relating solely to the above site. Any person who uses any information contained herein does so at their own risk and shall hold WSP harmless in any event.
- 1.2.2. Whilst this report was prepared using the reasonable skill and care ordinarily exercised by engineers practicing under similar circumstances and reasonable checks have been made on data sources and the accuracy of the data, WSP accepts no liability in relation to the report should any data, information or condition be incorrect or have been concealed, withheld, misrepresented, or otherwise not fully disclosed to WSP.

1.3. SCOPE OF ASSESSMENT

- 1.3.1. The assessment has been undertaken in accordance with the overarching national requirements for Flood Risk Assessments for proposed developments including, but not limited to, the following:
- » National Planning Policy Framework (NPPF) (July 2021)¹
 - » National Planning Practice Guidance (NPPG) (June 2021)²
 - » Flood Risk Assessments: Climate Change Allowances (October 2021)³

¹ <https://www.gov.uk/government/publications/national-planning-policy-framework--2>

² <https://www.gov.uk/government/collections/planning-practice-guidance>

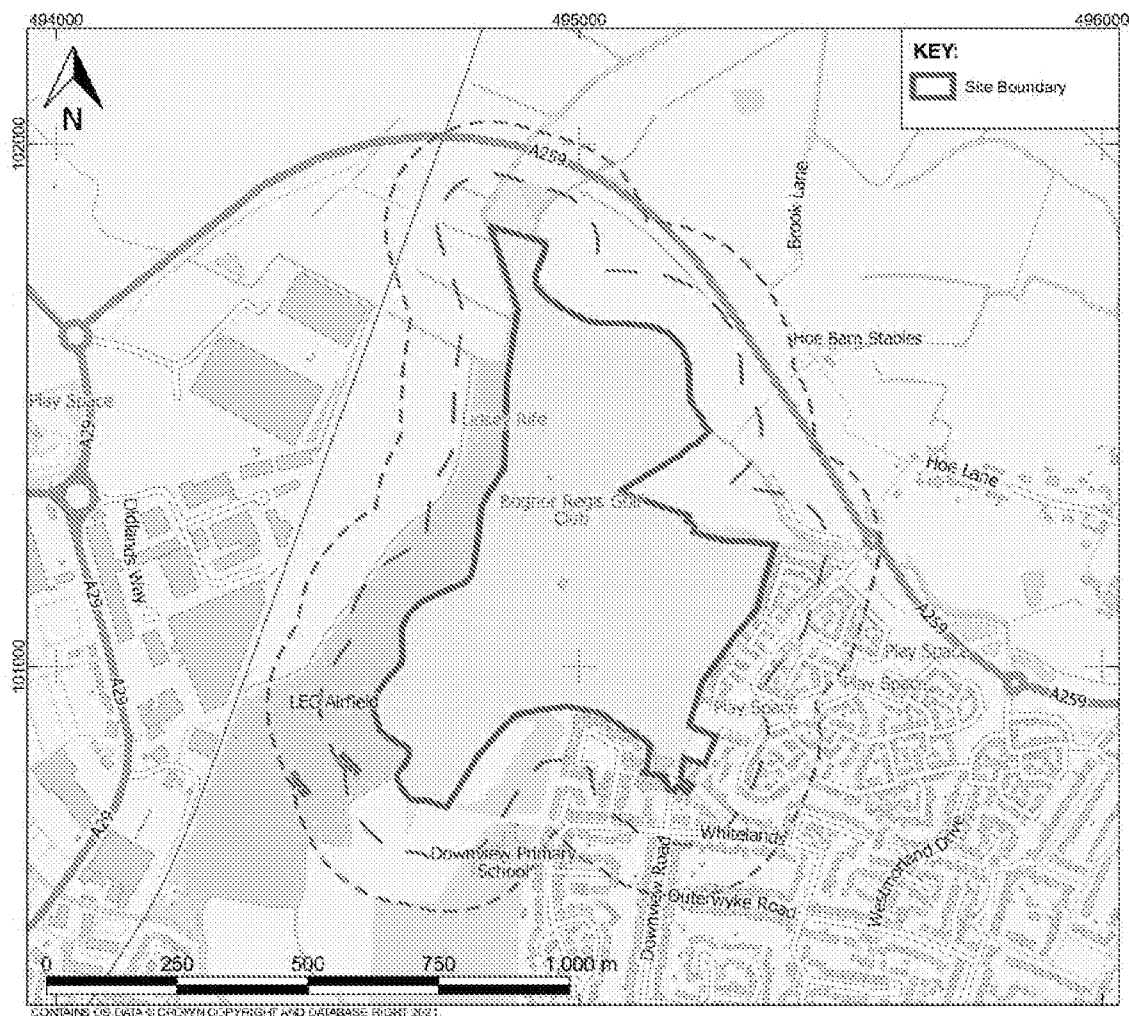
³ <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

2. SITE SETTING

2.1. LOCATION

- 2.1.1. The Site is located at Bognor Regis Golf Course, Felpham in West Sussex, with nearest postcode PO22 8JD, at an approximate National Grid Reference 494990, 101210.
- 2.1.2. The site extends over an area of approximately 40ha. The Site currently comprises the existing Bognor Regis Golf Course and associated Club House and car parking. Vehicular and pedestrian access is provided from Golf Links Road. The golf course comprises fairways, fairway trees with occasional drainage ditches, and a practice green located close to the Club House.
- 2.1.3. The Site is located to the north of Felpham and Bognor Regis and is adjacent to the north-western edge of the built up area of Felpham.
- 2.1.4. It is bounded to the west by Lidsey Rife, beyond which is the LEC Airfield, the Railway Line and beyond which are areas of commercial development. To the north is the A259. To the east is the existing residential environs of Felpham and to the southeast is Downview Primary School. To the south are open fields extending to the B2259 and further afield Felpham.
- 2.1.5. The Site currently comprises a number of trees and hedgerows as part of the golf course layout and its boundaries. A Tree Preservation Order exists (ref: TPO/FP/1/07) which covers trees on the eastern boundary of the golf course.
- 2.1.6. The site location plan is shown in Figure 2-1 - Site Location.

Figure 2-1 - Site Location



- 2.2.1. The project consists of two proposed developments, the relocation of the existing Bognor Golf Course and the construction of new housing on the existing Bognor Golf course.
- 2.2.2. The re-location is proposed as “ *[The] laying out of an 18 hole par 4 golf course, a 9hole par 3, practice greens and a driving range; the formation of a new access onto the A259; the construction of a club house with associated golf club facilities; the construction of a maintenance building and external area of hardstanding; the laying out of a car park and new roads and paths; new landscape planting, surface water drainage basins and water storage reservoir, and other earthworks and infrastructure*”.
- 2.2.3. The development of new houses is proposed as “*The construction of up to 500 new homes (C3), the formation of a new means of access onto Golf Links Road, the creation of new surface water drainage, new landscaping and habitat creation, ground works and other infrastructure. It includes the retention and re-purposing of the retained club house (F2(b)).*”
- 2.2.4. This assessment is based on the proposed development of new houses on the existing Bognor Golf Course. It does not provide an assessment of the flood risk to the relocated Bognor Golf Course, which will be covered by a separate FRA.
- 2.2.5. An extract of the Illustrative Masterplan is provided in Figure 2-2 below..

Figure 2-2 – Illustrative Masterplan



2.3. TOPOGRAPHY

- 2.3.1. The topography of the site has been assessed using both a site specific topographical survey (as provided in a stand alone document) and LiDAR from the Environment Agency. The Environment Agency LiDAR is shown in Figure 2-3. This shows that the site is located in a low elevation and slopes from an approximate elevation of 1mAOD in the north to an approximate elevation of 3mAOD by the southeast site boundary adjacent to Downview Road. Within the site boundary are localised areas of depressions that range from approximately 0mAOD to 1mAOD. These areas of depressions correspond to drainage ditches, the Lidsey Rife and the holes within the golf course.



Lidsey Rife, located on the western boundary of the site. Surface drains are present across the centre of the site and along the northern boundary. One small pond is present on the golf course.

2.5. WATERBODIES

- 2.5.1. The Lidsey Rife flows along the western boundary of the site from north to south and in its reaches past the site is categorised as a main river by the Environment Agency.
- 2.5.2. The Lidsey Rife is a tributary of the Aldingbourne Rife, with the confluence of these watercourses located near South Bersted, approximately 500m south of the site boundary.
- 2.5.3. The Aldingbourne Rife discharges into the sea within the Butlins site in Bognor Regis via two gravity outfall structures which have tidal flaps; when tidal conditions and river flows dictate, flow is pumped over the sea wall by Felpham pumping station to discharge into a stilling bay on the upper foreshore.
- 2.5.4. The tidal flaps and pumps on the Aldingbourne rife are designed to reduce the risk of tide-locking however it is understood that the tidal influence extends upstream to the reach of the Lidsey rife which flows past the site.

3. PLANNING POLICY CONTEXT

3.1. NATIONAL PLANNING POLICY FRAMEWORK

- 3.1.1. The National Planning Policy Framework (NPPF) as updated in July 2021, sets out the Government's national policies for flood risk management in a land use planning context within England.
- 3.1.2. Paragraph 159 of the NPPF states *"Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere."*
- 3.1.3. The guidance further states that local planning authorities should *"ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood-risk assessment."*
- 3.1.4. Allocation and planning of development must therefore be considered against a risk-based search sequence as provided by the guidance.
- 3.1.5. A sequential risk-based approach to determining the suitability of land for development in flood risk areas is central to the policy statement and should take into account the current and future impacts of climate change (Para. 161). This includes the intent to steer the most vulnerable parts of the development to the areas that experience the least, or an acceptable, degree of flood risk.

3.2. LOCAL PLANNING POLICY

Adopted Arun Local Plan 2011-2031 (July 2018)⁴

- 3.2.1. Policy W SP1 shows the local plan for general water management and is relevant to flood risk with the policy stating that *"The Council will also support development that:*
 - a. is appropriately located, taking account of flood risk and promotes the incorporation of appropriate mitigation measures into new development, particularly Sustainable Drainage Systems that reduces the creation and flow of surface water and improves water quality."*
- 3.2.2. Policy W DM2 within Arun's Local plan reaffirms with further details the current approach to flood risk management:

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

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

⁴ Arun District Council (2018) Adoption Arun Local Plan 2011-2031. Available online: <https://www.arun.gov.uk/download.cfm?doc=docm93jlim4n12844.pdf&ver=12984>

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

3.2.3. Policy W DM3 outlines ADC's approach to Sustainable Urban Drainage Systems (SUDS), stating that *"all developments must identify opportunities to incorporate a range of Sustainable Urban Drainage Systems (SUDS), appropriate to the size of development, at an early stage of the design process."*

3.2.4. Further details of policy W DM3 are outlined in Chapter 6, along with details of how the proposed development is compliant with the policy requirements.

Arun District Council Level 1 and Level 2 Strategic Flood Risk Assessment , November 2016 (SFRA)

3.2.5. The combined Level 1 and Level 2 Arun District Council SFRA⁵ reaffirms the need for Sustainable Urban Drainage systems and the sequential approach to flood risk management as set out in the Local Plan. Section 16.2.1 states for future development :

"The Council should consult the Environment Agency's 'Flood Risk Standing Advice (FRSA) for Local Planning Authorities', published in March 2014, when reviewing planning applications for proposed developments at risk of flooding. Planning permission for development affecting watercourses should normally only be granted where:

- » *the natural watercourse system which provides drainage of land is not adversely affected;*
- » *a minimum 8m width access strip is provided adjacent to the top of both banks of any Main River (5m for Ordinary Watercourses) for maintenance purposes and is appropriately landscaped for open space and biodiversity benefits;*
- » *it would not result in the loss of open water features through draining, culverting or enclosure by other means and culverts are opened up where ever possible;*
- » *surface water drainage is delivered by SuDS;*
- » *betterment in the surface water runoff regime is achieved; with any residual risk of flooding, from drainage features either on or off site not placing people and property at unacceptable risk; and*
- » *the application is compliant with the conditions set out by the Lead Local Flood Authority (LLFA).*

At the planning application stage, developers need to undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent, inform development zoning within the site and prove, if required, whether the Sequential and Exception Tests can be satisfied."

⁵ Arun District Council (2016) Level 1 and Level 2 Strategic Flood Risk Assessment. Available online: <https://www.arun.gov.uk/download.cfm?doc=docm93jilim4n9615.pdf&ver=9488>

4. VULNERABILITY AND SEQUENTIAL AND EXCEPTION TESTS

4.1. VULNERABILITY CLASSIFICATION

- 4.1.1. Under the NPPF the proposed residential development is classified as 'More Vulnerable' using the flood risk vulnerability classification. Vulnerable development in Flood Zone 3a (as discussed in Section 5) means that an Exception Test will be required as shown in Table 1.

Table 1 - Flood Vulnerability and Flood Zone Compatibility (PPG Table 3)

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

4.2. SEQUENTIAL TEST

- 4.2.1. The NPPF and NPPG states that Planning Authorities should complete a risk based "Sequential Test" when developing Local Plans, to ascertain areas most suitable, from a flood risk perspective, for future development.
- 4.2.2. The essence of the "Sequential Test" is to "*steer new development to areas with the lowest risk of flooding from any source*" (Paragraph 162 of the NPPF, July 2021).
- 4.2.3. Developments within Flood Zone 2 and Flood Zone 3 require a Sequential Test if a Sequential Test has not already been carried out for the development type in question at the proposed site.
- 4.2.4. No Sequential Tests have previously been undertaken for more vulnerable development at this site, therefore a Sequential Test is required. This is provided as a standalone document.

4.3. EXCEPTION TEST

- 4.3.1. While the Sequential Test should be employed on all sites to direct development to locations having the lowest probability of flooding, the Exception Test is to be used on select sites where it is shown necessary, through the Sequential Test, to apply development of a given Flood Risk Use Vulnerability in a Flood Zone that is ordinarily reserved for a less vulnerable use.
- 4.3.2. As the proposed development is classified as a 'More Vulnerable' development, is in Flood Zone 3a (according to the Environment Agency's Flood Map for Planning), an Exception Test will be required for the development. The Exception Test is detailed in paragraph 161 of the NPPF which states:

“The application of the exception test should be informed by a strategic or site-specific flood risk assessment, depending on whether it is being applied during plan production or at the application stage. To pass the exception test it should be demonstrated that:

(a) the development would provide wider sustainability benefits to the community that outweigh the flood risk; and

(b) the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.”

4.3.3. The site is considered to pass each of the elements of the Exception Test as:

- ※ **Part A** – The development provides wider sustainability benefits through the provision of the following aspects:
 - Delivering of a wide range of open market and affordable housing;
 - Monetary contributions to local infrastructure and services;
 - On-site enhancement to accessible public open space;
 - Achieving biodiversity net gain across the site;
 - Economic benefits both during construction and occupation of the development;
 - Locating development in a highly sustainable location with services and facilities within walking and cycling distance; and
 - Repurpose of the existing golf house as a local community facility.
- ※ **Part B** – This FRA demonstrates that the development will be safe for its lifetime taking account of the vulnerability of its users and does not increase flood risk elsewhere.

4.3.4. The assessment to support the conclusions of Part B of the Exception Test are in the following sections of this FRA (specifically Sections 5 and 6).

5. ASSESSMENT OF FLOOD RISK

5.1. OVERVIEW

- 5.1.1. An overview of flood risk for the proposed residential development at Bognor Golf Course and its surrounds is provided below, based on information obtained from a desk-based review and hydraulic modelling.

Table 2 - Flood Risk Overview

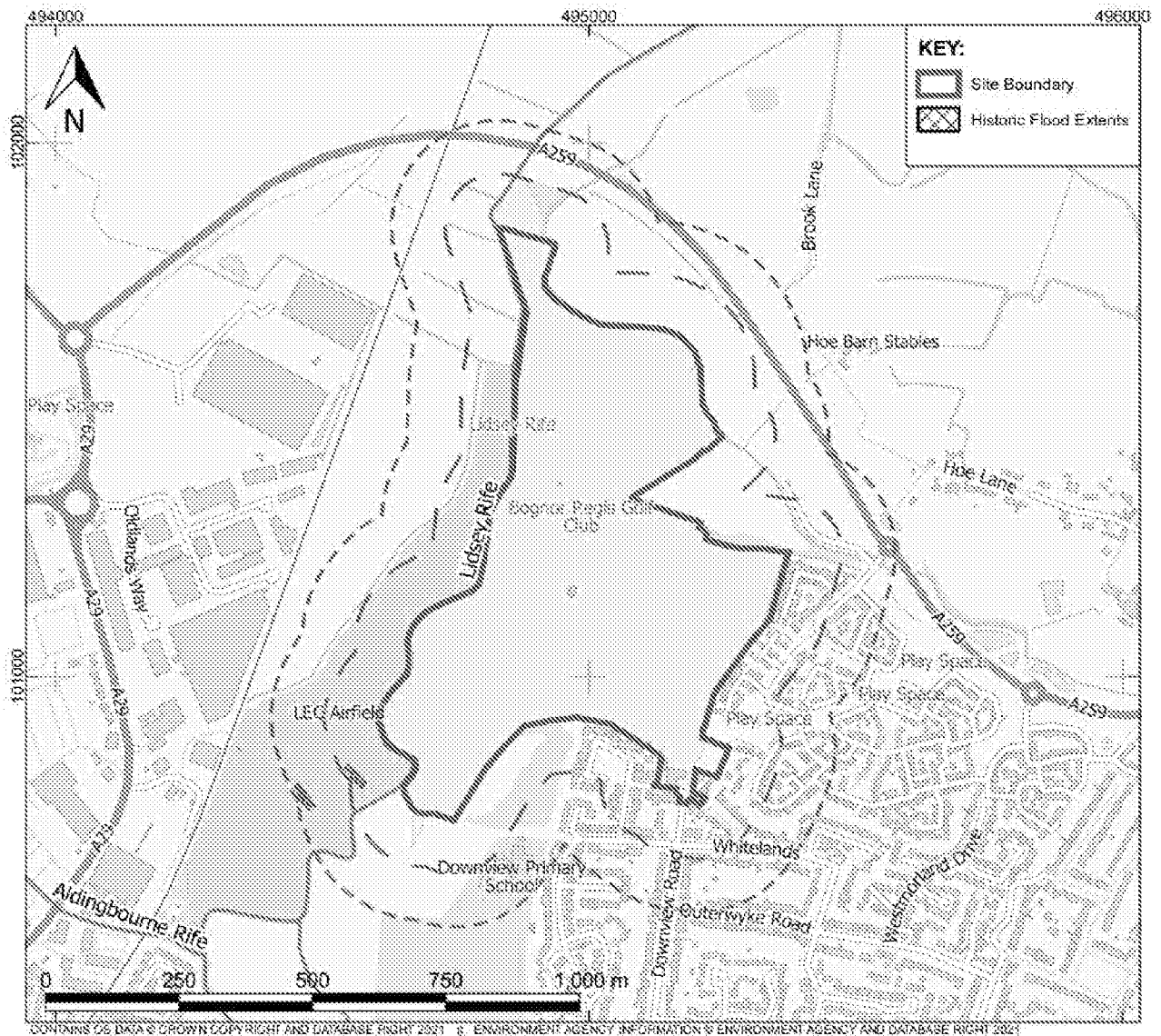
Mechanism	Risk to the development	Comment
Tidal Flood Risk	Low	The Environment Agency have confirmed that the coastal defences have a 1 in 200 year Standard of Protection and that this will keep pace with the impacts of climate change.
Fluvial	Low	The Lidsey Rife forms the western boundary of the development, flowing from north to south. The majority of the proposed development is located in Flood Zone 3 according to the Environment Agency's Flood Map for Planning. Site specific hydraulic modelling has been undertaken for the site which demonstrates that the development platforms are not at risk of flooding during the 1 in 100 year plus climate change event and there is no increase in flood risk elsewhere.
Surface Water Flood Risk	Low.	The Environment Agency's Flood Risk from Surface Water map demonstrates that the risk of surface water flooding to the proposed development is Low. Additionally the site specific hydraulic modelling confirms that the development platforms are not at risk of surface water flooding. A drainage strategy has been presented to manage the overall flow of surface water across the site, including the use of SUDS.
Groundwater Flood Risk	Low	Baseline – High, the nearest borehole log records a water strike at 1.6mbgl in a perched aquifer. Post Development – Low, as mitigation measures will be included within the scheme design, these include a positive surface water drainage system, the residential units to be constructed on a raised platform with FFL raised a further 300mm above the platform levels.
Sewers	Medium	Appendix C of the West Sussex, Lidsey SWMP states that surface water and foul water sewer flooding has occurred at the golf course.
Artificial Sources	Negligible	The site is outside of the maximum flood extents in the event of a reservoir failure and there are no canals or other artificial waterbodies in the vicinity of the site.

5.2. HISTORIC FLOODING

- 5.2.1. The Environment Agency's Historic Flood Map (see Figure 5-1 and Appendix A) does not show any historic flood events within the site boundary or the surrounding area. The Environment Agency have however provided a photo of historic flooding of the site from 2000 which has been used to help verify the assessment of fluvial flood risk (see Section 5.5). This photo shows that fluvial flooding did affect northern parts of the Site but that the entire Site was not affected. The magnitude and dominant source of this historical event is currently not known.
- 5.2.2. There is no mention of flooding occurring within the site boundary in the combined Level 1 and Level 2 SFRA² but it does highlight in Table 5-2 SIFR Database for Arun District (2016) that there was 12 flood incidents within the postcode PO22 8 which is close to the site vicinity.
- 5.2.3. Appendix C of the West Sussex Lidsey Surface Water Management Plan (SWMP)⁶ mentions Arun District Council confirmed surface water and foul water flooding had previously occurred at the golf course. It also mentions that ditch maintenance and creation of additional flood storage on the golf course is required.

⁶ West Sussex County Council (2014) Lidsey Surface Water Management Plan. Available online: https://www.westsussex.gov.uk/media/4734/lidsey_swmp.pdf

Figure 5-1 - Environment Agency's Historic Flood Map

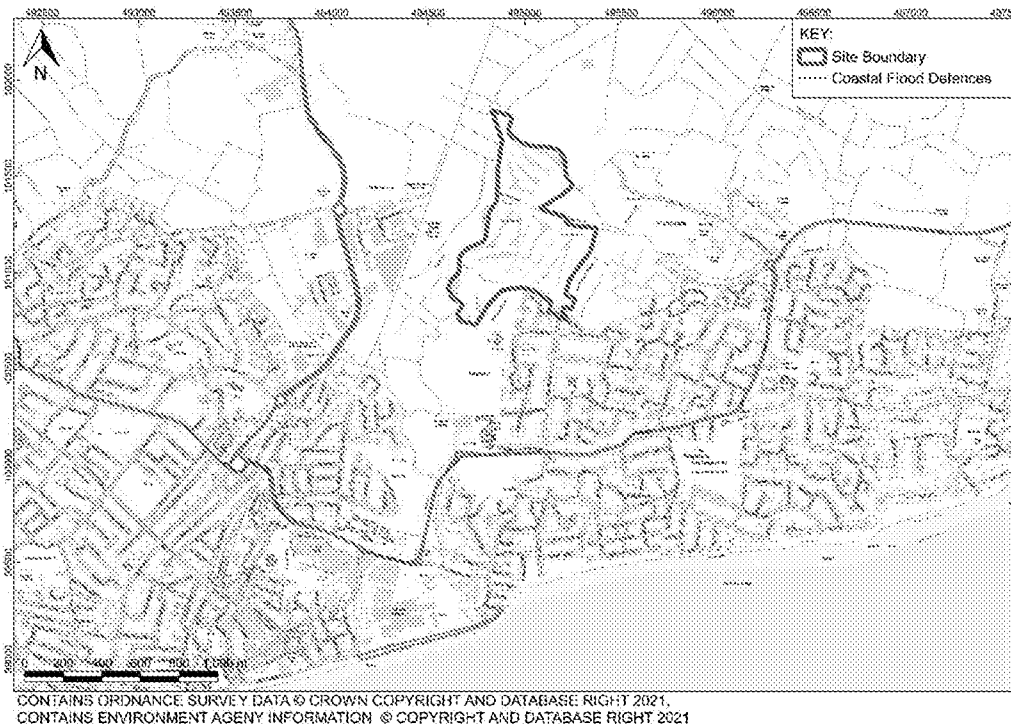


5.3. FLOOD DEFENCES

- 5.3.1. There are no flood defences in the immediate vicinity of the site. However, the Environment Agency have confirmed that Bognor Regis is currently protected from coastal flood risk by two parallel formal flood defence features that extend for approximately 800m along the coastline at the Aldingbourne Rife estuary, as shown in Figure 5-2.

- 5.3.2. These are a combination of walls, groynes and embankments which provide a 1 in 200 year Standard of Protection (Figure 5-3). The River Arun to Pagham Flood and Coastal Erosion Risk Management Strategy⁷ details that these defences are expected to keep pace with climate change.

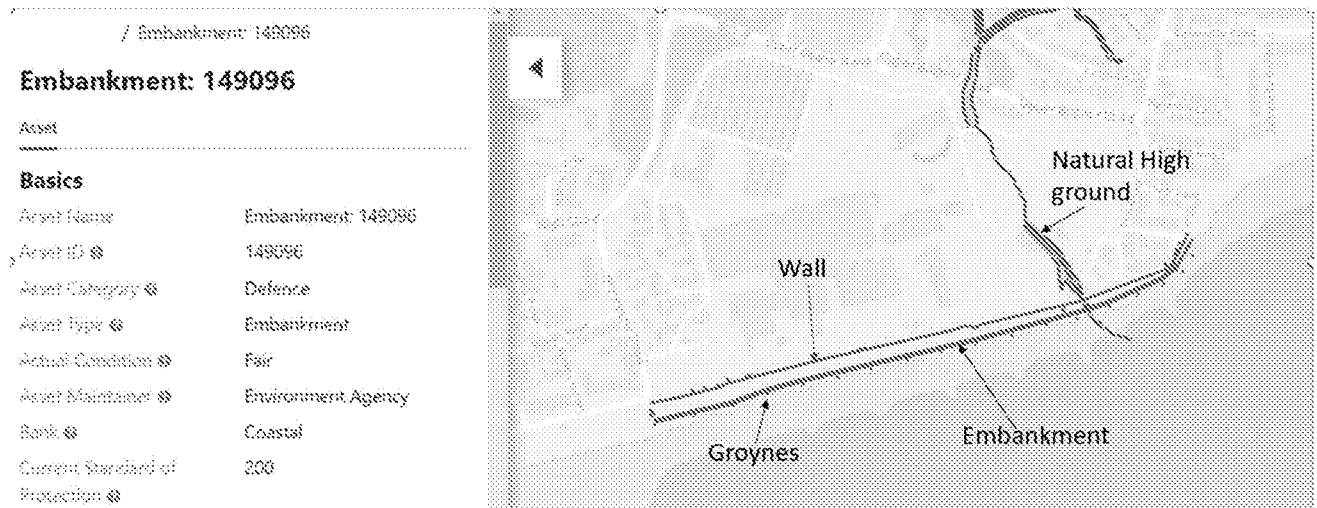
Figure 5-2 - Bognor Regis coastal flood defences



- 5.3.3. The coastal defences constitute an embankment with a foreshore and wave return wall, and immediately inland of that a secondary defence concrete wall, as shown in more detail in Figure 5-3. The Environment Agency's Spatial Flood Defences dataset indicate that the foreshore and wave return wall has a 200-year standard of protection, which corroborates the Emsworth to Littlehampton West Bank Coastal Modelling study's suggestion that Bognor Regis is not at flood risk for up to a 1 in 200 year (0.5% AEP) design event.
- 5.3.4. A further defence measure is that the Aldingbourne Rife discharges into the sea within the Butlins site in Bognor Regis via two gravity outfall structures which have tidal flaps; when tidal conditions and river flows dictate, flow is pumped over the sea wall by Felpham pumping station to discharge into a stilling bay on the upper foreshore.
- 5.3.5. The current policy, as detailed in the Arun to Pagham Flood Risk Management Strategy, is to ensure that these defences are maintained to provide the indicated standard of protection, taking account of

the impacts of climate change. This should be sufficient to provide ample protection from tidal flood risk itself, although it is important to recognise the impact that varying tidal levels may have on fluvial flood risk. This has therefore been factored into the hydraulic modelling for the fluvial risk.

Figure 5-3 - Environment Agency Flood Defences



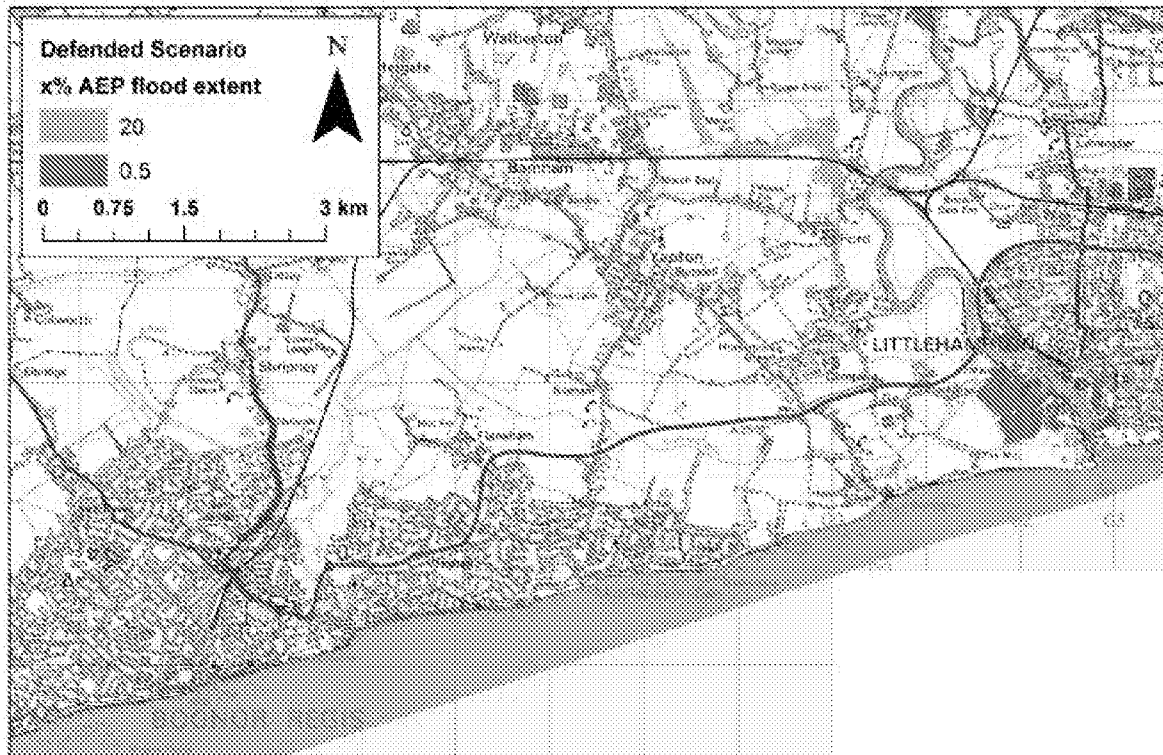
Extract of the Environment Agency's Asset Management website⁸

5.4. TIDAL FLOODING

- 5.4.1. The site is not considered to be at risk of tidal flooding given the presence of flood defences which are expected to be maintained in the future to provide a 1 in 200 year Standard of Protection so that they will continue to provide protection to Bognor and thus the site against the 1 in 200 year coastal flood event.
- 5.4.2. The current understanding of tidal flood risk to the Site is based on the Environment Agency's Emsworth to Littlehampton West Bank Coastal Modelling study (Environment Agency, 2016). This study assessed the flood risk from tidal surge and wave overtopping sources.
- 5.4.3. The study demonstrates that there is no tidal flood risk to the Site, or indeed Bognor Regis itself, for up to the 1 in 200 year (0.5% AEP) defended design event, as shown in Figure 5-4.

⁸ <https://environment.data.gov.uk/asset-management/index.html?element=http%3A%2F%2Fenvironment.data.gov.uk%2Fasset-management%2Fid%2Fasset%2F149096&layer=all-assets>

Figure 5-4 - Reproduced Figure 7-1 from the Emsworth to Littlehampton West Bank Coastal Modelling Final Report (JBA, April 2016) – Bognor Regis and Littlehampton flood extents for the 5% and 0.5% AEP defended scenarios



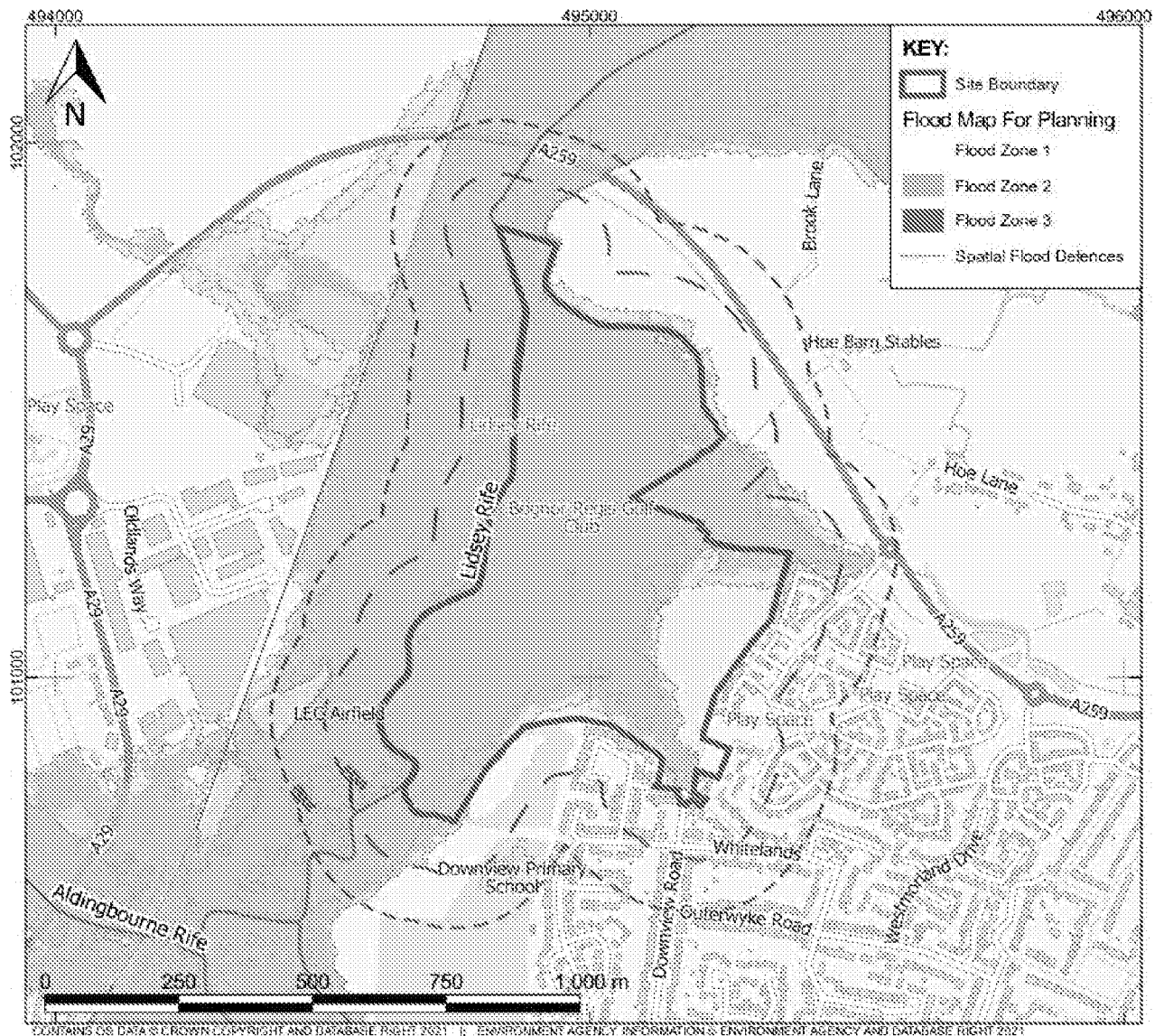
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5.5. FLUVIAL FLOOD RISK

ENVIRONMENT AGENCY MAPPING

- 5.5.1. The Environment Agency's Flood Map for Planning for the site and the surrounding area is shown in Figure 5-5. The map shows areas that are affected by tidal and/or fluvial flooding and provides a classification of whether there is a High level of risk (Flood Zone 3), Medium level of risk (Flood Zone 2) or a Low level of risk (Flood Zone 1).

Figure 5-5 - Environment Agency's Flood Map for Planning



- 5.5.2. The Environment Agency's Flood Map for Planning shows the majority of the site, to be located within Flood Zone 3, which comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1% Annual Exceedance Probability - AEP).
- 5.5.3. This mapping is based upon strategic scale modelling undertaken by the Environment Agency to understand the flood risk across the catchment and not that at individual sites. This modelling has been refined to enable the flood risk to be assessed at the site level, this is detailed in subsequent sections.

HYDRAULIC MODELLING

Environment Agency Consultation

- 5.5.4. Prior to undertaking hydraulic modelling consultation was undertaken with the Environment Agency, this included a meeting in January 2020 and subsequent discussions. As part of this the scope and methodology for the completion of the modelling was agreed.

Climate Change

5.5.5. The Environment Agency's Climate Change guidance⁹ in place at the time of preparation of this report have been used for the assessment of fluvial flood risk within the hydraulic model and mitigation design, this is:

※ 2080s - Central 25%

5.5.6. In addition, sea level rise was factored into the downstream tidal boundary of 1.2m.

5.5.7. This allowance has also been used for the mitigation design, including the on and off site impacts and determining the need for floodplain storage compensation.

Baseline Hydraulic Modelling

5.5.8. Baseline hydraulic modelling has been undertaken to refine the Environment Agency's flood extents for the site. This involved some small updates to the 2015 Aldingbourne direct rainfall Integrated Catchment Model (ICM) model, to make it suitable for the purposes of a site-specific assessment of flood risk.

5.5.9. Details of the updates to the 2015 Aldingbourne model are included in the modelling technical note which is a standalone document.

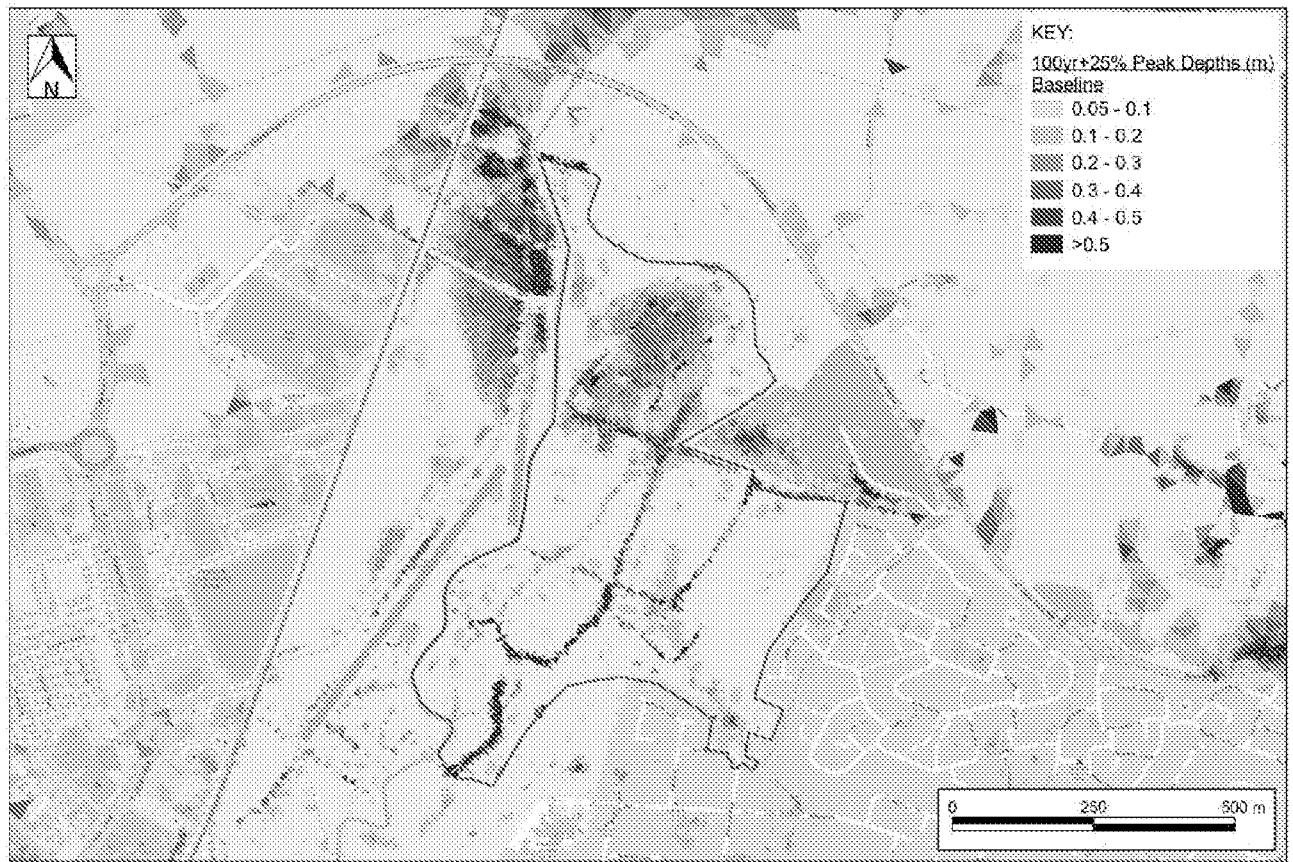
5.5.10. The 2015 Aldingbourne model is a 1D-2D, direct rainfall ICM model, which was commissioned by the Environment Agency for the Aldingbourne Flood Risk Mapping Study. It includes a fluvial and surface water drainage component and allows water to flow from the modelled 1D watercourses into the 2D floodplain. The Scheme specific updates included:

- ※ Utilising the FEH 2013 rainfall model to estimate the hydrology inputs;
- ※ Changes to the runoff parameters for buildings;
- ※ Assigning roughness values to all 1D components;
- ※ improvements to the representation of the watercourse confluences and at structures and manholes;
- ※ Updates to a number of coefficients where required e.g. discharge coefficients;
- ※ Consideration of the infiltration within the modelling;
- ※ Inclusion of local topographic survey information for the existing golf course site to improve the ground model used within the 2D elements;
- ※ An additional structure was added to the north of the development site to represent a bridge at Charles Purley Way; and
- ※ Additional baseflow added to river reaches of 0.01m³/s where instabilities were identified.

5.5.11. The hydraulic model was tested for a range of scenarios, however the main focus was the 1 in 100 year with an allowance for climate change (+25%), as shown in Figure 5-6 and Appendix B.

⁹ <https://www.gov.uk/guidance/flood-risk-and-coastal-change>

Figure 5-6 - 1 in 100 year plus climate change baseline flood depths (m)



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- 5.5.12. The 1 in 100 year showed flooding in the northern section of the site, however the majority of the lower section only showed flooding within the existing ditches. There are isolated low points of the site that do also show some ponding of water but generally these areas are less than 300mm in depth. This confirms that when flood defences are taken into account the majority of the Site is not at risk of fluvial or surface water flooding in the present day scenario.
- 5.5.13. The 1 in 100 year plus climate change (25%) also shows the majority of the flood risk is in the north, with increased depths and extent over what is shown for the current day 1 in 100 year event. The existing ditches in the south of the Site are also more pronounced, along with more connectivity between the areas of localised ponding. However, in general the majority of the southern part of the Site is still shown to not be at risk in the 1 in 100 year event including climate change.
- 5.5.14. It was not possible to calibrate the hydraulic model due to a lack of available data, however the photograph of the 2000 flooding was compared to the flood extents from the modelling and showed a relatively good match. This helps to provide a level of verification to the hydraulic modelling.

Post Development Hydraulic Modelling

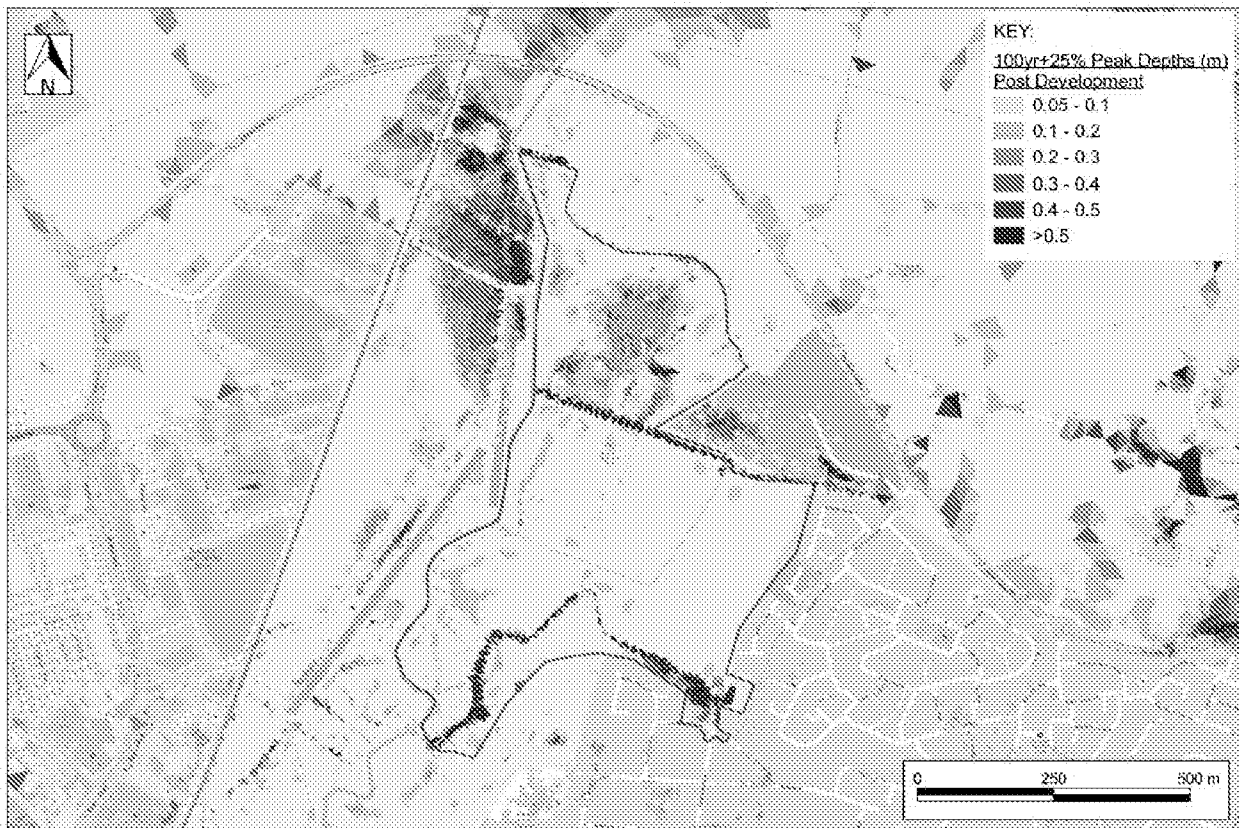
- 5.5.15. The baseline model was modified to incorporate the proposed development. The key differences between the baseline model and the post-development model are as follows:
- ≈ Inclusion of the development platforms;
 - ≈ Inclusion of the road network;

- » Inclusion of the surface water channels;
- » Inclusion of flood management features in the north of the site (i.e. a flood berm); and
- » Removal of rainfall from the development platforms and road network, as surface water runoff from these areas will be managed through the SuDS strategy.

5.5.16. As discussed above the hydraulic model is a Direct Rainfall model. For the purposes of the post-development hydraulic model the rainfall within the Site red line boundary has been turned off as that will be managed by the surface water drainage system and is therefore modelled as part of the drainage design.

5.5.17. The 1 in 100 year including climate change post development model results are shown in Figure 5-7 (and Appendix B). The results demonstrate that the platforms and the surface water attenuation ponds are free from flooding. The access and egress route to the north is also shown to be dry. The primary access to the site via Shirley Drive is shown to be safe during the 1 in 100 year plus climate change event.

Figure 5-7 - 1 in 100 year plus climate change post development flood depths (m)

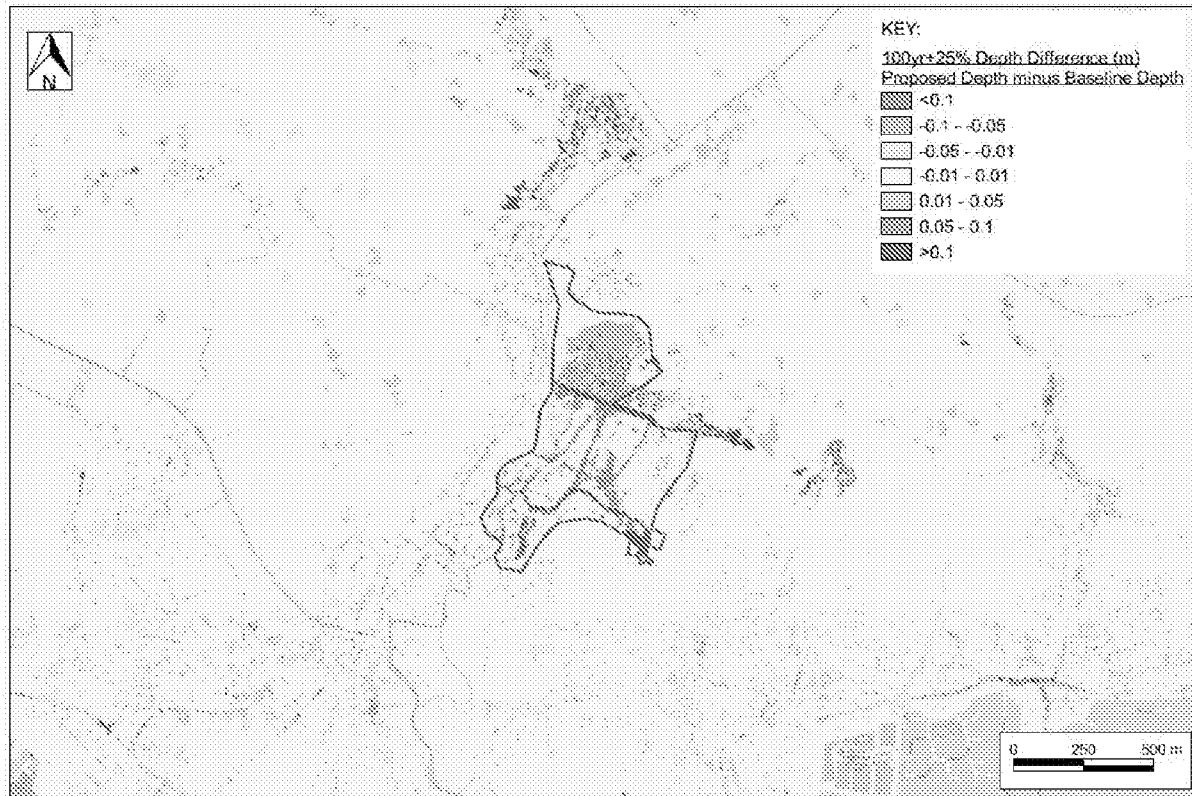


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5.5.18. Figure 5-8 then shows the impact of the development on the flood risk to the surrounding area. This presents a difference grid where a negative depth relates to a reduction in flood risk with the development in place compared to the baseline, which a positive depth relates to an increase in flood risk. Figure 5-8 shows there is less flooding across the area of the development parcels and water is directed through the drainage channels, particularly adjacent to the berm and the southern drainage channel. For the wider area there is negligible change to the depths of flooding observed,

there are minor differences across the model domain due to the irregular mesh generation within ICM, this is normal for this modelling approach as there are differences between the baseline and post development grids and thus the subsequent calculations. This demonstrates that the development does not increase the flood risk to the surrounding areas.

Figure 5-8 - 1 in 100 year plus climate change depth difference map



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- 5.5.19. The hydraulic modelling has therefore shown that the development can be safe for its lifetime, has safe access and egress during times of flooding and does not increase the flood risk to the surrounding areas.

FLUVIAL FLOOD RISK SUMMARY

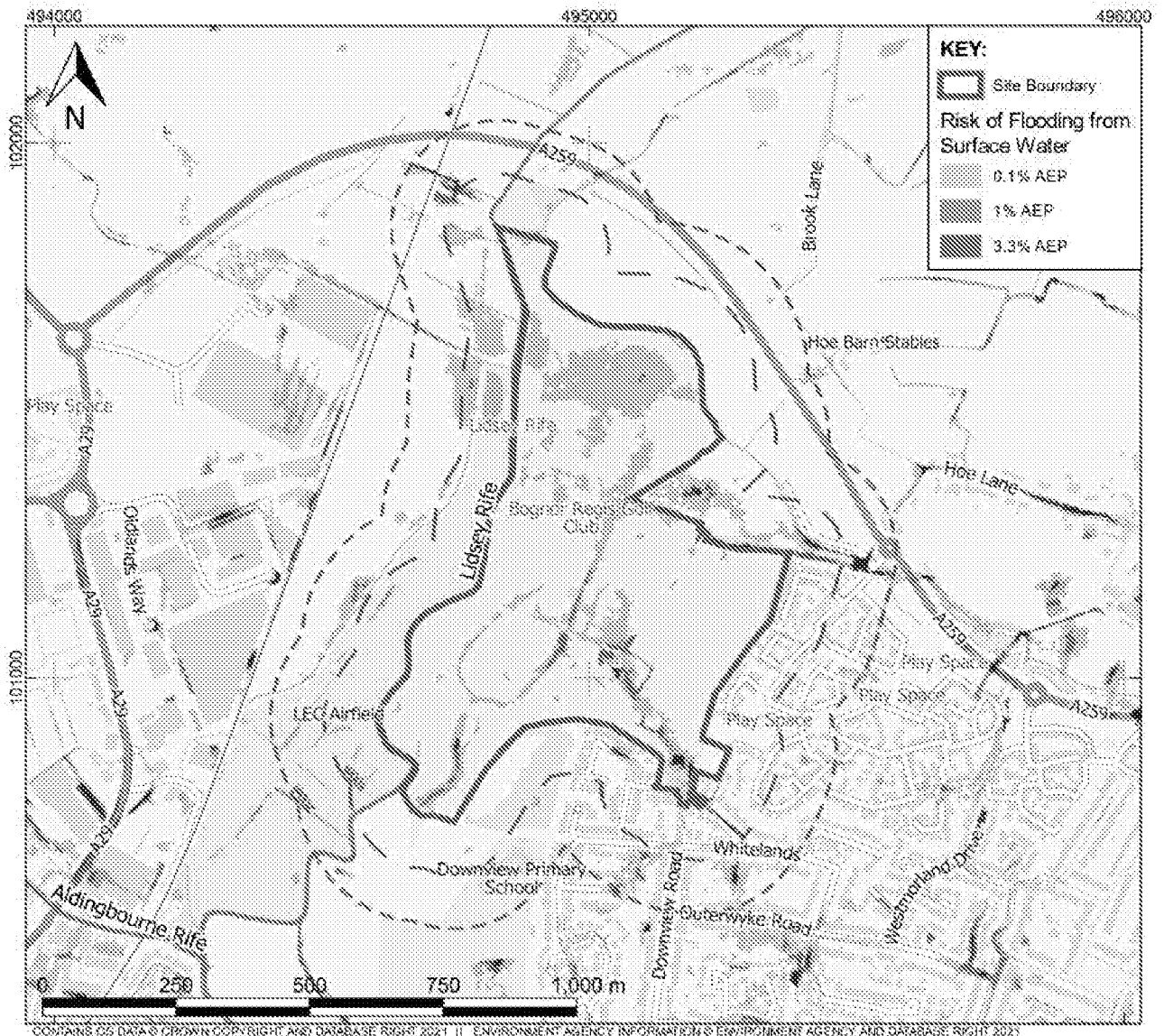
- 5.5.20. The Lidsey Rife, categorised as a main river, flows from north to south along the western boundary of the site.
- 5.5.21. The majority of the site is shown to be located within Flood Zone 3 on the Environment Agency's Flood Map for Planning, which comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%AEP).
- 5.5.22. Baseline and post-development hydraulic modelling has been undertaken for the site, the results of which show that the development can be safe for its lifetime, has safe access and egress during times of flooding and does not increase the flood risk to the surrounding areas.

Identified Fluvial Flood Risk: Low

5.6. SURFACE WATER FLOOD RISK

- 5.6.1. Flooding from surface water is caused when rainfall cannot soak away because the ground is fully saturated, or drainage systems are full. This form of flooding is usually associated with high intensity rainfall events but can also occur with lower intensity rainfall or melting snow where the ground is saturated, frozen, developed or otherwise has a low permeability. The flood risk relates to both the conveyance of waters to the site by overland flow from areas outside the site and also areas within the site itself, and the ponding of these waters in depressions in the topography.
- 5.6.2. The Environment Agency's Risk of Flooding from Surface Water (Figure 5-9) indicates that significant portions of the site are at low risk of surface water flooding, with small areas at medium and high risk. These are defined as:
- ※ Very low risk denotes an area that has less than a 1 in 1,000 (0.1% AEP) annual probability of flooding;
 - ※ Low risk denotes an area that has between a 1 in 1,000 (0.1% AEP) and 1 in 100 (1% AEP) annual probability of flooding ;
 - ※ Medium risk denotes an area that has between a 1 in 100 (1.0% AEP) and 1 in 30 (3.3% AEP) probability of surface water flooding; and
 - ※ High risk refers to areas that have greater than a 1 in 30 annual probability (3.3% AEP) of surface water flooding.
- 5.6.3. The areas at high risk of surface water flooding are located near the southeast and southwest corners of the site, near existing field drains and the depths in the high risk event (1 in 30 years) are predicted to be mostly below 300mm. In the medium risk event (1 in 100 years) surface water flood depths are also largely predicted to be below 300mm.
- 5.6.4. In the north of the site there is a large area at low risk of surface water flooding, where depths of between 300mm and 900mm are predicted to pond in the low risk (1 in 1000 years) event.

Figure 5-9 – Environment Agency’s Risk of Surface Water Flooding Map



- 5.6.5. The hydraulic model (as detailed in Section 5.5) is a direct rainfall model which, therefore, also includes a representation of the surface water pathways onto the site. These pathways are limited to waters flowing along Shirley Drive and into the Golf Course via the eastern access adjacent to the club house. However, in the post development scenario this flow route is reduced due to the inclusion of a network of surface water channels which convey water away from this area.
- 5.6.6. The flood hazard maps demonstrate that the primary access is safe for all in the critical 1 in 100 year plus climate change flood event.
- 5.6.7. The modelling demonstrates that the existing club house is at risk of flooding during the 1 in 100 year plus climate change event. This risk will be managed through the installation of property level resistance / resilience measures to prevent water ingress as part of the detailed design. As part of the change in use works the electrical sockets will be located 600mm above the FFL, with consideration given to the inclusion of further measures as part of the detailed design works.

5.7. GROUND WATER FLOOD RISK

- 5.7.1. According to the Source Protection Zone map produced by the Environment Agency, the site does not lie within any Source Protection Zones (see Appendix A Flood Map Pack).
- 5.7.2. Aquifer designation mapping from the British Geological Survey (see Appendix A Flood Map Pack) shows that the site is underlain by a highly productive aquifer.
- 5.7.3. The RTD and RMD are both designated as Secondary A aquifers, defined by the Environment Agency as “permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers”. It is therefore assumed that they are in hydraulic connectivity with the Lidsey Rife.
- 5.7.4. Historical borehole records available from the BGS, indicate that resting groundwater level within the site varies from 1 m below ground level (bgl) to 2.5 m bgl. This includes the BGS Borehole record adjacent to Downview Primary School¹⁰ (located approximately 130m southeast of the site boundary) which shows that water was struck at 1.6mbgl.
- 5.7.5. Appendix F of the Level 1 SFRA, contains an extract of the Environment Agency’s Areas Susceptible to Groundwater Flooding (ASStGWF) mapping for Bognor Regis. The ASStGWF is a strategic-scale map showing groundwater flood areas on a 1km square grid, this data shows the proportion of each 1km grid square, where geological and hydrogeological conditions indicate that groundwater might emerge.
- 5.7.6. The ASStGWF mapping indicates that the north of the site is located in an area with a low susceptibility to groundwater flooding, whilst the south of the site is located in an area with a very low susceptibility to groundwater flooding. Low corresponds with 25-50% of each 1km grid square being susceptible to groundwater emergence, whilst very low indicates under 25% of the 1km grid square is susceptible to groundwater emergence.
- 5.7.7. Neither the Level 1 nor Level 2 SFRAs contain details of any groundwater flooding incidents within the vicinity of the site boundary.
- 5.7.8. Based on the Environment Agency’s ASStGWF map and the absence of any recorded groundwater flooding incidents in the vicinity of the site.
- 5.7.9. To mitigate the risk of groundwater flooding the following measures will be implemented:
 - ※ A positive surface water drainage system will be installed;
 - ※ The land drains which are present under the golf course will be maintained as far as possible;
 - ※ The network of surface water channels across the site will be increased and enhanced;
 - ※ The development platforms will be raised above existing ground levels;
 - ※ The FFL’s for the properties will be raised 300mm above the platform levels.
- 5.7.10. The risk that groundwater flooding poses to the site is assessed to be low.

¹⁰ http://scans.bgs.ac.uk/scbi_scans/boreholes/434486/images/10769176.html

Identified Groundwater Flood Risk: Low

5.8. SEWER FLOOD RISK

- 5.8.1. Sewer flooding occurs as a result of a number of influencing factors. It is most likely to occur during storms, when large volumes of rainwater enter the sewers. However, it can also occur when pipes become blocked or damaged.
- 5.8.2. Appendix C of the West Sussex, Lidsey SWMP states that surface water and foul water sewer flooding has occurred at the golf course, but no foul flooding has been reported to Southern Water Services due to hydraulic overload. This will however be mitigated by the drainage strategy and foul water strategy that will be implemented as part of the development.

Identified Sewer Flood Risk: Medium

5.9. ARTIFICIAL SOURCE FLOOD RISK

- 5.9.1. The Environment Agency Reservoir Flooding Map (see Appendix A flood map pack) shows that the site is located outside of the maximum extent of flooding in the event of a nearby reservoir failing.

OTHER ARTIFICIAL SOURCES

- 5.9.2. There are no canals or other artificial waterbodies in the vicinity of the site.

Identified Flood Risk from Artificial Sources: Low

6. SURFACE WATER DRAINAGE

- 6.1.1. To mitigate the risk of surface water flooding to the development a comprehensive drainage / SUDS strategy has been developed and is provided as a standalone document. This strategy involves attenuating the surface water runoff at source, via ponds and swales, prior to discharge to the Lidsey Rife.
- 6.1.2. The SUDS Strategy has been developed in accordance with the policies set out within Policy W DM3 of the Arun Local Plan¹, this requires the development to:
- ⌘ Incorporate SUDS within the private areas of the development in order to provide source control features (i.e. green roofs, permeable driveways and parking, soakaways and water harvesting and storage features including water butts) to the overall SUDS design.
 - ⌘ As a major development, there is also the requirement to integrate SUDS within public open spaces and roads, reflecting discussion with appropriate bodies. SUDS must therefore be integrated into the overall design of the development.
- 6.1.3. The post-development surface water drainage strategy will restrict peak flows for all events from the impermeable areas to the equivalent greenfield rate (QBAR), thereby ensuring the risk of surface water flooding does not increase both on the Site and for the surrounding area.
- 6.1.4. The drainage strategy utilises and enhances the current ditches across the site along with the creation of a new series of ditches / swales to convey and attenuate the surface water from the various parcels of the development to the attenuation ponds. The ditches / swales feed into the northern attenuation pond, which then drains into the southern attenuation pond before discharging into the Lidsey Rife via the existing outfall.
- 6.1.5. As part of the enhancements to the existing ditches there will be local raising of bed levels to help to increase the overall fall across drainage features for the Site. Further details on this are provided in the standalone report.
- 6.1.6. The strategy also includes a berm that separates the north and south of the site. This helps to ensure the fluvial and surface water flood risk storage is maximised in the northern part of the Site which is already at risk of flooding. The berm will range from 1.84mAOD to 1.9mAOD, whilst the maximum modelled water level upstream is shown to be 1.54mAOD.
- 6.1.7. In addition to the drainage features the development will be located on platforms that are raised above the surrounding ground levels. This is to ensure the platforms are above the predicted flood level (1.5mAOD) and to allow for gravity drainage across the Site.
- 6.1.8. The levels of the platform will vary across the Site, with the lowest level being approximately 1.4mAOD. The individual platform heights are constrained by the presence of the trees that need to be maintained on the Site. The platform levels have therefore been set to ensure the landscaping can effectively be tied into the ground levels of the trees that are being maintained.
- 6.1.9. The platforms will include a slight ridge along the centre and the FFL will be raised a further 300mm above the platform level to allow for drainage of each platform. The lowest FFL is therefore 1.7mAOD i.e. above the 1 in 100 year plus climate change peak water level.

7. FLOOD RISK MITIGATION

- 7.1.1. Mitigation measures are embedded within the development to ensure that the development is not exposed to an unacceptable level of flood risk and there is no increase in flood risk elsewhere are:
- ※ A positive surface water drainage system will be installed (including swales and attenuation ponds);
 - ※ The land drains which are present under the golf course will be maintained as far as possible;
 - ※ The network of surface water channels across the site will be increased and enhanced;
 - ※ The development platforms will be raised above existing ground levels;
 - ※ A berm and associated northern drainage feature will be installed along the northern development boundary to prevent the mixing of surface and fluvial flood waters;
 - ※ A ditch / swale is to be incorporated to channel exceedance overland flows from Shirley Drive to the Lidsey Rife;
 - ※ Demountable defences are to be installed on the retained club house with electrical sockets set at a minimum of 600mm above the FFL. The inclusion of additional measures will be considered at detailed design; and
 - ※ The FFL's for the properties will be raised 300mm above the platform levels.

7.2. PUBLIC OPEN SPACE

- 7.2.1. The inclusion of the public open space within the Scheme will result in additional users within the floodplain. No increase in risk to people is predicted as the flood waters are considered to rise relatively slowly given the size of the catchment. This will provide sufficient time for users of the public open space to exit the area via the numerous access / egress points which will be located along the boundaries of the park to the development parcels.
- 7.2.2. The detailed design stage will also consider the inclusion of additional signage at the access / egress points to the linear park to ensure that all users are aware that this is an active floodplain.

7.3. PLANNING POLICY

- 7.3.1. The inclusion of these mitigation measures demonstrates that the development meets the planning policy requirements as outlined in policy W DM2 of the ADC local plan:
- ※ It identifies adaptation and mitigation measures;
 - ※ It ensures that the development will be safe, including access and egress, without increasing flood risk elsewhere;
 - ※ Wider sustainability measures are provided to the community through:
 - Delivering of a wide range of open market and affordable housing;
 - Monetary contributions to local infrastructure and services;
 - On-site enhancement to accessible public open space;
 - Achieving biodiversity net gain across the site;
 - Economic benefits both during construction and occupation of the development;
 - Locating development in a highly sustainable location with services and facilities within walking and cycling distance; and
 - Repurpose of the existing golf house as a local community facility.

8. CONCLUSIONS

- 8.1.1. The risk of flooding to and from the proposed development has been assessed in accordance with the NPPF July 2021 and the adopted Arun Local Plan.
- 8.1.2. The majority of the development is located in Flood Zone 3, on the Environment Agency's Flood Map for Planning. The Lidsey Rife (categorised as a Main River) flows from north to south along the western boundary of the development.
- 8.1.3. Hydraulic modelling has been undertaken for the Lidsey Rife combined with the surface water flood risk via a 1D-2D linked ICM hydraulic model. The model has tested both the baseline and post-development scenarios and has shown that the development parcels are out of the flood risk areas both now and in the future, there is safe access and egress to the site and the development does not increase the flood risk to the surrounding area.
- 8.1.4. Mitigation measures are embedded within the development to ensure that it is not exposed to an unacceptable level of flood risk and there is no increase in flood risk elsewhere.
- 8.1.5. The post-development scenario includes the following mitigation measures:
 - ⌘ The land drains which are present under the golf course will be maintained as far as possible;
 - ⌘ The network of surface water channels across the site will be increased and enhanced;
 - ⌘ The development platforms will be raised above existing ground levels;
 - ⌘ A ditch / swale is to be incorporated to channel exceedance overland flows from Shirley Drive to the Lidsey Rife;
 - ⌘ Demountable defences are to be installed on the retained club house with electrical sockets set at a minimum of 600mm above the FFL. The inclusion of additional measures will be considered at detailed design;
 - ⌘ The FFL's for the properties will be raised 300mm above the platform levels.
 - ⌘ Installing a positive surface water drainage system (including swales and attenuation ponds); and
 - ⌘ Installing a flood berm that separates the area to the north that is at risk of fluvial flooding from the rest of the Site.
- 8.1.6. The present day risk of flooding from surface water to the site is considered to be low based on mapping from the Environment Agency.
- 8.1.7. To mitigate the risk of surface water flooding to the development a comprehensive drainage / SUDS strategy has been developed. This strategy will restrict peak flows for all events from the impermeable areas to the equivalent greenfield flow (QBAR), thereby ensuring the risk of surface water flooding does not increase.
- 8.1.8. The risk of the development flooding from groundwater and artificial sources considered to be low.
- 8.1.9. The majority of the proposed residential development is located in Flood Zone 3. Based on Table 2 of the PPG, the proposed residential development is classified as being 'More Vulnerable'. Table 3 of the PPG identifies that 'More Vulnerable' development can be located in Flood Zone 3, subject to the site passing both the sequential and exception tests.
- 8.1.10. The sequential test has been prepared as a standalone document, separate to this FRA.
- 8.1.11. It is considered that the proposed development passes the exception test because it provides wider sustainability benefits (as detailed in the standalone Sequential and Exception Test report) and this



FRA demonstrates that the development will be safe for its lifetime taking account of the vulnerability of its users and does not increase flood risk elsewhere.

Appendix A

FLOOD MAP PACK

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Appendix B

HYDRAULIC MODEL RESULTS

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3RD Floor, Kings Orchard
1 Queen Street
Bristol
BS2 0HQ

wsp.com