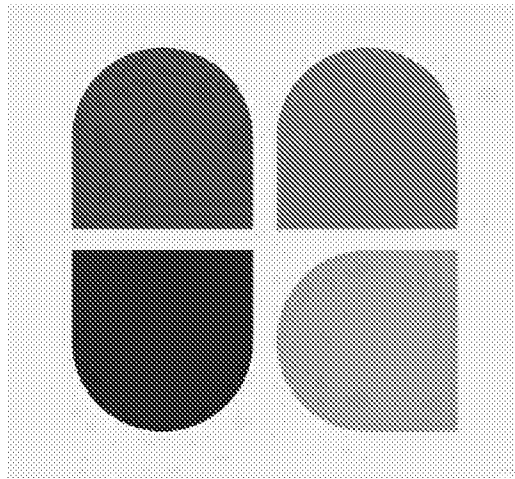




BRIGHT PLAN CIVILS

**LAND ADJACENT TO CHURCH LANE,
CLIMPING, WEST SUSSEX**

PROPOSED RESIDENTIAL DEVELOPMENT

Flood Risk Assessment & Drainage Strategy
Report

Prepared on Behalf of
Vivid and Climping Homes Ltd.

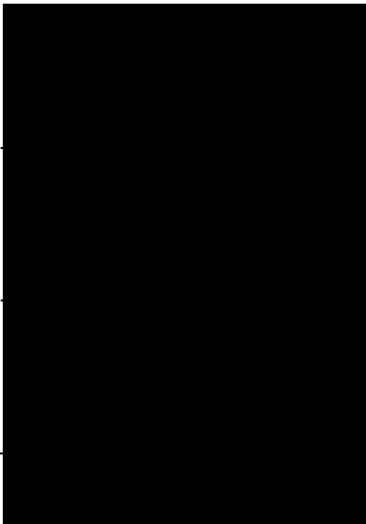
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April 2022

DOCUMENT CONTROL

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 Proposed Residential Development
 Document: Flood Risk Assessment & Drainage Strategy Report
 Client: Vivid and Climping Homes Ltd.
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Appendix A	Architectural Development Proposals
Appendix B	Topographic Survey
Appendix C	Site-Specific Ground Investigation (including Trial Pit Logs and Infiltration Test Results)
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1 INTRODUCTION

1.1 Background

- 1.1.1 Bright Plan Civils is instructed by Vivid and Climping Homes Ltd. to prepare a Drainage Strategy Report to support a planning application for a proposed residential development at the Land adjacent to Church Lane, Climping, West Sussex.
- 1.1.2 This report has been undertaken in accordance with National Planning Policy Framework (NPPF) and The Planning Practice Guidance on the use of SuDS for achieving sustainable development.
- 1.1.3 The proposed development will involve construction of 300 dwellings and two buildings within use class A1 and D1, together with public open space, LAPs, LEAP and ancillary works, including car parking and drainage arrangements, with access off Church Lane and Horsemere Green Lane as demonstrated by the architectural development proposals, contained within **Appendix A**.
- 1.1.4 In preparing this report, Bright Plan Civils has referred to the following documents and information:
- Arun District Council Drainage Records
 - British Geological Survey Records
 - Environment Agency Flood Maps for Planning
 - Long Terms Flood Risk Maps
 - Southern Water Drainage Records
 - West Sussex County Council Drainage Records
- 1.1.5 This document has been prepared to assess the risks of flooding relative to the site, as well as to identify and assess drainage constraints and propose a drainage strategy that is appropriate for the design life of the development, without causing offsite impacts from run-off in a design event.
- 1.1.6 This report has been prepared for the benefit of the named Client only.

1.2 Site Location and Description

- 1.2.1 The site is an undeveloped 'greenfield' location located immediately to the west of Church Lane, Climping, measuring 27.15Ha.
- 1.2.2 The site is bound to the north by Horsemere Green Lane, Yapton Road (B2233) to the west and A259 to the south.
- 1.2.3 A topographical survey has been undertaken at the site by Encompass Surveys, dated September 2020, and is included within **Appendix B**.
- 1.2.4 The topographical survey demonstrates levels broadly in the range of 5.00m AOD to 6.75m AOD. Despite this range in levels, the site can be largely considered flat. A localised high point (7.00m AOD) is identified towards the western boundary of the site, with the low point located towards the eastern boundary (4.75m AOD).
- 1.2.5 An existing watercourse exists along the southern boundary of the site, which assists in draining A259.

The site, at present, drains largely via infiltration, with no existing 'formal' drainage infrastructure present to support the dispersal of run-off. Despite the flat nature of the site, run-off will also follow the natural topography, to lower lying land.

- 1.2.6 In addition to the watercourse identified in 1.2.5, to the south of the site, an additional watercourse is present to the east of Church Lane, immediately to the south of 'Field Place' (existing property). It would appear that this watercourse has downstream connectivity with Ryebank Rife and its minor tributaries, which in turn discharge to River Arun, which is located approximately 1.20km to the east.

1.3 Ground Conditions

- 1.3.1 Site-specific ground investigation has been undertaken at the site, inclusive of infiltration testing and groundwater monitoring.
- 1.3.2 The client has provided trial pit logs and infiltration test results as undertaken by Soils Ltd. This information can be found within **Appendix C**.
- 1.3.3 A summary of the encountered geology as per the trial pit logs (contained within **Appendix C**) is provided, below;

Trial Pit	Pit Depth	Encountered Geology	Depth	Water Strike
TPA	1.50m	Brown slightly gravelly SILT with frequent rootlets. Gravel is sub-angular to sub-rounded fine to medium flint. TOPSOIL.	0.50m Below Ground Level	N/A
		Brown slightly gravelly silty CLAY with rare rootlets and black discolouration. Gravel is sub-angular to sub-rounded fine to medium flint. RAISED BEACH DEPOSITS.	0.50m to 1.50m Below Ground Level.	
TPB	1.60m	Brown slightly gravelly SILT with frequent rootlets. Gravel is sub-angular to sub-rounded find to	0.40m Below Ground Level	N/A

		medium flint. TOPSOIL.		
		Orangish brown slightly gravelly sandy CLAY with rare rootlets and black discolouration. Gravel is sub-angular to sub-rounded fine to medium flint. RAISED BEACH DEPOSITS.	0.40m – 1.60m Below Ground Level	
TPC	1.00m	Brown slightly gravelly SILT with frequent rootlets. Gravel is sub-angular to sub-rounded fine to medium flint. TOPSOIL.	0.50m Below Ground Level	N/A
		Orangish brown slightly gravelly sandy CLAY with rare rootlets and black discolouration. Gravel is sub-angular to sub-rounded fine to medium flint. RAISED BEACH DEPOSITS.	0.50m to 1.00m Below Ground Level	
TPD	1.00m	Brown slightly gravelly SILT with frequent rootlets. Gravel is sub-angular to sub-rounded fine to medium flint. TOPSOIL.	0.50m Below Ground Level	N/A
		Orange brown slightly gravelly	0.50m to 1.00m Below Ground	

		sandy CLAY with rare rootlets. Gravel is sub-angular to sub-rounded fine flint. RAISED BEACH DEPOSITS.	Level	
TPE	1.50m	Brown slightly gravelly SILT with frequent rootlets. Gravel is sub-angular to sub-rounded fine to medium flint. TOPSOIL.	0.50m Below Ground Level	N/A
		Orangish brown slightly gravelly sandy CLAY with rare rootlets and black discolouration. Gravel is sub-angular to sub-rounded fine to medium flint. RAISED BEACH DEPOSITS.	0.50m to 1.50m Below Ground Level	
TPF	1.00m	Brown slightly gravelly SILT with frequent rootlets. Gravel is sub-angular to sub-rounded fine to medium flint. TOPSOIL.	0.50m Below Ground Level	N/A
		Mottled orangish brown grey slightly gravelly sandy CLAY with occasional rootlets. Gravel is sub-angular to sub-rounded fine flint. RAISED BEACH DEPOSITS.	0.50m to 1.00m Below Ground Level	

TPG	1.00m	Brown slightly gravelly SILT with frequent rootlets. Gravel is sub-angular to sub-rounded fine to medium flint. TOPSOIL.	0.50m Below Ground Level	N/A
		Mottled orangish brown grey slightly gravelly sandy CLAY with occasional rootlets. Gravel is sub-angular to sub-rounded fine flint. RAISED BEACH DEPOSITS.	0.50m to 1.00m Below Ground Level	
TPH	1.00m	Brown slightly gravelly SILT with frequent rootlets. Gravel is sub-angular to sub-rounded fine to medium flint. TOPSOIL.	0.50m Below Ground Level	N/A
		Mottled orangish brown grey slightly gravelly sandy CLAY with occasional rootlets. Gravel is sub-angular to sub-rounded fine flint. RAISED BEACH DEPOSITS.	0.50m to 1.00m Below Ground Level	
TPI	1.00m	Brown slightly gravelly SILT with frequent rootlets. Gravel is sub-angular to sub-rounded fine to medium flint. TOPSOIL.		N/A

		Orangish brown slightly gravelly sandy CLAY with rare rootlets. Gravel is sub-angular to sub-rounded fine flint. RAISED BEACH DEPOSITS.	0.50m to 1.00m Below Ground Level	
TPJ	1.00m	Brown slightly gravelly SILT with frequent rootlets. Gravel is sub-angular to sub-rounded fine to medium flint. TOPSOIL.		N/A
		Orangish brown slightly gravelly sandy CLAY with rare rootlets. Gravel is sub-angular to sub-rounded fine flint. RAISED BEACH DEPOSITS.		

1.3.4 The exploratory works established in the above table were undertaken in June 2020.

1.3.5 Infiltration testing, in accordance with BRE365 has also been undertaken at the site. Full results of the infiltration tests undertaken at the site are also contained within **Appendix C**, although a summary is provided in the table, below;

Trial Pit	Infiltration Rate
TPA	8.209×10^{-6}
TPB	7.596×10^{-6}
TPC	8.363×10^{-6}
TPD	8.670×10^{-6}

TPE	2.996x10 ⁻⁶
TPF	2.799x10 ⁻⁶
TPG	7.647x10 ⁻⁶
TPH	4.532x10 ⁻⁶
TPI	TEST FAILED
TPJ	1.524x10 ⁻⁶

- 1.3.6 The above infiltration rates were established further to testing undertaken in June 2020.
- 1.3.7 In addition to the site-specific investigatory works undertaken, reference has also been made to the British Geological Survey (BGS) website in order to verify the findings of the works undertaken on site.
- 1.3.8 The BGS Geology of Britain Viewer confirms a bedrock geology consisting of 'Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation and Portsdown Chalk Formation (undifferentiated) – Chalk', as shown in **Figure 1**.

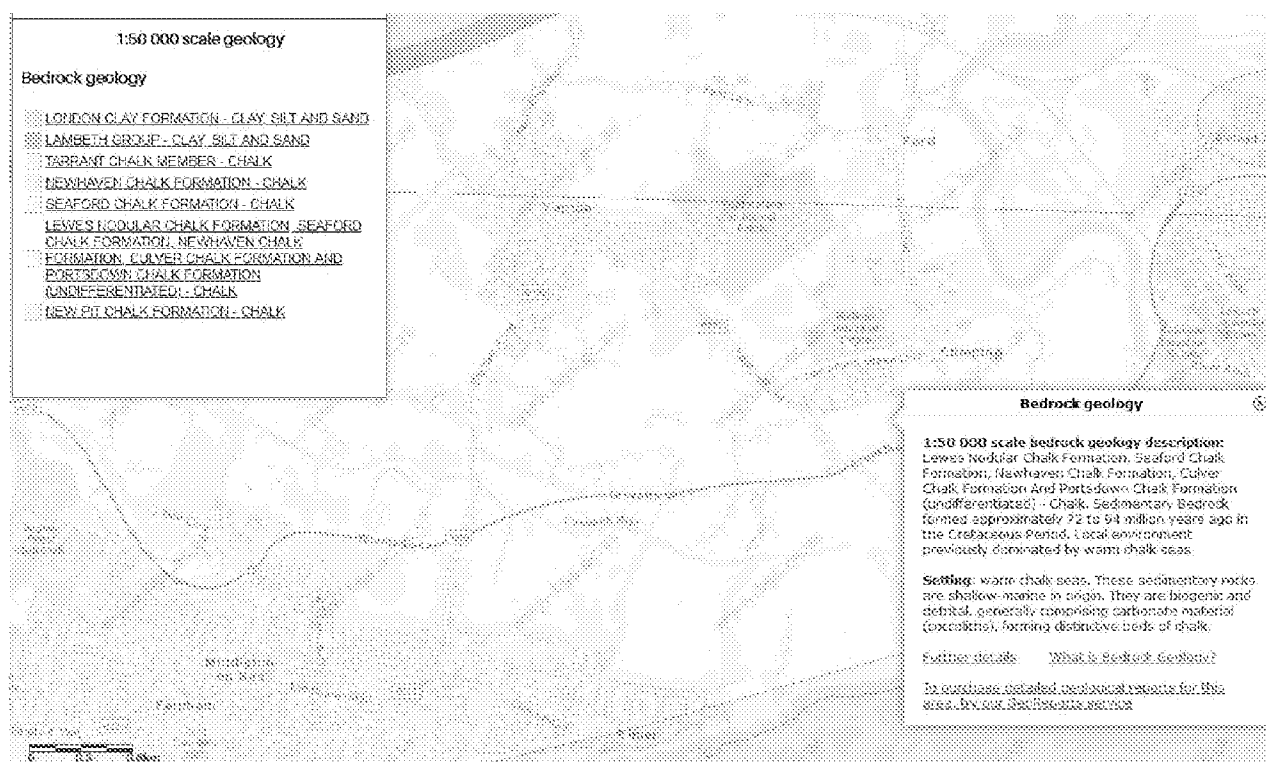


Figure 1. BGS Geology of Britain Viewer – Bedrock Geology

- 1.3.9 Superficial Deposits are recorded as 'Raised Beach Deposits, 1 - Sand and Gravel' for the eastern half

of the site, with 'River Terrace Deposits (undifferentiated) – Sand, Silt and Clay' identified to the west of the site.

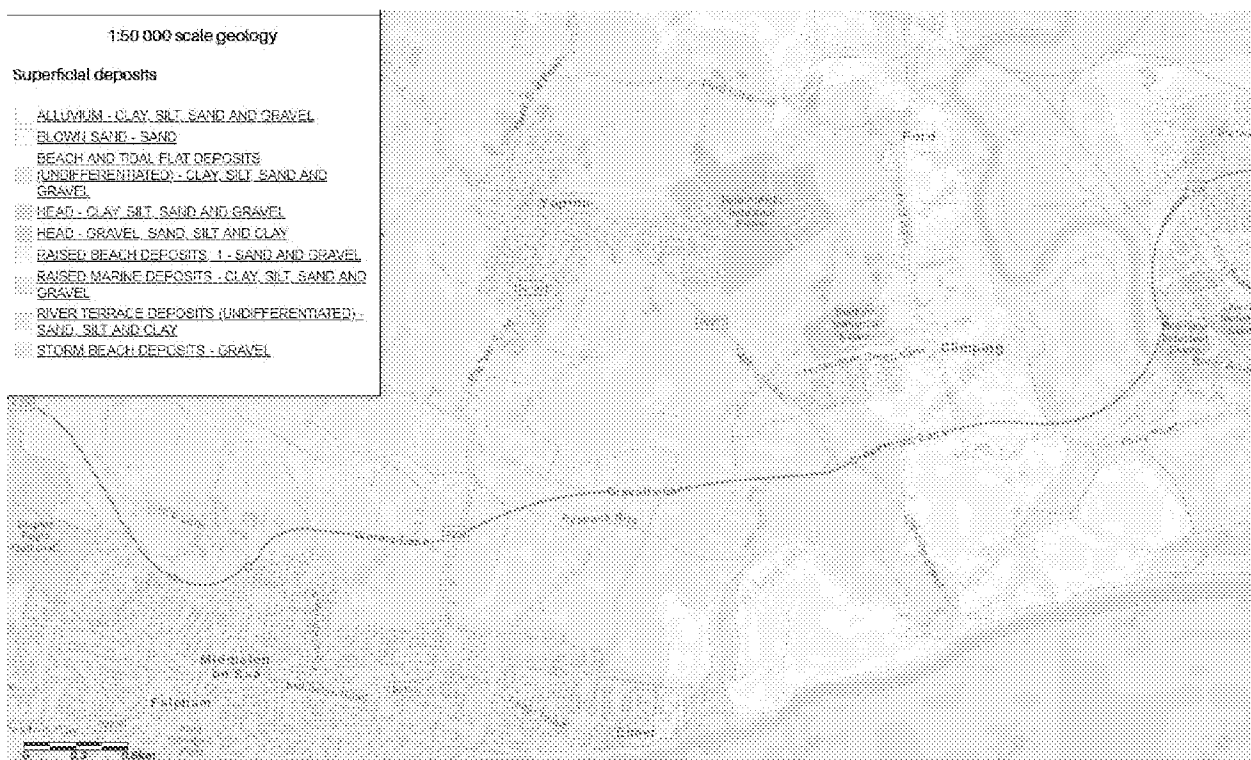


Figure 2. BGS Geology of Britain Viewer – Superficial Deposits

1.4 Groundwater

- 1.4.1 Winter groundwater monitoring has been undertaken at the site, the results of which can be found within **Appendix D**.
- 1.4.2 A summary of the winter groundwater monitoring results is contained within the table, below;

	Groundwater Level (m Below Ground Level)				
Location	September	October	November	December	January
WS101	3.97	3.42	2.70	2.02	2.17
WS103	4.25	4.00	3.28	2.24	2.61
WS107	3.44	3.07	1.91	0.56	0.67
WS114	3.45	3.24	2.00	0.22	0.20

WS115	-	4.20	3.36	1.53	1.53
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- 1.4.3 Additional groundwater monitoring has been undertaken between 29th October 2021 and 28th March 2022, with the results also contained within **Appendix D**. This additional groundwater monitoring was co-ordinated with Arun District Council's Drainage Officers (26th October 2021).
- 1.4.4 Mapping managed by MAGIC (magic.defra.gov.uk) provides geographic information concerning the natural environment from across government. This mapping tool has been referred to in order to confirm whether the site is located within either any groundwater source protection zones or groundwater vulnerability zones.
- 1.4.5 The site is situated within a 'Principal' Bedrock Aquifer and a 'Secondary A' Superficial Drift Aquifer, as seen in **Figure 4**.
- 1.4.6 A 'Principal' aquifer provides significant quantities of drinking water, and water for business needs, whilst may also support rivers, lakes and wetlands. A 'Secondary A' aquifer comprises permeable layers that can support local water supplies and may form an important source of base flow to rivers.

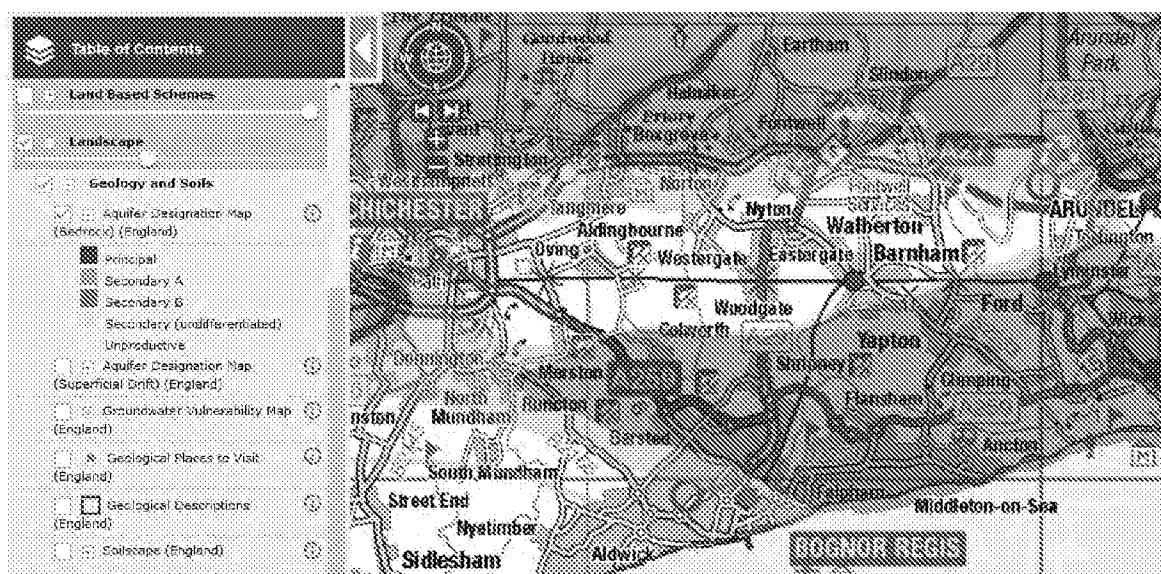


Figure 4. Bedrock Aquifer Designation Map (DEFRA)

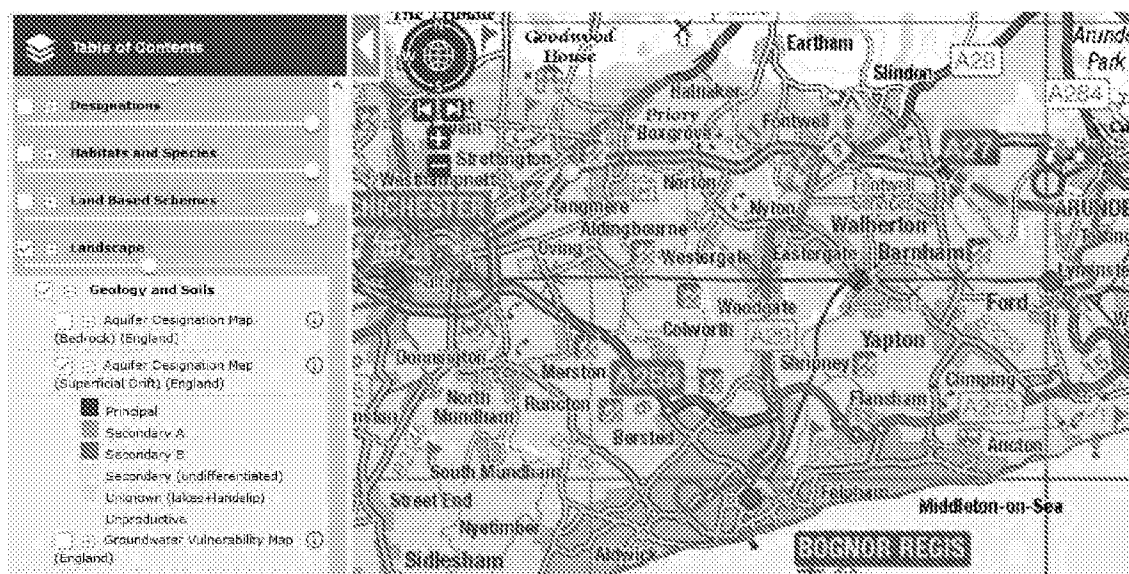


Figure 5. Superficial Drift Aquifer Designation Map (DEFRA)

- 1.4.7 The site falls within both a 'Medium-High' (west of the site) and also a 'Medium' (east of the site) Groundwater Vulnerability Zone. A 'Soluble Rock Risk' is also identified.
- 1.4.8 Areas deemed to present a 'Soluble Rock Risk' are defined as areas where solution features that enable rapid movement of a pollutant may be present.

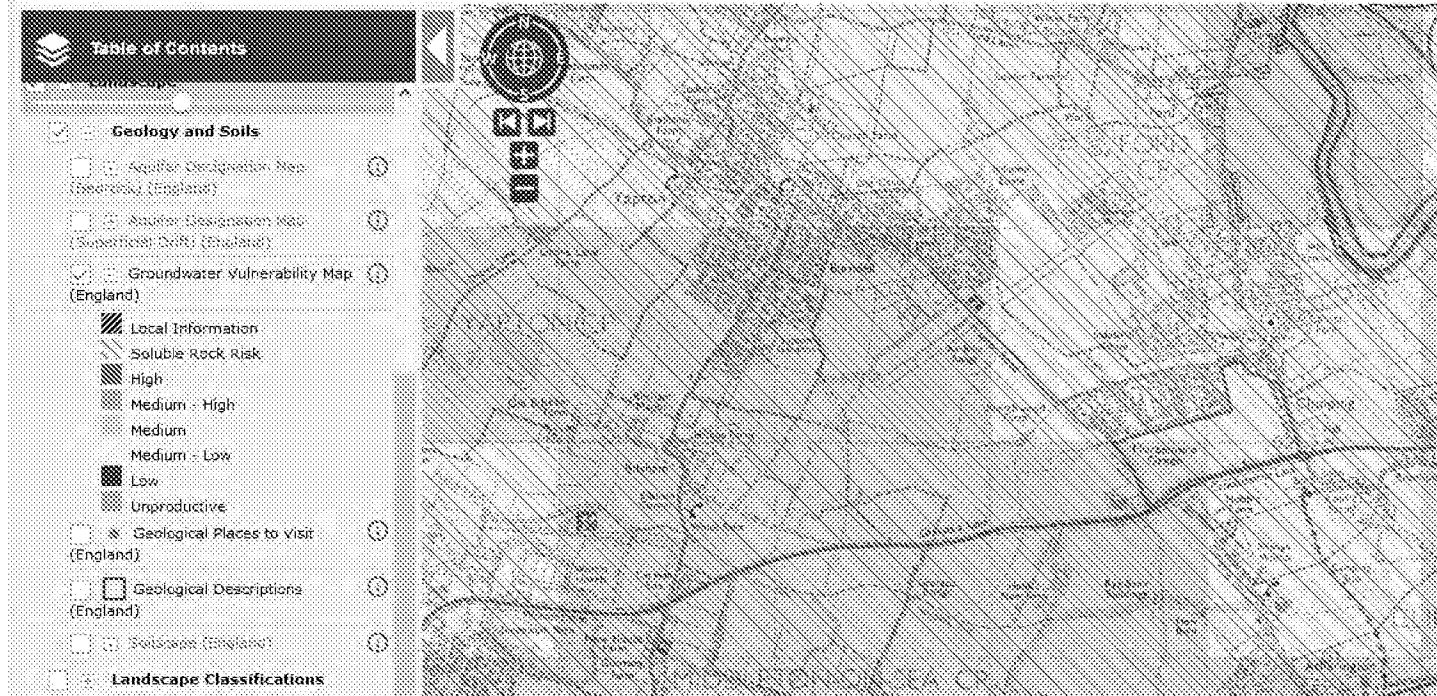


Figure 5. Groundwater Vulnerability Map (DEFRA)

- 1.4.9 The site is not identified as falling directly within or within the vicinity of any Drinking Water Safeguard Zones or Groundwater Source Protection Zones.

1.5 Existing Drainage

1.5.1 The local Water Authority is Southern Water, who provide sewerage services within the area. Public sewer records have been obtained from Southern Water, as contained within this report in **Appendix E**.

1.5.2 Surface Water:

- i. The Southern Water public sewer records do not show any public surface water sewers within the bounds of the site or within the immediate vicinity of the site to which a connection could be established.
- ii. The site currently drains via infiltration, with run-off also following the natural topography of the site, to lower lying areas.
- iii. An open watercourse exists beyond the southern boundary of the site, which assists in providing drainage to A259.
- iv. An open watercourse, with downstream connectivity to Climping Church Farm Ditch (which in turn discharges to River Arun) is located to the east of the site and Church Lane, south of the existing property known as 'Field Place'.
- v. The estimated greenfield run-off rate (QBar) has been calculated to be 80.87l/s using the Wallingford Greenfield Run-off Calculator.

1.5.3 Foul Water:

- The Southern Water public sewer records confirm the presence of a 700mm dia. Treated Effluent Rising Main which passes through the bounds of the site.
- A 500mm dia. Foul Water Rising Main also passes through the bounds of the site, with records indicating this following the same route as the Treated Effluent Rising Main.
- An additional 100mm dia. Foul Water Rising Main also passes through the bounds of the site, towards the north-western corner of the site.
- Southern Water has confirmed that no development or new tree planting shall take place within 4.00m (either side) of the 700mm dia. Treated Effluent Rising Main, within 3.50m (either side) of the 500mm dia. Foul Water Rising Main or within 3.00m (either side) of the 100mm dia. Foul Water Rising Main.
- There are no public foul water sewers located within the bounds of the site, with the nearest within the vicinity of the site being located in Horsemere Green Lane, to the north of the site.
- The nearest point of connection is manhole 0302, located on Horsemere Green Lane, at the junction of Cropthorne Drive.

1.5.4 Highway Drainage:

- vi. Arun District Council and West Sussex County Council have both provided existing drainage records for the site and surrounding areas. These records are contained within **Appendix F** and **Appendix G** respectively.
- vii. Investigation into the existing highway drainage infrastructure has been undertaken, with CCTV survey works undertaken by Ultraflow. Records from these survey works can be found within **Appendix H**.
- viii. Drawing **D1886-PL102 Rev. A 'Existing Impermeable Areas and Drainage Catchments'** has been prepared to demonstrate the existing drainage arrangement supporting the public highway.
- ix. Church Lane is served by traditional road gullies, which are collected and discharge to the watercourse to the south of 'Field Place' (to the east of the site and Church Lane).
- x. A259 drains predominantly 'over the edge', either to the adjacent verge(s) and/or to the watercourse which abuts the southern boundary of the site.
- xi. Drawing **D1886-PL102 Rev. A - 'Existing Impermeable Areas and Drainage Catchments'** provides an assessment of drainage catchments relating to A259 and Church Lane.

2.1 Sources of Information

2.1.1 The NPPF requires that all sources of flooding are considered being Tidal, Fluvial, Pluvial, Groundwater, Sewers and Man-made reservoirs/canals.

2.1.2 The likelihood of the site flooding has been established by reviewing the following information:

- Environment Agency Flood Maps for Planning
- Long Term Flood Risk Assessment Surface Water Flood Risk Maps
- Long Term Flood Risk Assessment Reservoir Flood Risk Maps
- Arun District Council and West Sussex County Council Strategic Flood Risk Assessments
- Consultation with Arun District Council (Local Planning Authority)
- Consultation with West Sussex County Council (Lead Local Flood Authority)

2.2 Flood Maps and Modelling

2.2.1 The Environment Agency's online Flood Map for Planning (Rivers and Sea) shows that the site is located fully within Flood Zone 1, as depicted below;



2.2.2 Flood Zone 1 is defined as 'Land having a less than 1 in 1,000 annual probability of river or sea flooding, as confirmed in the table, below.

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3)
Zone 2 Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding. (Land shown in dark blue on the Flood Map)
Zone 3b The Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map)

2.2.3 The Environment Agency's Long-Term Flood Risk Map for Rivers or the Sea does not identify the site as being at risk of flooding from such sources.

2.2.4 An area to the east of the site, marginally capturing Church Lane, is identified as being at 'Low' to 'Medium' risk of flooding from such sources, specifically in relation to River Arun.

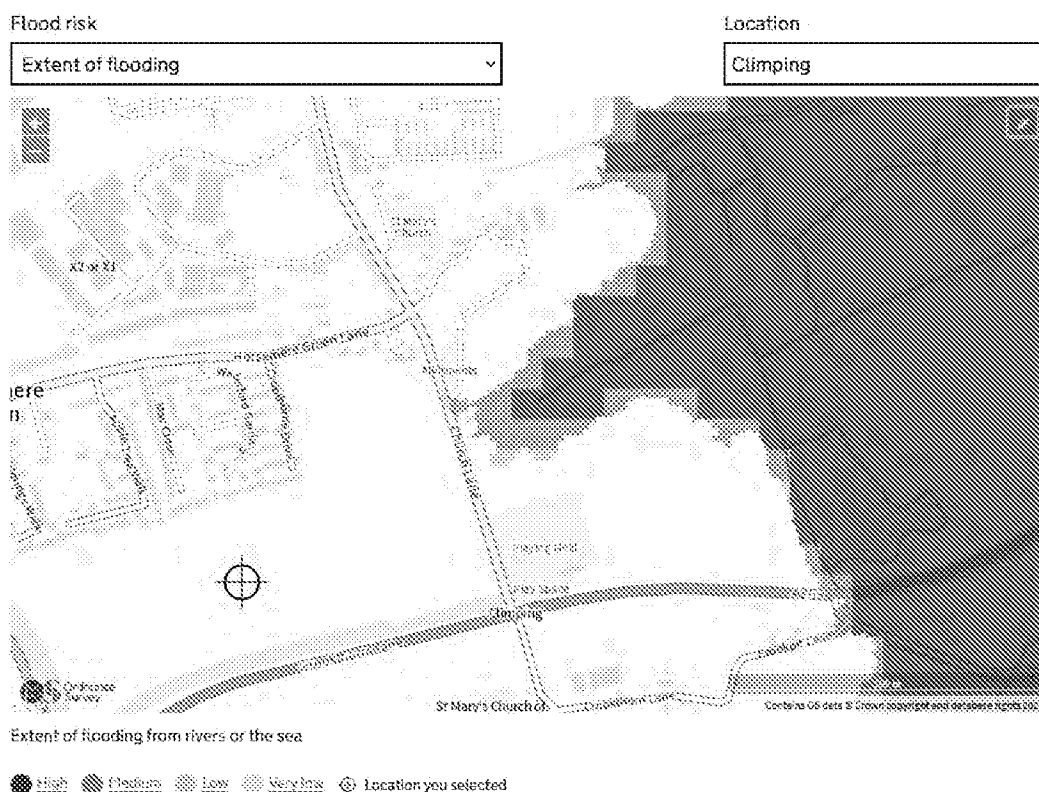
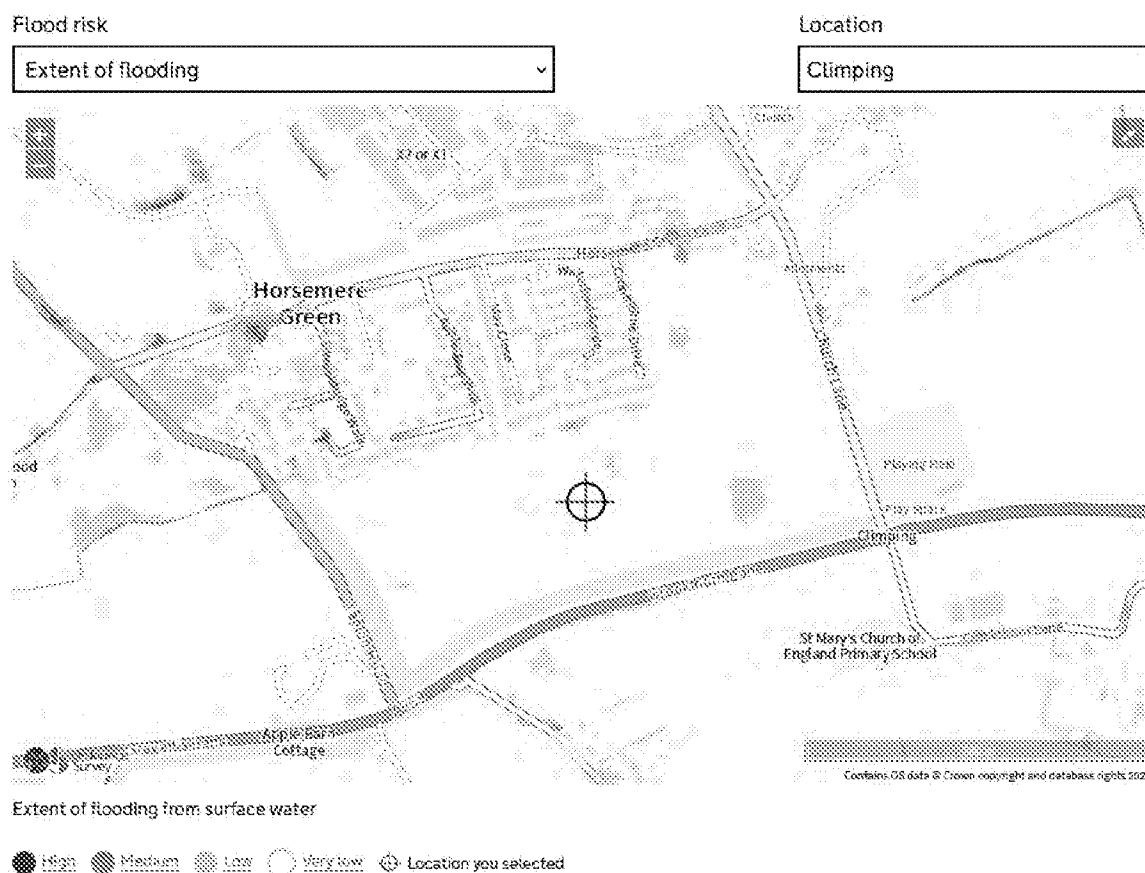


Figure 7. Long-Term Flood Risk Map – Rivers or the Sea (Gov.uk)

2.2.5 The Long-Term Flood Risk Map for Surface Water largely identifies a 'Very Low' risk of surface water flooding, with isolated pockets identified as being at 'Low' risk of surface water flooding.

2.2.6 In 'Low' risk scenarios, it is deemed that each year there is a chance of flooding in the range of 0.1% and 1%.



2.2.7 The anticipated depths of flooding relating to the areas identified as being at 'Low' risk of surface water flooding have also been assessed and are identified as falling within the 'Below 300mm' classification, as shown in **Figure 9**.

2.2.8 The Long-Term Flood Risk Map for Reservoirs confirms that the site is not at risk of flooding from such sources, as shown in **Figure 10**.

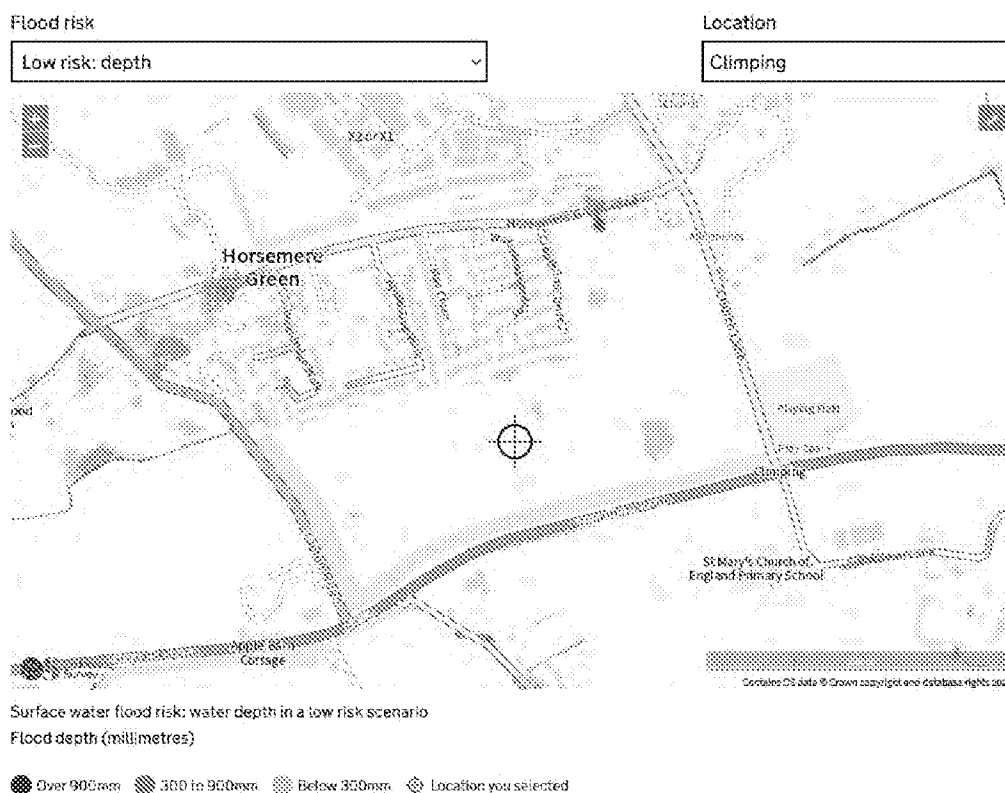


Figure 9. Long-Term Flood Risk Map – Surface Water; 'Low' Risk Scenarios (Gov.uk)

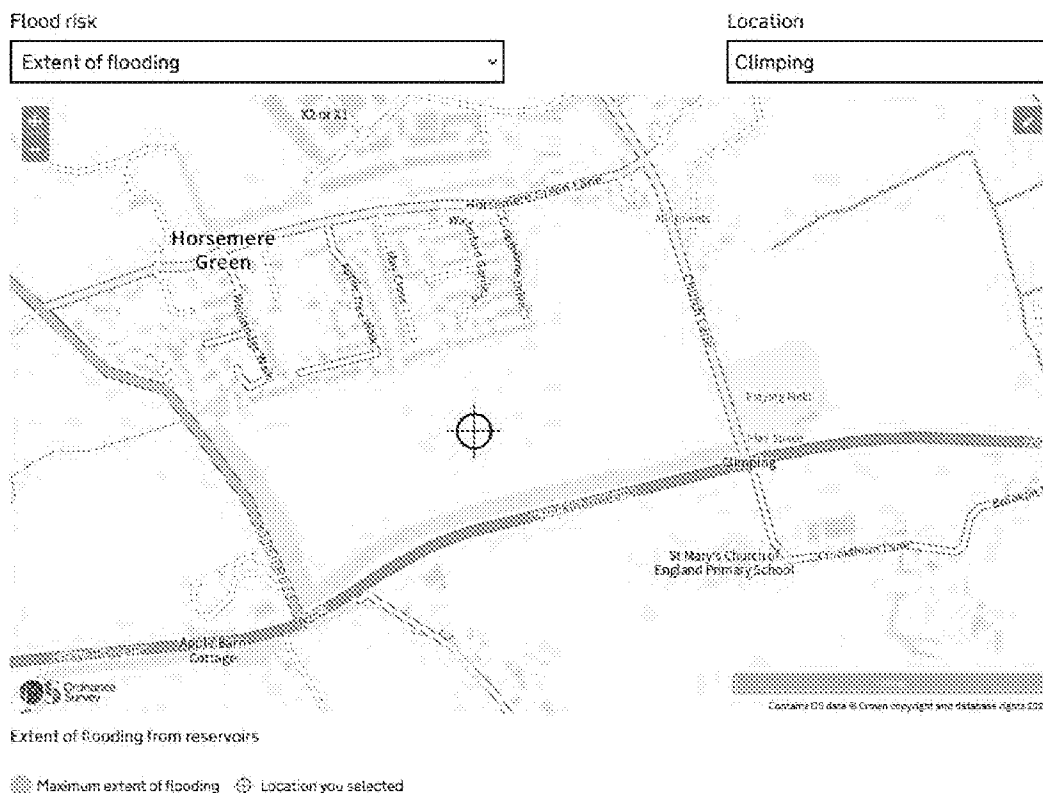


Figure 10. Long-Term Flood Risk Map – Reservoirs (Gov.uk)

2.3 Strategic Flood Risk Assessment

- 2.3.1 The Arun District Council Strategic Flood Risk Assessment acknowledges Climping Church Farm Ditch as a recognised watercourse within the Arun District and River Arun catchment.
- 2.3.2 The Arun District Council Strategic Flood Risk Assessment make reference to the Lidsey Surface Water Management Plan (SWMP42), which covers Southern Water's Lidsey wastewater drainage catchment and includes parts of Climping. The site itself falls outside of this area, although marginally (the south-west corner of the site abuts the catchment, which captures the Oystercatcher Public House and a section of A259 to the south-west of the site).
- 2.3.3 West Sussex County Council's Strategic Flood Risk Assessment does not make specific reference to the site.

2.4 Historic Flooding

- 2.4.1 Arun District Council and West Sussex County Council have both been consulted in relation to the site and proposed development, and neither have confirmed any history of flooding having occurred at the site in the past.
- 2.4.2 In addition to Arun District Council and West Sussex County Council, the Environment Agency has also been consulted. The Environment Agency has also confirmed that they are not aware of any historic records of flooding affecting the site.

2.5 Summary of Flood Risk

2.5.1 The potential sources of flooding are:

Source of Flooding	Level of Risk
Rivers and Coastal	Very Low The site falls fully within Flood Zone 1 and is not identified as being at risk of flooding from Rivers or the Sea as per the current day Long-Term Flood Risk Map.
Surface Water	Very Low The long-term flood risk for surface water is classified as 'Very Low' across the site location. Surface water flooding within the adjacent highway is also generally 'Very Low' to 'Low' with depths indicated to be a maximum of 300mm, which not impact access or egress. Surface Water flooding on Horsemere Green Lane is identified as being at increased risk of flooding, indicated as being 'Low' to 'Medium' risk.
Groundwater	Medium to High Groundwater monitoring during winter months has established groundwater at shallow depths in places across the site; as shallow as 200mm below ground level. Elsewhere on site, groundwater was encountered at much greater depths, in excess of 2.50m below ground level during winter months.
Sewers	Very Low There are no surface water sewers located within close proximity of the site, whilst the nearest foul water sewer is located in Horsemere Green Lane, to the north of the site. There is no known history of flooding from sewers having affected the site historically. There are 3 No. rising mains (Treated Effluent and Foul Water) within the bounds of the site, which should be considered in the design of the site and associated drainage design.
Artificial Sources	None The site is not indicated as being at risk of flooding from artificial sources.

2.5.2 The site is deemed to be at 'Very Low' risk of flooding from all sources, with the exception of groundwater

flooding. Groundwater has been established at shallow depths across the site, and should be considered in view of the development proposals in order to provide sufficient mitigation.

- 2.5.3 The proposed drainage system for the proposed development should be designed in order to provide capacity up to the design event, whilst affording consideration towards potential exceedance routes and overland flow paths as so not to increase the risk of surface water flooding on or off site.

3 PROPOSED DEVELOPMENT

3.1 Description of Development

3.1.1 The proposed development will involve the construction of 300 dwellings and two buildings within use class A1 and D1, together with public open space, LAPs, LEAP and ancillary works, including car parking and drainage arrangements, with access off Church Lane and Horsemere Green Lane as demonstrated by the architectural development proposals, contained within **Appendix A**.

3.1.2 The type of development falls within the 'More Vulnerable' classification (Flood Risk and Coastal Change Table 2) and is appropriate in Flood Zone 1 (Flood Risk and Coastal Change Table 3).

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

✓ = Development is appropriate
 ✗ = Development should not be permitted

3.1.3 The proposed development will result in the introduction of impermeable surfacing; however SuDS measures will be used where possible in order to prevent any increase in the rate of run-off generated by the site.

3.1.4 The proposed post-development impermeable area has been determined to be 6.65Ha, inclusive of the footprint(s) of the ponds/basins proposed across the site.

3.1.5 The use of Sustainable Drainage System (SuDS) methods and techniques (where site conditions and constraints allow) within the bounds of the site (whilst adhering to the SuDS hierarchy as stated within Building Regulations (Part H) and The CIRIA SuDS Manual C753) will be used to provide a betterment of surface water run-off compared to the existing site.

3.1.6 The specific Surface Water and Foul Water drainage proposals are detailed in **Section 4** of this report.

4 SEQUENTIAL AND EXCEPTION TESTS

4.1 Sequential Test

- 4.1.1 The Sequential test aims to steer new development to areas with the lowest probability of flooding, with the intention being to steer new development to Flood Zone 1.
- 4.1.2 Flood Risk and Coastal Change, Table 3 confirms that "More Vulnerable" development is 'appropriate' in Flood Zone 1.
- 4.1.3 As the site is located fully within Flood Zone 1, application of the Sequential test is not required.

4.2 Exception Test

- 4.2.1 The Exception test, as set out in Paragraph 160 of Flood Risk and Coastal Change, is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available.
- 4.2.2 The Exception test, in two parts, firstly requires proposed development to show that it will provide wider sustainability benefits to the community that outweigh flood risk, but secondly, that it will be safe for its lifetime without increasing flood risk elsewhere and where possible reduce flood risk overall.
- 4.2.3 The site is located fully within Flood Zone 1, and as confirmed in 4.1.2, "More Vulnerable" development is 'appropriate' in Flood Zone 1.
- 4.2.4 As the site is located fully within Flood Zone 1, application of the Exception test is not required.

5 PROPOSED DRAINAGE STRATEGY

5.1 Surface Water

5.1.1 The SUDS manual and Building Regulations set out a hierarchy of drainage methods to ensure that developments maximise the use of sustainable drainage techniques. The hierarchy favours infiltration methods of disposal over other methods such as watercourse and sewers, as detailed below;

- i. Utilise infiltration techniques
- ii. Attenuate rainwater in ponds or open water features for gradual release
- iii. Attenuate rainwater by storing in tanks or sealed water features for gradual release
- iv. Discharge rainwater direct to a watercourse
- v. Discharge rainwater to a surface water sewer/drain
- vi. Discharge rainwater to a combined sewer

SUDS Technique	Suitable	Comments
Living Roof	No	Implementation not possible owing to client's development proposals.
Basins and Ponds (such as Wetlands, Balancing Ponds, Detention Basins, Retention Ponds)	Yes	Opportunities exist to provide such features and will be maximised in support of the proposed development.
Filter strips and swales	Yes	No initial constraints. Sufficient space available on site to utilise.
Infiltration Devices - Soakaways - Infiltration trenches and basins	Yes	The presence of groundwater at shallow depths across the site will restrict the use of infiltration, the introduction of shallow infiltration features and/or where ground conditions permit will however be considered and maximised.
Permeable surfaces and filter drains (such as gravelled areas and porous block paving)	Yes	No initial constraints. Can be implemented to provide both treatment (water quality) as well as attenuation at shallow depths.
Tanked systems (such as oversized pipes or cellular tanks)	Yes	No initial constraints, although 'above ground', more sustainable means will

		be maximised, meaning such features will likely be unnecessary.
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- 5.1.2 Following the undertaking of groundwater monitoring and infiltration testing, there are limited opportunities to propose infiltration-based methods and techniques as a means of dealing with run-off generated by the development.
- 5.1.3 It is proposed that a 'hybrid' strategy will be implemented, with infiltration maximised where possible in view of site constraints, with a connection also to be established with a piped outfall to the manhole located to the east of the site and Church Lane which discharges to the watercourse adjacent to 'Field Place' (existing property).
- 5.1.4 It is proposed that attenuation will be provided on site in the form of 8 No. ponds/basins, designed as follows;

Pond/Basins	Top Level	Base Level	Depth	Banks
Pond #1	5.500m AOD	4.000m AOD	1.500m	1:3 Slope
Pond #2	5.250m AOD	3.500m AOD	1.750m	1:3 Slope
Pond #3	5.250m AOD	3.750m AOD	1.500m	1:3 Slope
Pond #4	4.900m AOD	3.400m AOD	1.500m	1:3 Slope
Pond #5	4.750m AOD	3.250m AOD	1.500m	1:3 Slope
Pond #6	4.750m AOD	3.500m AOD	1.250m	1:3 Slope
Pond #7	4.725m AOD	3.250m AOD	1.475m	1:3 Slope
Pond #8	4.700m AOD	2.750m AOD	1.950m	1:3 Slope

- 5.1.5 Permeable paving will be introduced covering a plan area to the order of 9,752m², providing a further 1,404m³ of attenuated storage (based on a sub-base of 450mm with 32% voids).
- 5.1.6 In view of the proposed impermeable area (6.65Ha), a rate of greenfield run-off has been attributed to this area, in order to determine an appropriate rate of discharge from the development. Based on this impermeable area of 6.65Ha, QBar has been determined to be 19.50l/s.
- 5.1.7 Further to 5.1.6, the rate of discharge from the site will be restricted to QBar, at 19.50l/s.
- 5.1.8 It is proposed that all captured run-off from the proposed areas of impermeable surfacing is captured up to the 100-year event including 40% climate change without exceedance.

- 5.1.9 With regards to off-site works it will be necessary to realign Church Lane and construct a new roundabout junction with the A259. The existing highway drainage and ordinary watercourse routing in this vicinity will therefore be diverted accordingly thus maintaining connectivity towards the ultimate outfall along Church Lane. In addition new highway drainage apparatus will be provided inclusive of storage and attenuation to ensure the highway works comply with NPPF requirements. The highway drainage will be designed for up to the 100-year event including 40% climate change; however the flow rates will be subject to agreement with West Sussex County Council highways team.
- 5.1.10 The strategy above will ensure that there is no increase in the rate of run-off leaving the site, therefore no increase in the risk of flooding from this source.

5.2 Treatment

- 5.2.1 The use of permeable paving will ensure that run-off from the site receives a level of treatment required by the SuDS manual, with hydrocarbons being filtered by the aggregate and geotextile layers.
- 5.2.2 In accordance with the CIRIA SuDS Manual C753 regarding methods for managing pollution risks, the risk posed by surface water runoff to the receiving environment depends on the pollution hazard at the site (the source), SuDS treatment techniques (the pathway), and the sensitivity of the environment (the receptor).
- 5.2.3 The simple index approach considers whether SuDS techniques are appropriate for the site. The states that for SuDS components to deliver adequate treatment, the total pollution mitigation index for each contaminant type should equal or exceed the pollution hazard index.
- 5.2.4 The SuDS Manual outlines three categories of pollution hazard identification, which vary depending on proposed land use, which are as follows:
- Total Suspended Solids (TSS).
 - Metals (M).
 - Hydrocarbons (H).
- 5.2.5 In accordance with C753 Table 26.2, the proposed land uses at the site are categorised as follows:
- Residential Roofs – Very Low/TSS=0.2/M=0.2/H=0.05
 - Individual property driveways and low traffic roads - Low/TSS=0.5/M=0.4/H=0.4
 - All roads except low traffic roads and trunk roads/motorways - Medium/TSS=0.7/M=0.6/H=0.7
- 5.2.6 In accordance with C753 Table 26.3, the values of SuDS Mitigation indices are provided for permeable paving:
- Permeable Pavement – TSS=0.7/M=0.6/H=0.7

- Pond/Basin – TSS=0.7/M=0.7/H=0.5
- Swale - TSS=0.5/M=0.6/H=0.6

5.2.7 As the pollution hazard index does not exceed any pollution mitigation index for any contaminant type, the proposed SuDS methods will provide sufficient treatment for the proposed development.

5.3 Foul Water Drainage

- 5.3.1 The proposed development will establish a new connection to the public foul water sewer located in Horsemere Green Lane. The nearest point of connection is manhole 0302.
- 5.3.2 It is proposed the flows from the site will be pumped, with a Type 3 adoptable pumping station required.
- 5.3.3 In relation to the proposed Type 3 pumping station, the wet well must be positioned at least 15.00m from habitable buildings.
- 5.3.4 Post development, there will be an estimated increase in peak foul water flows to 13.89l/s (based on Water UK Sewerage Sector Guidance, Design and Construction Guidance).
- 5.3.5 Recent changes to infrastructure and connection charges (OFWAT Charging Rules) place the onus on the sewerage undertaker to reinforce their network should there no longer be sufficient capacity to serve the new development. Funding for this is provided by revised charging arrangements for infrastructure and connection charges for each dwelling constructed comprising a Network Reinforcement Charge and Site-Specific Charges. The revised charging arrangement (funded by the developer) covers alterations to the Existing Sewer Network and the sewerage undertaker remains responsible for the cost of reinforcing their Strategic Assets. The developer is responsible for connecting the development to the public sewer network.

5.4 Climate Change

- 5.4.1 In July 2020 the Environment Agency updates the latest climate change allowances (available online at <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>), which supports the NPPF in making an allowance for climate change within flood risk assessment. The allowances provide predictions of anticipated change for peak river flow by river basin district and peak rainfall intensity.
- 5.4.2 The table below shows the anticipated changes in extreme rainfall intensity. For flood risk assessments, both the central and upper end allowances should be assessed to understand the range of impact.

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper End	10%	20%	40%
Central	5%	10%	20%

- 5.4.3 Based on the latest allowances, an increase of 20% should be applied to peak rainfall to this development, with a review undertaken to determine the impact of a 40% increase.
- 5.4.4 Given the close proximity to Flood Zones 2 and 3, the Environment Agency has been contacted, with

Product 4 data requested.

- 5.4.5 The site is on the proximity of the tidal influence (in relation to River Arun). The site is, however, located approximately 0.70km to 1.20km inland of this Main River. As a result, the increases in sea levels rising and tidal locking co-incidence scenarios are anticipated to be negligible. Owing to existing defences in relation to River Arun, any risk of flooding would be as a result of 'overtopping' of the existing defences, which comes in the form of a residual risk. It should be noted that the proposed site is being elevated above the natural ground by at least 300mm, therefore providing mitigating the potential future allowances.

5.5 Urban Creep

- 5.5.1 West Sussex County Council's Policy for the Management of Surface Water confirms that urban creep shall be considered where residential development is proposed. Urban creep acknowledges that permeable surfacing can, over time, be replaced with impermeable surfacing, the impact of such should therefore be considered in the design of surface water drainage systems.
- 5.5.2 In view of the proposed development, which consists of the construction of 300 dwellings and two buildings within use class A1 and D1, together with public open space, LAPs, LEAP and ancillary works, including car parking and drainage arrangements, with access off Church Lane and Horsemere Green Lane, an allowance has been made of 10% to mitigate the potential change in impermeable area at the site.

6 RESIDUAL RISK AND MITIGATION

6.1 Residual Risk

6.1.1 The following residual risks have been identified in relation to the proposed development:

- i. Increased flow through watercourses as a result of climate change causing flooding to the site
- ii. Blockage of watercourses as a result of debris or otherwise, causing flooding to the site
- iii. Extreme rainfall events that exceed the design criteria used for the drainage system causing surface water flooding
- iv. Blockage/failure of the proposed drainage system causing flooding to the site
- v. Groundwater flooding to the site caused by groundwater levels exceeding the ground surface level
- vi. Surface water flooding of proposed buildings
- vii. Climate change resulting in increased flood zone extents resulting in flooding of the site

6.2 Mitigation

6.2.1 Consideration has been taken to the residual risks stated in Section 6.1, and the following mitigation measures are proposed:

- i. The nearest watercourse to the site is located to the south of the site, which assists in providing drainage functionality to A259. In addition to this watercourse, a further watercourse is located to the east of Church Lane (south of 'Field Place') which has downstream connectivity with Climping Church Farm Ditch (which in turn discharges to River Arun). River Arun is tidally influenced, and the impacts of climate change have been considered as confirmed in Section 5.4 - 'Climate Change'.
- ii. Riparian owners have a responsibility to ensure that any watercourse (including rivers, streams or ditches) that runs within or adjacent to the boundaries of their property is maintained, clear of obstruction(s) and able to convey flows without restriction. By conducting such duties will ensure that the risk of flooding is reduced. Section 8 'Maintenance' confirms standard actions which must be undertaken in order to ensure that the risk of blockage and/or potential flooding is both minimised and mitigated.

- iii. The drainage strategy has been developed to capture run-off up to a 1 in 100-year critical rainfall event, with 40% allowance for climate change as well as an allowance for urban creep (10%). However, should a more extreme rainfall event occur, there is the potential for the drainage system to be exceeded. The existing topography of the site has been reviewed and the existing overland flow routes assessed. As has been established earlier in this report, the site can largely be considered flat, meaning that run-off would likely collect and 'pond' on site. Levels will be designed in order to ensure that run-off is directed away from properties, and into both existing and proposed drainage features on site. Existing and proposed drainage infrastructure should also be considered which can intercept run-off in an exceedance event, including gullies and channel drains.
- iv. The proposed drainage system will attenuate and store run-off up to the design event. Blockage of the drainage system has the potential to cause flooding on the site, however maintenance measures proposed in Section 8 – 'Maintenance' will mitigate the risk of the system becoming blocked.
- v. Due to the underlying ground conditions at the site and the presence of groundwater in the upper layers, there is a risk of groundwater exceeding the surface level and emerging on the site. There are no records of previous groundwater flooding, however. If groundwater flooding were to occur, it would follow the natural topography of the site, and either collect or 'pond' at the lower lying areas, and/or reach the watercourse to the south of this site, if not intercepted by proposed drainage infrastructure.
- vi. The site is currently deemed to be at 'Very Low' risk of surface water flooding, with the exception of a number of isolated low points, which are identified as being at 'Low' risk of surface water flooding. The introduction of impermeable surfacing will result in an increase in surface water run-off, which will be collected by the proposed surface water drainage system. As referred to above, in the event of exceedance of the proposed surface water drainage system follow the natural topography of the site. It is proposed that finished floor levels will be set 150-300mm above the existing ground profile in order to mitigate the risk of potential surface water flooding at the site. Levels will also be designed across the site in order to convey flows away from thresholds and buildings.
- vii. The effects and impacts of climate change have been considered, as detailed within Section 5.4 - 'Climate Change'. The site is on the proximity of the tidal influence (in relation to River Arun). The site is, however, located approximately 0.70km to 1.20km inland of this Main River. As a result, the increases in sea levels rising and tidal locking co-incidence scenarios are anticipated to be negligible. Owing to existing defences in relation to River Arun, any risk of flooding would be as a result of 'overtopping' of the existing defences, which comes in the form of a residual risk. It should be noted that the proposed site is being elevated above the natural ground by at least 300mm, therefore providing mitigating the potential future allowances.

7 FLOOD RISK MANAGEMENT

7.1 Safe Access and Egress

- 7.1.1 The proposed access to the development will be via a newly constructed bellmouth on Church Lane, in conjunction with significant off-site highway works.
- 7.1.2 The proposed access falls within Flood Zone 1 and is therefore deemed to be at the lowest risk of flooding.
- 7.1.3 Church Lane is deemed to be at 'Very Low' risk of surface water flooding within the vicinity of the proposed access.
- 7.1.4 Pedestrian access to the site is available in several locations; via the vehicular access provided off of Church Lane, an additional pedestrian-only access also on Church Lane to the north of the proposed vehicular access, a link to the shared footway/cycleway to the south of the site adjacent to A259, in addition to pedestrian access points to the west (linking with Yapton Road B2233) and also to the north (Horsemere Green Lane). In all locations with the exception of Horsemere Green Lane, the risk of flooding is deemed to be 'Very Low'. In relation to the pedestrian access off of Horsemere Green Lane, there is an associated 'Low' to 'Medium' risk of surface water flooding in this location. The anticipated depths of flooding in both scenarios is stated to be between 'Below 300mm' and '300 to 900mm'. Given that there are multiple points of access and egress to and from the site, should flooding occur on Horsemere Green Lane, this location can be avoided, with an alternative route in or out of the site available.

7.2 Flood Warning

- 7.2.1 The site is located fully within Flood Zone 1, therefore there is no requirement for a Flood Warning System to be implemented, or Flood Evacuation Plan to be prepared.

8 MAINTENANCE

8.1 Proposed Maintenance Regime

- 8.1.1 Maintenance is required to ensure the long-term operational performance of the proposed surface water drainage system.
- 8.1.2 The drainage system has been designed to minimise maintenance requirements; however, a number of key tasks will need to be undertaken so that the system remains in optimal condition. These operations are summarised in the table below, along with the required frequency of works.

Drainage System feature	Proposed maintenance / remedial works	Required frequency of works
Permeable Paving	Surface sweeping to reduce silt and debris accumulation.	Every 8 to 12 weeks
	Removal / management of weed growth	At least once a year
	Silt removal from permeable surfaces, possibly involving raking out of joints, redressing, removal and remedial works.	As required / to be specified by manufacturer
Pond/Basin	Inspection, vegetation clearance and additional clearing/cleansing of potential blockages. Particular attention to incoming/outcoming connections.	At least once a year
	Inspection and clearance of blockages	After major storm events
Swale	Inspection and clearance	Annual, and after every storm event
	Desilting	Year 1, Year 3 then every 5 Years
Diffuser units & catch pits, gully sumps and drains	Inspection and additional cleansing as required.	Annual
	Desilting	Year 1, Year 3, then every 5 years
Inlets and Outfalls	Clearance of safety grilles and pipework	After every storm event/regularly/to be specified by manufacturer
Pipework	Jetting to clear blockages	As required
HydroBrake	As specified by manufacturer	As specified by manufacturer

- 8.1.3 The responsibility of maintenance regime will be determined by the Developer, by agreed appointment.
- 8.1.4 A detailed maintenance document shall be established prior to appointment in order to detail the roles and responsibilities where maintenance is concerned.

Permeable Paving / Diffuser Units

- 8.1.5 The areas of permeable paving are designed to allow infiltration of surface water run-off through the joints in the block paving surface course and into the sub-base below. The water is then collected and discharged into the positive drainage system.

- 8.1.6 As part of the permeable paving system, diffuser units are used to discharge surface water run-off from roof areas into the sub-base, as well as forming links between areas of permeable paving. These diffuser units are small heavy-duty cellular units which allow more efficient discharge of surface water into the sub-base base of the permeable paved areas.
- 8.1.7 The areas of permeable paving will require additional maintenance measures to ensure they operate as designed. Failure in carrying out this maintenance, could increase the risk of flooding. The additional measures are as follow:
- Periodic surface sweeping to reduce silt and debris accumulation. The permeable surfaces should be swept at least every 8 to 12 weeks with additional sweeps in the autumn to clear fallen leaves
 - Removal / management of weed growth, as required. Typically, once or twice a year for regularly used areas
 - Periodic silt removal from permeable surfaces as described by the manufacturer. If any areas are showing signs of ponding, they shall be dealt with by raking out the joints and redressing. The entire surface shall be monitored and when there are signs of excessive siltation resulting in poor drainage over the whole area, the blocks shall be taken up and a replacement of bedding layer and geotextile shall be undertaken
 - Redressing of joints on the block paving as required
 - Catchpits upstream of diffuser units, should be emptied and inspected on the same regime as all catchpits specified previously set out in this document

HydroBrake (Flow Control Chamber)

- 8.1.8 It is proposed that HydroBrake (or similar) flow control unit will be introduced on site in order to restrict flows outfalling from the drainage system to the off-site point of discharge. The HydroBrake flow control system is self-activating, relying on upstream hydraulic head to generate an air-filled vortex within the centre of the casing. Once the vortex is initiated water drains down through a small opening in the back of the device at the designed restricted flow rate.
- 8.1.9 The flow control device has two measures in case of emergency (i.e. blockage). The first is a door situated in the front of the unit itself, this can be operated from the surface by a release cable situated just under the manhole cover which closes under its own weight and does not require any mechanism to operate. The second is a high-level overflow pipe situated with the flow control manhole. Both measures allow the system to drain down freely, until the blockage can be cleared.
- 8.1.10 The HydroBrake flow control chamber will require additional maintenance measures to ensure it operates as designed. The additional measures are as follows:

- The sump within the flow control chamber should be monitored for build-up of silts and should be emptied, as a minimum, on the same regime as specified for catchpits previously within this document
- The drain down door located on the centre of the unit will require inspection and opening annually, to ensure it is operating as intended

Remedial/Repair Actions

- 8.1.11 Significant storm events may cause considerable damage to SuDS and their associated components. As such, it may be necessary to inspect and carry out essential recovery works to return the feature to full working order.
- 8.1.12 Resetting of uneven blocks by lifting block area, removing bedding material and relaying to match original design are all actions which may need to be undertaken.

Accidental Spillages

- 8.1.13 It is not envisaged that any materials are to be stored onsite once the development has been completed, which could cause major spills and potential pollution issues within the drainage system. If this situation alters in the future consultation with a specialist will be required in order to confirm if any upgrades to the existing system are necessary.
- 8.1.14 Minor spillages of fuels and oils will be dealt with by the permeable paving and deep trapped gullies, by bio-degrading and collecting the hydrocarbons respectively.

Future Alterations to the Development

- 8.1.15 Any future alterations to the permeable paving should be confirmed by a specialist. Where possible any future services are to avoid being located through areas of permeable paving. If new services are required to run through areas of permeable paving, services should be installed below the depth of permeable paving with the permeable system reinstalled above.

9 OFFSITE IMPACTS

- 9.1.1 The proposed development will not result in any increase in run-off from the site, and therefore will not cause an increase in flood risk off-site. Flows will be restricted to a total of 15l/s – a betterment compared with pre-development greenfield run-off rates.
- 9.1.2 Post development foul water flows will contribute an increase to the sewer network compared to the previous use – it is expected that the foul sewer flow will be 13.89l/s.
- 9.1.3 The effects of climate change have been considered in the design of the proposed surface water drainage system, to ensure there is no off-site impact.
- 9.1.4 Significant off-site highway works are proposed in relation to this residential development, which will be supported by changes and improvements to the associated off-site drainage infrastructure.

10 SUMMARY

- 10.1.1 In preparing this report, Bright Plan Civils has referred to the following documents and information; Arun District Council Drainage Records, British Geological Survey Records, Environment Agency Flood Maps for Planning, Long Terms Flood Risk Maps, Southern Water Drainage Records and West Sussex County Council Drainage Records.
- 10.1.2 The site is an undeveloped greenfield location, measuring 27.15Ha and is located fully within Flood Zone 1.
- 10.1.3 Levels on site fall broadly within the range of 5.00m AOD to 6.75m AOD. Despite this range in levels, the site can be largely considered flat. A localised high-point (7.00m AOD) is identified towards the western boundary of the site, with the low point located towards the eastern boundary (4.75m AOD).
- 10.1.4 The site, in its existing use is fully permeable, with no areas of impermeable surfacing located within the bounds of the site.
- 10.1.5 The proposed development will involve the construction of 300 dwellings and two buildings within use class A1 and D1, together with public open space, LAPs, LEAP and ancillary works, including car parking and drainage arrangements, with access off Church Lane and Horsemere Green Lane.
- 10.1.6 The risk of flooding from all sources has been determined as being 'Very Low' from all sources, with the exception of groundwater flooding. Groundwater has been identified as varying depths across the site, as shallow as 200mm below ground level following a period of winter groundwater monitoring.
- 10.1.7 The site currently drains via infiltration, with run-off also following the natural topography of the site. The site is largely considered to be flat, with ponding occurring at present at localised low points. There is no formal existing drainage infrastructure within the bounds of the site serving the site.
- 10.1.8 Southern Water records confirm the presence of 3 No. rising mains within the bounds of the site. 1 No. 700mm Treated Effluent Rising Main, 1 No. 500mm Foul Water Rising Main and also 1 No. 100mm Foul Water Rising Main.
- 10.1.9 Post-development, surface water run-off will be managed through sustainable means, with the provision of permeable paving, ponds/basins, swales and supplementary infrastructure. Run-off leaving the site will discharge to the existing manhole on Church Lane, to the south of the existing property 'Field Place'. This manhole discharges to the watercourse to the east. Flows will be restricted to a total of 19.50l/s (QBar).
- 10.1.10 The surface water drainage system has been designed to accommodate a 1-in-100-year storm event inclusive of an allowance for climate change (40%) as well as urban creep (10%).
- 10.1.11 Wastewater from the development will be pumped to the Southern Water public foul water sewer located in Horsemere Green Lane (existing manhole 0302). An adoptable pumping station (Type 3) is proposed to support the development.
- 10.1.12 The completion of the development will not increase flood risk on or off the site.
- 10.1.13 In conclusion, this development is suitable with regards to flood risk and surface water drainage.