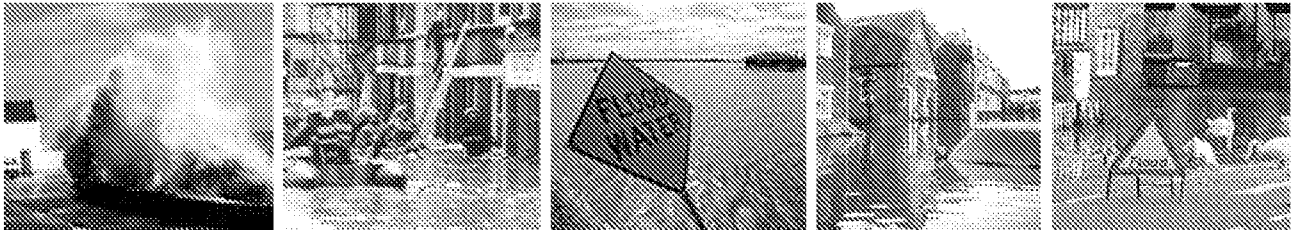


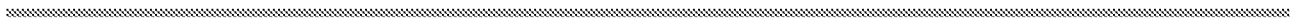
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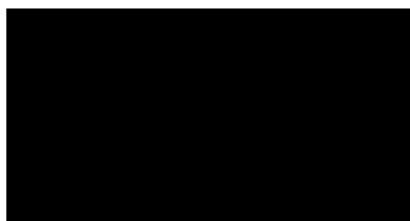
Client: Angmering Park Estate
Flood Risk Assessment for the
Proposed Development at Land off
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Client: Angmering Park Estate

Flood Risk Assessment for the Proposed Development at Land off Queens Lane, Arundel

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1 Background and Scope of Appraisal

In 2018, Herrington Consulting was commissioned by Angmering Park Estate to prepare a Flood Risk Assessment (FRA) for the proposed development at **Land adjacent to 18 Queens Lane, Arundel, West Sussex, BN18 9JN.**

Whilst the FRA concluded that the site could be at risk of flooding from the River Arun, mitigation measures were proposed to manage the risk. A planning application was subsequently submitted (planning ref. AB/73/18/PL) and no objections were raised by the Environment Agency or the LPA. Consequently, **planning permission was granted in December 2018.**

The planning permission has since lapsed and as such, a new application has been submitted for the same scheme (planning ref. AB/136/21/PL). However, both the Environment Agency and the drainage engineers have raised objections, requiring further information to be provided. Consequently, Herrington Consulting has been commissioned to update the FRA for the above site to provide this additional level of detail.

This appraisal has been undertaken in accordance with the requirements of the National Planning Policy Framework (2021) and the National Planning Practice Guidance Suite (August 2021) that has been published by the Department for Communities and Local Government. The *Flood Risk and Coastal Change* planning practice guidance included within the Suite represents the most contemporary technical guidance on preparing FRAs. In addition, reference has also been made to Local Planning Policy.

To ensure that due account is taken of industry best practice, this FRA has been carried out in line with the CIRIA Report C624 'Development and flood risk - guidance for the construction industry'.

2 Development Description and Planning Context

2.1 Site Location and Existing Use

The site is located at OS coordinates 501859, 106816, off Queens Lane in Arundel. In total the site covers an area of approximately 0.1 hectares and currently comprises a garage surrounded by undeveloped land. The location of the site in relation to the surrounding area and the River Arun is shown in Figure 2.1.

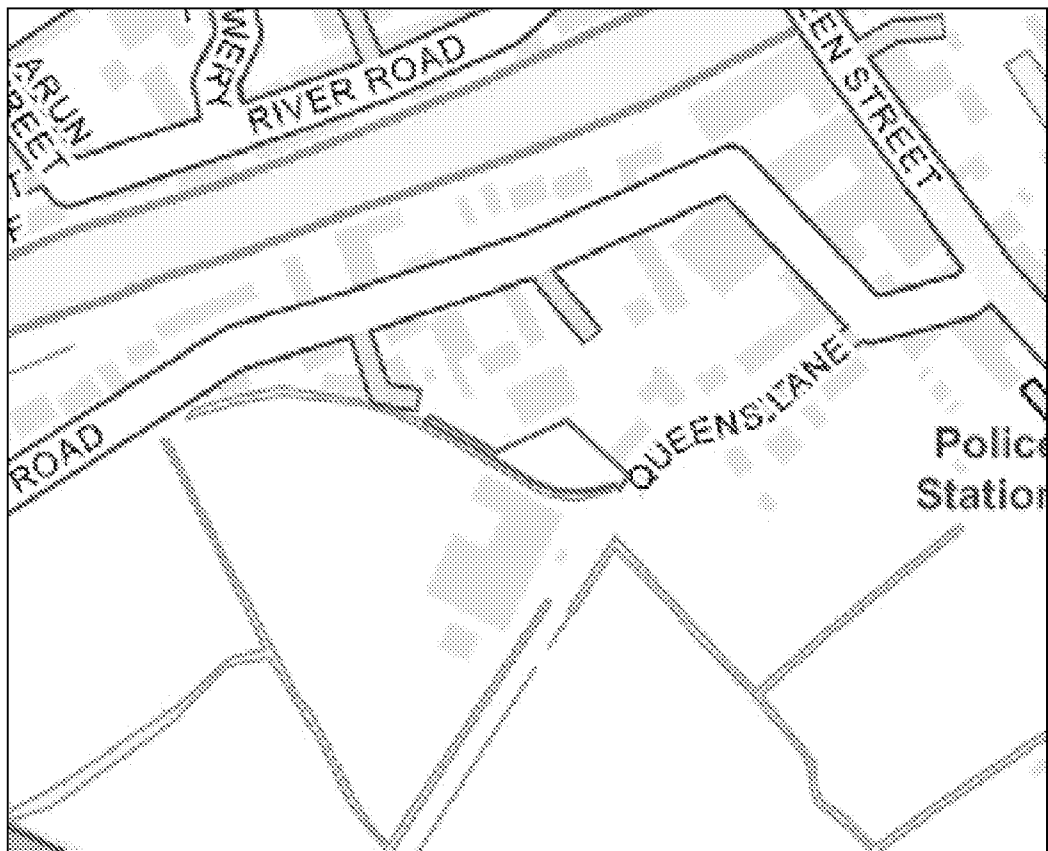


Figure 2.1 – Location map (contains Ordnance Survey data © Crown copyright and database right 2022).

The site plan included in Appendix A.1 of this report provides more detail in relation to the site location and layout.

2.2 Proposed Development

Planning permission has previously been granted for the same development in December 2018 (planning ref. AB/73/18/PL), however, planning permission has since expired. Therefore, the applicant has re-submitted a new planning application for development comprising two residential dwellings with associated parking, as shown in Figure 2.2 below. These proposals are identical to those previously granted (planning ref. AB/73/18/PL).

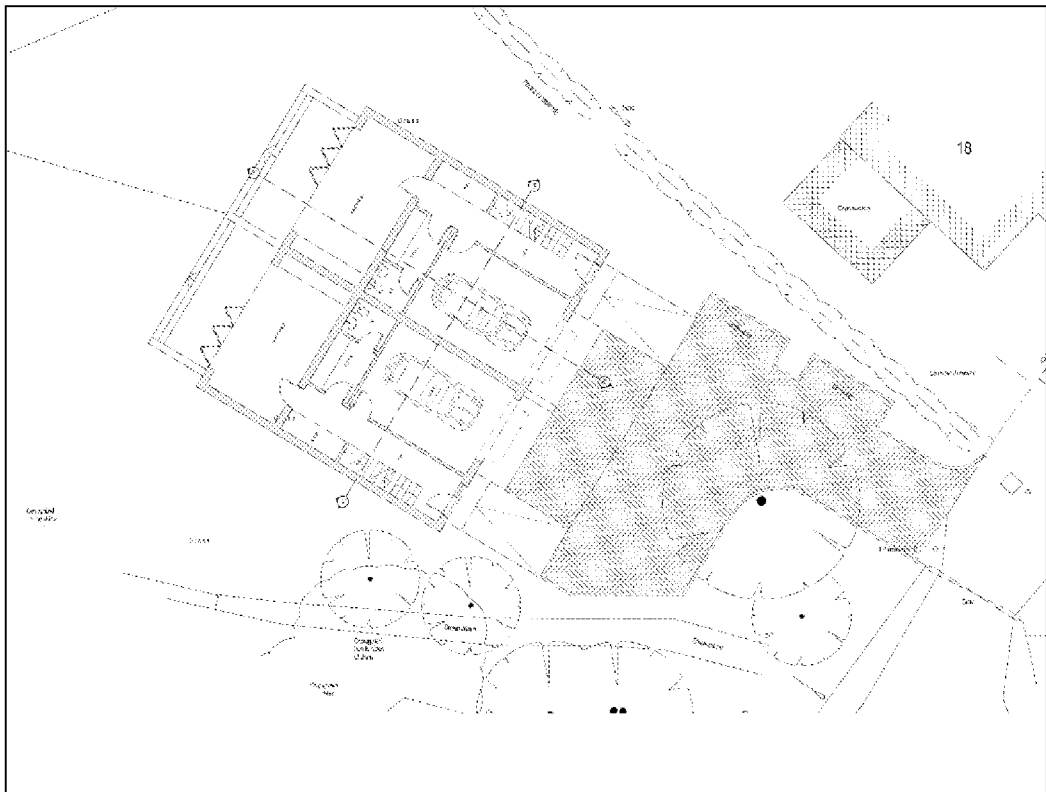


Figure 2.2 – Proposed site layout.

More detailed drawings of the proposed scheme are included in Appendix A.1 of this report.

2.3 The Sequential Test

The National Planning Policy Framework (NPPF) requires the Sequential Test to be applied at all stages of the planning process and generally the starting point is the Environment Agency's (EA) 'Flood Map for Planning' (Figure 2.3). These maps and the associated information are intended for guidance and cannot provide details for individual properties. They do not take into account other considerations such as existing flood defences, alternative flooding mechanisms and detailed site-based surveys. They do, however, provide high level information on the type and likelihood of flood risk in any particular area of the country. The Flood Zones are classified as follows:

Zone 1 – Low probability of flooding – This zone is assessed as having less than a 1 in 1000 annual probability of river or sea flooding in any one year.

Zone 2 – Medium probability of flooding – This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding or between 1 in 200 and 1 in 1000 annual probability of sea flooding in any one year.

Zone 3a – High probability of flooding - This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding or 1 in 200 or greater annual probability of sea flooding in any one year.

Zone 3b – *The Functional Floodplain* – This zone comprises land where water has to flow or be stored in times of flood and can be defined as land which would flood during an event having an annual probability of 1 in 20 or greater. This zone can also represent areas that are designed to flood in an extreme event as part of a flood alleviation or flood storage scheme.



Figure 2.3 – EA's 'Flood Map for Planning' (© Environment Agency).

Figure 2.3 shows the development site is located within Flood Zone 3 and identifies that the site does not benefit from existing flood defences. This mapping does not distinguish between high risk areas and the functional floodplain, i.e., Zones 3a and 3b. This is an important differentiation that needs to be made by the FRA because the NPPF states that no development, other than essential transport and utilities infrastructure, should be located within the functional floodplain. The NPPG states that the Functional Floodplain is land where water has to flow or be stored in times of flood. The NPPG provides the following definition:

The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. But land which would flood with an annual probability of 1 in 20 (5%) or greater in any year, or is designed to flood in an extreme (0.1%) flood, should provide a starting point for consideration and discussions to identify the functional floodplain.

Arun Council states in comments previously received as part of new application that the results used within the SFRA show the site to be situated within the functional floodplain, and that the EA has been made aware of this. However, a more detailed review of the data reveals that the extents of the functional floodplain represented in the SFRA are incorrect at the study site, as the flood extent is based on the outputs from a model that is only appropriate for use in coastal areas, i.e. the Emsworth to Littlehampton coastal model, completed in 2016. Recent correspondence with the

EA, in relation to this appraisal, confirms that the Lower Tidal Arun Strategy Study (2011) is '*the appropriate model for use when considering tidal flood risk in Arundel.*' (refer to Appendix A.2). The EA goes on to state that the study area for the Emsworth to Littlehampton coastal model is restricted to the coast. The lower Arun (main river) was simply included to account for the influence of the fluvial flows from the Arun, however, the Arun was out of the study area and therefore, '*only used low resolution ground levels and defence information.*'

Consequently, the results provided by the EA for use at the site are obtained from the Lower Tidal Arun Strategy Study, which have been referenced in this report and define the true extent of the functional floodplain.

The more relevant results include flood levels for both 'undefended' and 'defended' scenarios for a number of return periods, including the 1 in 20 year flood event, which is classified as the functional floodplain. The data reveals that under the 'undefended' 1 in 20 year flood event, the site could be subject to flooding.

Nevertheless, the NPPG further states that

Areas which would naturally flood with an annual exceedance probability of 1 in 20 (5%) or greater, but which are prevented from doing so by existing infrastructure or solid buildings will not normally be defined as functional floodplain.

Further interrogation of the EA's data shows that the site benefits from existing defence infrastructure, which provides a 1 in 50 year to a 1 in 200 year standard of protection. The site is therefore protected from a flood event with a 1 in 20 year return period. **In conclusion, as set out in the NPPG, the site is not located within the functional floodplain.**

Based on information provided by the EA and that derived as part of this appraisal, the flood zone mapping and associated information has been summarised in Table 2.1 below.

Flood Zone (percentage of site within zone)		Source of Flooding	Benefiting from existing flood defences
Zone 1	0%		
Zone 2	0%		
Zone 3a	100%	River (Tidal/Fluvial)	Yes
Zone 3b	0%		

Table 2.1 – Flood zone classification.

The NPPF states that the Local Planning Authority (LPA) should apply the sequential approach as part of the identification of land for development in areas at risk from flooding. The overarching objective of the Sequential Test is to ensure that lower risk sites are developed before sites in higher risk areas. When applying the Sequential Test, it is also necessary to ensure that the subject site is compared to only those sites that are available for development and are similar in size.

A Sequential Test has been undertaken by others which concludes that the site passes the Sequential Test.

The second level of appraisal is through the application of the more detailed and refined flood risk information contained within the Strategic Flood Risk Assessments (SFRA). Such a document has been prepared for the Arun District Council and this has been referenced as part of this site-specific FRA.

The most detailed stage at which the sequential approach can be applied is at a site-based level. Careful consideration of the topography of the site and development uses can provide opportunities to locate more vulnerable buildings on the higher parts of the site and placing less vulnerable elements such as car parking or recreational use in the areas exposed to higher risk. This approach is examined later on in this FRA.

2.4 The Exception Test

According to the NPPF, if it is not possible, consistent with wider sustainability objectives, for the development to be located in areas at lower risk, the Exception Test may have to be applied. The application of the Exception Test will depend on the type and nature of the development, in line with the Flood Risk vulnerability classification set out in the NPPG. This has been summarised in Table 2.2 below.

Flood Risk Vulnerability Classification	Zone 1	Zone 2	Zone 2a	Zone 3b
Essential Infrastructure – Essential transport infrastructure, strategic utility infrastructure, including electricity generating power stations.	✓	✓	e	e
High Vulnerability – Emergency services, basement dwellings, caravans and mobile homes intended for permanent residential use.	✓	e	x	x
More Vulnerable – Hospitals, residential care homes, buildings used for dwelling houses, halls of residence, pubs, hotels, non-residential uses for health services, nurseries and education.	✓	✓	e	x
Less Vulnerable – Shops, offices, restaurants, general industry, agriculture, sewerage treatment plants.	✓	✓	✓	x
Water Compatible Development – Flood control infrastructure, sewerage infrastructure, docks, marinas, ship building, water-based recreation etc.	✓	✓	✓	✓
Key : ✓ Development is appropriate x Development should not be permitted e Exception Test required Shaded cell represents the classification of this development				

Table 2.2 - Flood risk vulnerability and flood zone compatibility.

From Table 2.2 above it can be seen that the development falls into a classification that requires the Exception Test to be applied. For the Exception Test to be passed 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.

Both parts of the test will have to be passed for development to be allocated or permitted.

Demonstrating that the development provides wider sustainability benefits to the community that outweigh flood risk is outside the scope of this report. Nevertheless, reference is made to the SFRA to establish the key risks associated with flooding and to help demonstrate that this objective can be achieved. The key focus of this FRA is therefore to establish whether the site is likely to pass Part B of the Exception Test.

3 Definition of Flood Hazard

3.1 Site Specific Information

Information from a wide range of sources has been referenced to appraise the true risk of flooding at this location. This section summarises the additional information collected as part of this FRA.

Site specific flood level data provided by the EA – The EA has been re-consulted as part of this appraisal and following further correspondence, the results from the Lower Tidal Arun Strategy Study (2011) (LTAS) have been referenced as part of this report. A copy of the results is included in Appendix A.2 of this report.

Information contained within the SFRA – The Arun District Council SFRA (2016) contains detailed mapping showing historic flood records for a wide range of sources. This document has been referenced as part of this site-specific FRA.

Information provided by Southern Water – Southern Water has provided the results of an asset location search for the site. The response is included in Appendix A.3.

Site specific topographic surveys – A topographic survey has been undertaken for the site and a copy of this is included in Appendix A.1. From this it can be seen that the level of the site varies between 1.18m and 2.26m Above Ordnance Datum Newlyn (AODN) with ground levels gradually reducing from northwest to southeast.

Geology – Reference to the British Geological Survey map shows that the underlying solid geology in the location of the subject site is Spetisbury Chalk Member (chalk). Overlying this are superficial deposits of Raised Marine Deposits (clay, silt, sand and gravel).

Historic flooding – The EA has confirmed that there are no historic records of flooding at the development site from main rivers or the sea. In addition, information contained within the Arun District Council SFRA reveals that there are no records of flooding at the site from any other sources in the past.

3.2 Potential Sources of Flooding

The main sources of flooding have been assessed as part of this appraisal. The specific issues relating to each one and its impact on this development are discussed below. Table 3.1 at the end of this section summarises the risks associated with each of the sources of flooding.

Flooding from Rivers (Fluvial) – The site lies within Flood Zone 3 of the River Arun (main river) as shown on the EA's flood map. The flood zone maps are used as a consultation tool by planners to highlight areas where more detailed investigation of flood risk is required. Consequently, given the location of the site within Flood Zone 3, the risk of flooding from this source has been examined in more detail as part of this FRA.

Flooding from Rivers (Tidal) – The site lies within Flood Zone 3 of the tidal reaches of the River Arun (main river) as shown on the EA's flood zone mapping. Consequently, the risk of flooding from this source has been examined in more detail as part of this FRA.

Flooding from Ordinary or Man-Made Watercourses – Natural watercourses that have not been enmained and man-made drainage systems such as irrigation drains, sewers or ditches could potentially cause flooding.

Inspection of OS mapping of the site and surrounding area reveals that there is a drainage ditch along the southern site boundary which forms part of a wider drainage network to the south of the development site. The primary purpose of this network is to reduce the groundwater level within the surrounding area. Extreme rainfall or high water levels within the adjacent River Arun may result in increased water levels in the network of drains and ditches. The consequence of such an event is likely to be water logging of the ground and shallow flooding in the lower-lying areas to the south. However, inspection of the topographic survey reveals that the area of proposed development is located approximately 0.5m above the lower-lying area and as such, it is considered extremely unlikely that floodwater within the lower-lying land could reach a depth that could affect the development site.

Therefore, the risk of flooding from this source is considered to be significantly less than risk of flooding a tidal/fluviat event which is appraised further in Section 5 of this report. In addition, the mitigation measures discussed in later sections of this report, which are aimed at reducing the risk of flooding from all sources, will be more than adequate in preventing flooding from this source. As such, the risk of flooding from this source is considered to be *low*.

Flooding from the Sea – The site is a significant distance inland and whilst the River Arun is still tidally influenced at this location, the risk of flooding from the sea is considered to be extremely low and is not investigated further as an independent source of flooding.

Flooding from Surface Water – Surface Water, or overland, flooding typically occurs in natural valley bottoms as normally dry areas become covered in flowing water and in low spots where water may pond. This mechanism of flooding can occur almost anywhere, but is likely to be of particular concern in any topographical low spot, or where the pathway for runoff is restricted by terrain or man-made obstructions.

Figure 3.1 below is an extract of the Environment Agency's 'Risk of Flooding from Surface Water' map which can be interrogated to identify whether the site is located in an area at risk of surface water flooding.

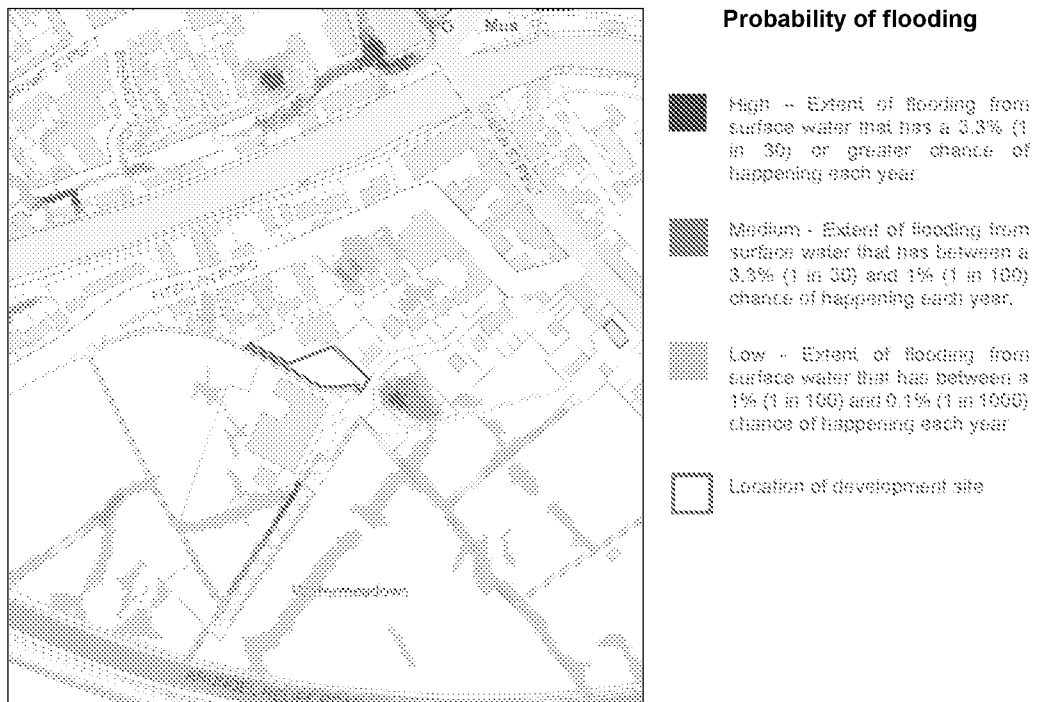


Figure 3.1 – Surface water flooding map showing the location of the development site
(© Environment Agency)

The above mapping does not include an allowance for climate change, but as it includes an event that exceeds the 1 in 100 year design rainfall event, it can be used to consider the impact that climate change may have over the lifetime of the development. In this circumstance the proposed development site is shown to be located outside the flood extents of an extreme pluvial event with a return period of 1 in 1000 years (i.e. it has a very low probability of flooding).

Inspection aerial height data and a site specific topographic survey shows that land levels fall naturally across the site towards the southeast. In addition, there are no topographical low points within the site which could encourage flood water to pond. It is therefore considered that flooding through this mechanism is *low*.

Flooding from Groundwater – Water levels below the ground rise during wet winter months, and fall again in the summer as water flows out into rivers. In very wet winters, rising water levels may lead to the flooding of normally dry land, as well as reactivating flow in 'bournes' (streams that only flow for part of the year).

Groundwater flooding is most likely to occur in low-lying areas that are underlain by permeable rock (aquifers). The underlying geology in this area is Septisbury Chalk Member, with overlaying superficial Raised Marine deposits. While chalk is characteristically impermeable, chalk formations can be susceptible to groundwater flooding as water rises through faults and discontinuities within the rock. Additionally, the more permeable superficial deposits can also be susceptible to groundwater emergence.

Information contained within the Arun District Council SFRA shows that the development site lies within an area susceptible to groundwater emergence. In addition, the more detailed mapping on groundwater emergence provided as part of the Defra Groundwater Flood Scoping Study (May 2004) shows that the site itself is located near an area where groundwater emergence is predicted.

Nevertheless, the role of the drainage network to the south of the development site is to retain a low groundwater table in this area. Consequently, if the groundwater table was to rise, water would be intercepted by the drainage network in the lower-lying land to the south. If the drainage network becomes overwhelmed, the mechanism of flooding is comparable to the risk of flooding from watercourses, which has been discussed further above and is considered to be low.

This is supported by information contained within the Arun District Council SFRA which reveals that there are no records that the site has been subject to groundwater flooding in the past. Consequently, the risk of groundwater flooding is considered to be *low*.

Flooding from Sewers – In urban areas, rainwater is typically drained into surface water sewers or sewers containing both surface and wastewater known as “combined sewers”. Flooding can result when the sewer is overwhelmed by heavy rainfall, becomes blocked, or has inadequate capacity; this will continue until the water drains away.

Inspection of asset location data provided by Southern Water (Appendix A.3) identifies that there are no sewers within close proximity of the site. Additionally, there is no record of historic sewer flooding in this location contained within the Arun District Council SFRA. Consequently, the risk of flooding from this source is considered to be *low*.

Flooding from Reservoirs, Canals and Other Artificial Sources – Non-natural or artificial sources of flooding can include reservoirs, canals, and lakes, where water is retained above natural ground level. In addition, operational and redundant industrial processes including; mining, quarrying, sand and gravel extraction, may also increase the depth of floodwater in areas adjacent to these features.

The potential effects of flood risk management infrastructure and other structures also needs to be considered. For example; reservoir or canal flooding may occur as a result of the facility being overwhelmed and/or as a result of dam or bank failure.

Inspection of the Ordnance Survey mapping for the area shows that there are no artificial sources of flooding within close proximity to the site. In addition, the EA’s ‘Risk of Flooding from Reservoirs’ website shows that the site is not within an area considered to be at risk of flooding from reservoirs. Therefore, the risk of flooding from this source is considered to be *low*.

A summary of the overall risk of flooding from each source is provided in Table 3.1 below.

Source of flooding	Initial level of risk	Appraisal method applied at the initial flood risk assessment stage
Rivers (fluvial)	Appraised further in Section 5	OS mapping and Environment Agency flood zone map
Rivers (tidal)		OS mapping and Environment Agency flood zone map
Sea/Estuaries	Low	OS mapping and Environment Agency flood zone map
Ordinary and man-made watercourses	Low	OS mapping and aerial height data
Overland flow	Low	Environment Agency 'Risk of Flooding from Surface Water' flood maps, aerial height data, OS mapping, topographic survey
Groundwater	Low	BGS geological data, Defra Groundwater Flood Scoping Study, aerial height data, OS mapping, topographic survey, historic records within the Arun District Council SFRA
Sewers	Low	Southern Water asset location data and historic records contained within the Arun District Council SFRA
Artificial sources	Low	OS mapping and Environment Agency 'Risk of Flooding from Reservoirs' flood map

Table 3.1 – Summary of flood sources and risks.

3.3 Existing Flood Risk Management Measures

The flood defences in this area are in the form of an embankment along the River Arun with a varying standard of protection between 1 in 50 year and 1 in 200 year.

4 Climate Change

The global climate is constantly changing, but it is widely recognised that we are now entering a period of accelerating change. Over the last few decades there have been numerous studies into the impact of potential changes in the future and there is now an increasing body of scientific evidence which supports the fact that the global climate is changing as a result of human activity. Past, present, and future emissions of greenhouse gases are expected to cause significant global climate change during this century.

The nature of climate change at a regional level will vary: for the UK, projections of future climate change indicate that more frequent short-duration, high-intensity rainfall and more frequent periods of long-duration rainfall could be expected.

These effects will tend to increase the size of Flood Zones associated with rivers, and the amount of flooding experienced from other inland sources. The rise in sea level will change the frequency of occurrence of high water levels relative to today's sea levels. It will also increase the extent of the area at risk should sea defences fail. Changes in wave heights due to increased water depths, as well as possible changes in the frequency, duration and severity of storm events are also predicted.

4.1 Planning Horizon

To ensure that any recommended mitigation measures are sustainable and effective throughout the lifetime of the development, it is necessary to base the appraisal on the extreme flood level that is commensurate with the planning horizon for the proposed development. The NPPF and supporting Planning Practice Guidance Suite state that residential development should be considered for a minimum of 100 years, but that the lifetime of a non-residential development depends on the characteristics of the development. For commercial development, a 60 year design life is typically assumed. The development that is the subject of this FRA is classified as residential therefore a design life of 100 years has been assumed.

4.2 Potential Changes in Climate

Extreme Sea Level

Global sea levels will continue to rise, depending on greenhouse gas emissions and the sensitivity of the climate system. The relative sea level rise in England also depends on the local vertical movement of the land, which is generally falling in the south-east and rising in the north and west.

Reference to guidance published by the EA specifies allowances for different epochs and regions across England. The predicted rates of relative sea level rise for the 'South East' region, relevant to the subject site, are shown in Table 4.1. These values which correspond with the Higher Central and Upper End percentiles (the 70th and 90th percentile respectively).

Administrative Region	Allowance Category	Net Sea Level Rise (mm/yr) (Relative to 2000)			
		2000 to 2035	2036 to 2065	2066 to 2095	2096 to 2125
South East	Higher Central	5.7	8.7	11.6	13.1
	Upper End	6.9	11.3	15.8	18.2

Table 4.1 – Recommended contingency allowances for net sea level rise.

The development site is not subject to coastal flooding; however, the River Arun is a tidal river and therefore the figures above are still applicable.

Peak River Flow

Recognising that the impact of climate change will vary across the UK, the allowances show the anticipated changes to peak flow by management catchment. Management catchments are sub-catchments of river basin districts. The proposed development site is covered by the **South East River Basin District**, as defined by the EA 'River Basin District' maps, and is located in the **Arun and Western Streams Management Catchment**, as defined on the EA's 'Peak River Flow' map.

For each Management Catchment, a range of climate change allowances are provided for three different time epochs. For each epoch there are three climate change allowances defined. These represent different levels of statistical confidence in the possible emissions scenarios on which they are calculated. The three levels of allowance are as follows:

- Central: based on the 50th percentile
- Higher Central: based on the 70th percentile
- Upper End: based on the 95th percentile

The EA has provided guidance regarding the application of the climate change allowances and how they should be applied in the planning process. The range of allowance for the Management Catchment in which the development site is located are shown in Table 4.2 below.

Management Catchment Name (River Basin District)	Allowance Category	2020s	2050s	2080s
Arun and Western Streams (South East)	Upper End	27%	36%	64%
	Higher Central	16%	19%	36%
	Central	11%	13%	25%

Table 4.2 – Recommended peak river flow allowances for each epoch for the South East Management Catchment (1981 to 2000 baseline).

For more vulnerable development with a design life of 100 years in Flood Zone 3a, a **Central** climate change allowance is recommended. From Table 4.2 above, it can be seen that the recommended climate change allowance for this site is a **25%** increase for all peak river flows.

Peak Rainfall Intensity

The recommended allowances for increases in peak rainfall intensity are applicable nationally. There is a range of values provided which correspond with the central and upper end percentiles (the 50th and 90th percentile respectively) over three time epochs. The recommended allowances are shown in Table 4.3 below.

Allowance Category (applicable nationwide)	Total potential change anticipated for each epoch		
	2015 to 2039	2040 to 2069	2070 to 2115
Upper End	+10%	+20%	+40%
Central	+5%	+10%	+20%

Table 4.3 – Recommended peak rainfall intensity allowance for small and urban catchments (1961 to 1990 baseline).

Guidance published by the EA states that the 'Upper End' allowance should be considered when designing a sustainable drainage system. As the development subject to this FRA has a planning horizon of 100 years, a 40% increase in peak rainfall intensity has been applied to the hydraulic model constructed to inform the outline surface water management strategy (refer to Section 8).

5 Probability and Consequence of Flooding

When appraising the risk of flooding to new development it is necessary to assess the impact of the 'design flood event'. Flood conditions can be predicted for a range of return periods, and these are expressed in either years or as a probability, i.e., the probability that the event will occur in any given year, or Annual Exceedance Probability (AEP). The design flood event is taken as the 1 in 100 year (1% AEP) event for fluvial flooding and the 1 in 200 year (0.5% AEP) event for sea or tidal flooding, including an appropriate allowance for climate change (refer to Section 4.2).

5.1 The Fluvial Risk of Flooding

The EA has been consulted as part of this appraisal and a copy of their response is included in Appendix A.2. The information has been taken from the Lower Tidal River Arun Strategy Study Model completed in 2011 (by others). The data provided contains modelled flood level data for different return periods for node points on site. The location of the node points in relation to the development site is shown in Figure 5.1 below.



Figure 5.1 – Flood node location map (provided by the EA). Development site outlined in red.

Inspection of the modelled flood levels for the node points shows that the site is located outside of the predicted flood extents under an event with a 1 in 100 year return period. However, this modelled flood level for the 1 in 100 year event does not include an allowance for climate change

as defined by the Environment Agency's climate change guidance, which would require a 35% increase in peak river flow to be considered over the lifetime of the development.

In this instance, modelled in-channel flow and stage values have been provided by the Environment Agency in addition to node points across the site. As such, it is possible to estimate the design flood level for the site using the 'intermediate' approach, which is considered to provide a more accurate estimation of the impacts of climate change on the predicted flood level at the development site.

The 'intermediate' approach involves constructing a stage-flow rating curve for current day conditions, which is extrapolated to derive a flood level based on the increase in peak flow (25%). Figure 5.2 below shows the stage-flow curve constructed for the nearest in-channel node to the development site, which has been identified as node point LOW054.

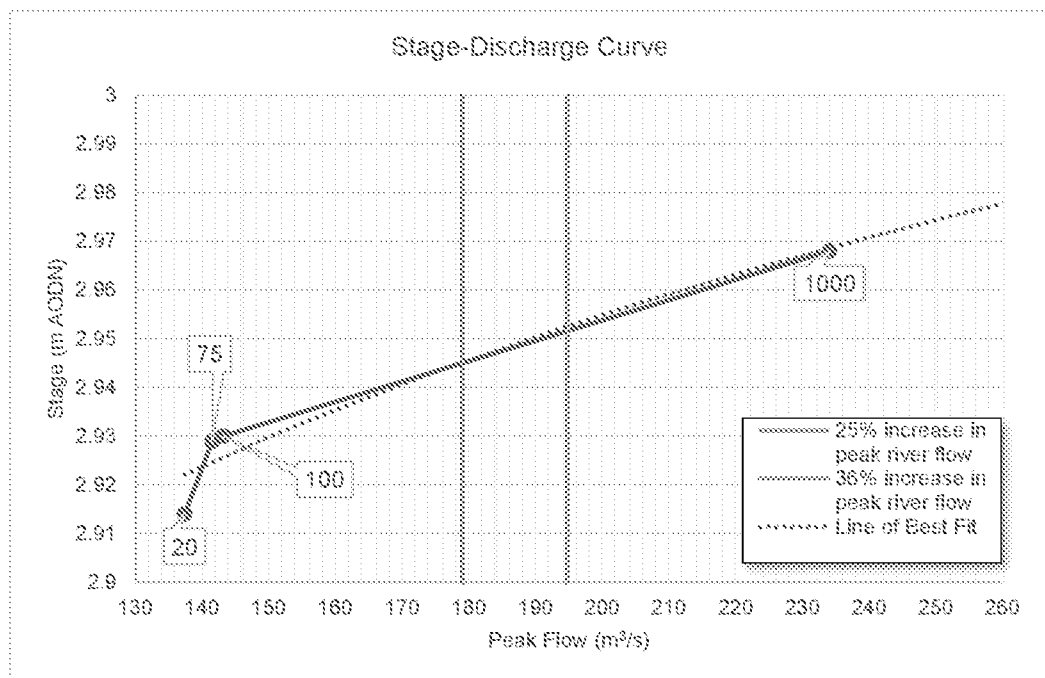


Figure 5.2 – Stage-flow curve for in-channel node LOW054.

From Figure 5.2 above, it can be seen that the maximum predicted in-channel water level for a 25% increase in peak river flow is approximately 2.95m AODN. However, comparison of the in-channel water level for other return periods (provided by the EA) with the predicted land levels on site shows that the direct application of the derived flood level would significantly over-estimate the risk of flooding at the site.

Therefore, given the small difference in the in-channel flood levels between the derived level including a 25% allowance for climate change (i.e. 2.95m AODN) and the 1 in 1000 year flood level (i.e. 2.97m AODN), a conservative approach has been adopted and the flood extent under the 1 in 1000 year return period has been referenced as a direct substitute for the design flood event. Under this scenario, the data provided by the EA shows that the maximum predicted flood level on site is **1.75m AODN**.

When the design flood level is compared to the land levels shown on the topographic survey, it can be seen that the proposed dwelling is situated on land raised above the design flood level. However, inspection of the scheme drawings identifies that the ground floor of the dwellings is to be lowered slightly (below the existing ground level) to provide vehicular access.

Notwithstanding this, the external parking area will be raised slightly to a level of 1.82m AODN before the driveway slopes towards the dwellings, and will prevent floodwater from reaching the dwelling. **Consequently, the ground floor is likely to remain dry under the design flood event.**

It is only if the water level were to exceed 1.82m AODN (e.g. as a result of an exceedance event or a bow wave from moving vehicles) that floodwater could flow down the driveway subjecting the ground floor of the development to shallow flooding. Based on the proposed internal floor levels, the maximum depth of flooding under this scenario is predicted to be less than 300mm within the garage area, and up to 150mm where the resident's access the first floor. As the ground floor will only comprise non-habitable uses (i.e. W/C, garage etc.), opportunities to reduce the impact of such an event have been explored in the following sections of this report.

5.2 The Tidal Risk of Flooding

The River Arun is also tidally influenced in this location, and the EA has provided tidal modelled flood level data for the three node points on the site (refer to Figure 5.1), representing different future climate change scenarios. As discussed in Section 4 of this report, the proposed development is assumed to have a lifetime of 100 years and as such, the design flood event is taken as the 1 in 200 year flood event including an appropriate allowance for climate change (i.e. future year 2110).

The EA has provided flood level data for the development site for both 'defended' and 'undefended' scenarios. Using the undefended level to define the design flood level at the site will result in a significant over-estimation of risk and therefore, in such situations, it is necessary to reference the more realistic 'defended' flood level at the site.

Inspection of the data provided shows that the development site is currently defended from a 1 in 200 year flood event. Nevertheless, within the response provided as part of the current planning application, the EA has stated that the design flood event for tidal flooding should be considered as the 1 in 200 year flood return period including an allowance for climate change up to the future year 2125. The modelling study provided by the EA only includes results up to the year 2110 and therefore, an overly conservative approach has been adopted and the predicted additional increase in sea level rise from the year 2110 to 2125 has been applied directly to the flood level.

Inspection of the EA's data shows that the maximum predicted flood level at the site for the future year 2110 is 3.5m AODN. Reference to the values presented in Table 4.1 shows that the sea level could rise by 13.1mm per year for a 'Higher Central' scenario and 18.2mm per year for an 'Upper End' scenario. When these predictions are applied to the flood level of 3.5m AODN over an additional 15 years, to account for climate change for the future year 2125, the flood level could

reach a maximum of **3.70m AODN** for 'Higher Central' scenario and **3.77m AODN** for the 'Upper End' scenario.

When these levels are compared to land levels across the site, it is evident that the site could flood up to a maximum depth of 1.9m in the area of proposed development. Nevertheless, it is recognised that the coarse approach taken above is likely to significantly *overestimate* the increase in flood level up to the future year 2125 and there are several limitations when analysing the data in this simplistic way.

Comparison of the sea level at the estuary of the River Arun with the sea provided as part of the EA's LTAS identifies that the sea level applied within the model for the 1 in 200 year return period for the future year 2110 is 5.19m AODN. When this level is compared to the results of the latest sea level predictions as provided by the Coastal Flood Boundary Condition database (2017) and the climate change allowances, it is evident that the level is equivalent to the sea level rise predictions for the 'Upper End' scenario.

Year	'Higher Central' Scenario	'Upper End' Scenario
Current Day (year 2017)	3.97	3.97
2110	4.88	5.18
2125	5.07	5.45

Table 5.1 – Climate change impacts on extreme sea levels for a 1 in 200 year return period event based on values taken from the EA's Coastal Flood Boundary Condition database.

Consequently, the design flood level for the future year 2125 is likely to be less for the 'Higher Central' allowance. In addition, further review of tidal water levels within the River Arun in proximity to the site suggests that a significant increase in sea level rise downstream at the Estuary results in a relatively marginal increase in water level within the River Arun.

As such, it is concluded that the tidal risk of flooding from the river Arun is likely to be significantly less than stated within this report. Nevertheless, in the absence of any other data and following the response from the EA, the mitigation measures outlined in the following sections of this report have been designed to this *worst-case* scenario.

5.3 Velocity and Rate of Rise of Floodwater

Information on the velocity and rate of rise of floodwater at the development site has not been provided. However, given the relatively close proximity of the development to the tidal River Arun, it is likely that floodwater will reach the site rapidly once water exceeds the river banks. From this point, the rate of rise is likely to be gradual, as the flood compartment in which the proposed development is located is relatively large and unconfined. As such, it is concluded that the velocity of floodwater at the site will be low.

6 Offsite Impacts and Other Considerations

6.1 Displacement of Floodwater

The construction of a new building within the floodplain has the potential to displace water and to increase the risk elsewhere by raising flood levels. A compensatory flood storage scheme can be used to mitigate this impact, ensuring the volume of water displaced is minimised.

Where development is proposed in **tidal** floodplains, such as is the case here, it is generally accepted by the EA that raising the ground or building on the floodplain is unlikely to impact on maximum tidal levels.

Where development is proposed in **fluvial** floodplains, the current best practice guidance recommends that the potential cumulative impact of the loss of flood storage be considered, and that such assessments be appropriate to the scale and nature of the proposed development and the flood risk. Only where the potential impact is unacceptable should mitigation be considered. In the case of the study site, it has been demonstrated that the dwellings are located outside of the 1 in 100 year fluvial flood extent, including an appropriate allowance for climate change. Nevertheless, it is recognised that the driveway is proposed to be raised and therefore, has the potential to displace some floodwater.

To determine whether additional compensatory floodplain storage is required under this worst-case scenario, the volume of water displaced by the pre-developed site has been compared with the volume displaced by the proposed development. The existing site comprises a garage with a total footprint of ~20m², located entirely within the fluvial flood extent. The average depth of flooding in the area of the garage is 0.03m and therefore, the existing garage would result in 0.6m³ of water being displaced.

The area of the proposed development which is situated within the flood extent, and which is now prevented to flood due to the raised driveway is ~111m². Inspection of the land levels shows that the average depth of flooding in this area is ~0.07m and therefore, the proposed development would displace 7.8m³ of water. Consequently, under the worst-case scenario, the proposals could result in a net increase in displacement of **7.2m³** when compared to the existing site.

The EA's guidance states that flood compensation should be provided by lowering an area outside the predicted flood extent on a level-per-level, volume-per-volume basis, in 100mm to 200mm increments. In this case, the predicted flood depth is less than 100mm and therefore, only one increment is required to be considered.

Consequently, to offset the volume displaced, it is recommended that an area within the rear garden is lowered. By lowering the area shown below in orange (approximately 74m²) to a level of 1.65m AODN (i.e. 100mm below the flood level), it will be possible to provide 7.4m³ of compensatory floodplain storage.

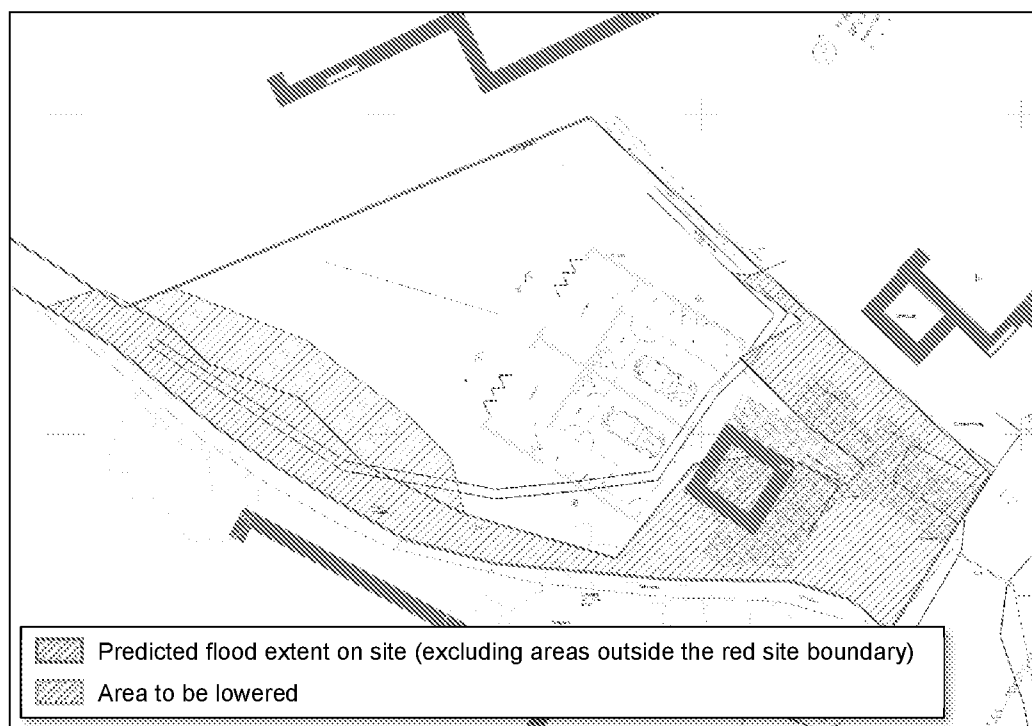


Figure 6.1 – Showing the predicted extent of flooding and area to be lowered to offset the volume displaced.

It is evident from Figure 6.1 that there is sufficient space on site to offset the volume of floodwater displaced, in accordance with the EA's requirements. Consequently, it is concluded that the proposed development will not increase the risk of flooding elsewhere.

6.2 Public Safety and Access

The NPPF states that safe access and escape should be available to/from new developments located within areas at risk of flooding. The Practice Guide goes on to state that access routes should enable occupants to safely access and exit their dwellings during design flood conditions and that vehicular access should be available to allow the emergency services to safely reach the development.

During a fluvial flood event, the ground floor has been shown to remain unaffected by flooding. Consequently, residents will have safe access to/from the development during the entire flood event. Even in the unlikely event that floodwater was to exceed the crest height of the driveway (i.e. due to an exceedance event or bow waves from moving vehicles), the ground floor can only flood up to a depth of 150mm where the residents would access the first floor and therefore, safe access will be possible.

Under a tidal flood event, the entire site is shown to flood and depths are predicted to reach a maximum of 1.9m at the buildings. As such, dry and safe access will not be available. Reference to the Practice Guide shows that in circumstances where it is not possible to provide dry access, the flood hazard to people under the design flood conditions needs to be quantified. In this instance,

no data has been provided by the EA with regard to the hazard rating on site. However, given the extent of the surrounding area which would also be affected during such an event, it is considered unlikely that residents will be able to leave the dwellings during the peak of the flood event. It will be necessary for the occupants to sign up to the EA's Early Flood Warning System (refer to Section 7.4 below), which will enable residents to receive forewarning of a potential flood event and be prepared to evacuate the site *before* an extreme flood occurs.

If insufficient time is available to evacuate, residents should seek safe refuge within their dwellings. Inspection of the scheme drawings shows that only non-habitable use is specified for the ground floor and all living and sleeping accommodation will be located on the first floor and above. This approach to raising the more vulnerable elements of the development will provide the occupants with a means of safe refuge in the extremely unlikely event of a flood.

6.3 Proximity to Watercourse

Inspection of OS mapping shows that there is a drainage ditch to the south of the development. To clarify the ownership of this ditch, both the Lead Local Flood Authority (LLFA) and Local Planning Authority (LPA) have been contacted. The LPA has confirmed that the drainage ditch is managed by the Internal Drainage Board (IDB), which is currently formed by the EA in this location. However, it should be recognised that this responsibility is in the progress of being dissolved.

Referencing the information provided, both the EA and Arun District IDB have been contacted regarding the proximity of the proposed buildings to the watercourse. From this correspondence it has been confirmed that the current scheme layout would be acceptable with regard to the distance to the adjacent drainage ditch. In addition, it has been stated that in this instance, the maintenance of the ditch will be the responsibility of the riparian owner.

Notwithstanding this, the EA has confirmed that a Flood Risk Activity Permit is required for construction within 3 to 5 metres of the ditch.

7 Flood Mitigation Measures

The key objectives of flood risk mitigation are:

- to reduce the risk of the development being flooded.
- to ensure continued operation and safety during flood events.
- to ensure that the flood risk downstream of the site is not increased by increased runoff.
- to ensure that the development does not have an adverse impact on flood risk elsewhere.

The following section of this report examines ways in which the risk of flooding at the development site can be mitigated.

Mitigation Measure	Appropriate	Comment
Careful location of development within site boundaries (i.e., Sequential Approach)	✓	Refer to Section 7.1
Raising floor levels	✓	Refer to Section 7.2
Land raising	X	Not required
Compensatory floodplain storage	X	Refer to Section 6.1
Flood resistance & resilience	✓	Refer to Section 7.3
Alterations/ improvements to channels and hydraulic structures	X	Not required
Flood defences	X	Not required
Flood warning	✓	Refer to Section 7.4
Surface water management	✓	Refer to Section 8.

Table 7.1 – Appropriateness of mitigation measures.

7.1 Application of the Sequential Approach at a Local Scale

The sequential approach to flood risk management can also be adopted on a site based scale and this can often be the most effective form of mitigation. For example, on a large scheme this would mean locating the more vulnerable dwellings on the higher parts of the site and placing parking, recreational land or commercial buildings in the lower lying and higher risk areas.

For the development that is subject of this FRA, it can be seen that this approach has been adopted. The ground floor only comprises non-habitable uses, whilst all living and sleeping accommodation have been located on the first floor and above.

7.2 Raising Floor Levels

Within the response previously provided as part of the re-submitted planning application, the EA has stated that they require all sleeping accommodation to be a minimum of 300mm above the design flood level, i.e. the 1 in 200 year return period including an allowance for climate change up to the future year 2125.

In this case, the maximum predicted flood level is 3.77m AODN (i.e. Upper End scenario for the future year 2125). Inspection of the scheme drawings shows that all living and sleeping accommodation will be situated on the first floor and above, at a minimum level of 4.1m AODN. This is 330mm above the maximum predicted flood level and therefore, is in accordance with the EA's requirements.

7.3 Flood Resistance and Resilience

During a flood event, floodwater can find its way into properties through a variety of routes including:

- Ingress around closed doorways.
- Ingress through airbricks and up through the ground floor.
- Backflow through overloaded sewers discharging inside the property through ground floor toilets and sinks.
- Seepage through the external walls.
- Seepage through the ground and up through the ground floor.
- Ingress around cable services through external walls.

Since flood management measures only manage the risk of flooding rather than eliminate it completely, flood resilience and resistance measures may need to be incorporated into the design of the buildings. The two possible alternatives are:

Flood Resistance or 'dry proofing', where flood water is prevented from entering the building. For example, using flood barriers across doorways and airbricks, or raising floor levels. These

measures are considered appropriate for 'more vulnerable' development where recovery from internal flooding is not considered to be practical.

Flood Resilience or 'wet proofing', accepts that flood water will enter the building and allows for this situation through careful internal design for example raising electrical sockets and fitting tiled floors. The finishes and services are such that the building can quickly be returned to use after the flood. Such measures are generally only considered appropriate for some 'less vulnerable' uses and where the use of an existing building is to be changed and it can be demonstrated that no other measure is practicable.

It has been demonstrated that the ground floor level of the existing development is at risk of flooding, to an estimated depth of 1.9m at the buildings during a tidal flood event. Therefore, it is recommended that flood resilient measures are incorporated into the design of the ground floor to minimise the impact of such an event. These measures could comprise the use of;

- Solid concrete floors
- No stud walls
- Bringing the electrical supply in at first floor
- Placing boilers and meter cupboards on the first floor
- Water-resistant plaster/tiles on the walls of the ground floor

Details of flood resilience and flood resistance construction techniques can be found in the document 'Improving the Flood Performance of New Buildings; Flood Resilient Construction', which can be downloaded from the Communities and Local Government website.

A Code of Practice (CoP) for Property Flood Resilience (PFR) has been put in place to provide a standardised approach for the delivery and management of PFR. Further information on the CoP and guidance on how to make a property more flood resilient can be accessed, and downloaded, from the Construction Industry Research and Information Association (CIRIA) Website:

https://www.ciria.org/Resources/Free_publications/CoP_for_PFR_resource.aspx

7.4 Flood Warning

The EA operate a flood forecasting and warning service in areas at risk of flooding from rivers or the sea, which relies on direct measurements of rainfall, river levels, tide levels, in-house predictive models, rainfall radar data and information from the Met Office. This service operates 24 hours a day, 365 days a year.

The primary risk of flooding to the site is from tidal sources associated with a tidal surge in the North Sea. Such an event is dependent on meteorological conditions that can be monitored reliably and therefore it is likely that a minimum of 12 hours warning could be given. This forewarning should be

sufficient to allow the users of the site to prepare the buildings for a flood event and to evacuate the site themselves.

Whilst the probability of an event of sufficient magnitude to cause floodwaters to reach the levels discussed in this report is very low, the risk of such an occurrence is always present. With the sophisticated techniques now employed by the EA to predict the onset of flood events the opportunity now exists for all residents within the flood risk area to receive early flood warnings.
[edit for breach event]

This forewarning could be sufficient to either allow residents to evacuate the area or prepare themselves and their property for a flood event. It is therefore recommended that the occupants of the site sign up to the EA's Flood Warning Service either by calling 0345 988 1188, or by visiting;

www.gov.uk/sign-up-for-flood-warnings

The flood warning service could also be used in combination with a robust Flood Warning and Evacuation plan (FEP) for the site. An FEP could be issued to each of the residents and would need to be reviewed on an annual basis.

A Flood Warning and Evacuation Plan:

- identifies areas of the site that are above the predicted flood level and will therefore be used as a safe haven until floodwaters recede.
- contains detailed site plans that identify emergency access routes through the site.
- provides information to residents on flood warning procedures.
- includes emergency contact numbers and other site-specific information that will enable residents to manage the impacts of flood event.

8 Surface Water Management Strategy

8.1 Background and Policy

The general requirement for all new development is to ensure that the runoff from the development is managed sustainably and that the drainage solution does not increase the risk of flooding at the site, or within the surrounding area. In the case of brownfield sites, drainage proposals are typically measured against the existing performance of the site, although it is preferable (where practicable) to provide runoff characteristics that are similar to greenfield behaviour.

The Non-statutory Technical Standards for SuDS (NTSS) specify criteria to ensure sustainable drainage is included within development classified as 'major development' as set out in Article 2(1) of the Town and Country Planning (Development Management Procedure) (England) Order 2015. It is, however, recognised that SuDS should be designed to ensure that the maintenance and operation requirements are economically proportionate.

In this instance, the proposed development is for the construction of two dwellings on land totalling 0.1ha. The development is classified as 'minor development' and therefore, the NTSS will not apply. Nevertheless, the NTSS has been reference when preparing the following sections of this report to ensure that the principles of sustainable drainage are still considered.

8.2 Surface Water Management Overview

The main characteristics of the site that have the potential to influence surface water drainage are summarised in Table 8.1.

Site Characteristic	Value
Total area of site	0.1 ha
Impermeable area (existing)	72 m ²
Impermeable area (proposed)	Roof area = 178 m ² Hardstanding = 150 m ² Total = 328 m²
Current site condition	Brownfield
Greenfield runoff rates (based on the ICP SuDS methodology)	QBar = 2.1 l/s/ha Q30 = 4.7 l/s/ha Q100 = 6.5 l/s/ha
Infiltration coefficient	~0.01 m/hr (assumed based on underlying geology and typical soil conditions)
Current surface water discharge method	Unknown
Is there a watercourse within close proximity to site?	Yes

Table 8.1 – Site characteristics affecting rainfall runoff.

Synthetic rainfall data has been derived using the variables obtained from the Flood Studies Report (FSR) and the routines within the Causeway Flow+ software. The water flows generated on site for the existing and post-development conditions have been calculated by using the Modified Rational Method.

Runoff rates have been calculated for a range of annual return probabilities including the 100 year return period event with a 40% increase in rainfall intensity to account for future climatic changes. These values are summarised in Table 8.2 for a range of return periods.

Return Period (years)	Peak Runoff (l/s)	
	Existing Site	Developed Site
1	1.6	7.7
30	4.0	19
100	5.3	24.8
100 + 40%	-	34.7

Table 8.2 – Summary of peak runoff.

The total volume of water discharged from the site for the 100 year 6 hour event is also summarised in Table 8.3 below, for both the existing and proposed site conditions.

Site Condition	Total Volume Discharged
Existing site (present day)	5 m ³
Proposed development, including a 40% increase in rainfall intensity to account for climate change (prior to any mitigation)	33.2 m ³
Difference in volume between existing site (present day) and proposed development (including allowance for climate change)	28.2m ³

Table 8.3 – Total volume discharged from the 100 yr+40%cc 6-hour event.

Reference to the tables above shows the proposed development will increase the percentage of impermeable area within the boundaries of the site and consequently, this will increase the rate and volume of surface water runoff discharged from the site. However, the development subject to this report is classified as 'minor development' and as such, it is not strictly necessary to reduce the rate of runoff from the site in accordance with the NTSS. Nevertheless, the potential use of SuDS within the proposed development will be considered to assess the opportunity to replicate pre-developed runoff behaviour and provide a betterment if feasible.

8.3 Opportunities to Discharge Surface Water Runoff

Part H of the Building Regulations summarises a hierarchy of options for discharging surface water runoff from developments. The preferred option is to **infiltrate** water into the ground, as this deals with the water at source and serves to replenish groundwater. If this option is not viable, the next option of preference is for the runoff to be discharged into a **watercourse**. Only if neither of these options are possible, the water should be discharged into the **public sewer** system.

Water re-use - Water re-use systems can rarely manage 100% of the surface water runoff discharged from a development, as this requires the yield from the building and hardstanding area to balance perfectly with the demand from the proposed development. Consequently, whilst rainwater recycling systems will be considered for inclusion within the scheme, an alternative solution for attenuating storm water will still be required.

Infiltration – Site-specific ground investigations have not been carried out at this stage in the development process. However, the geology in this area is Spetisbury Chalk Member overlain by Raised Marine Deposits. The superficial deposits within the area suggest some potential for infiltration, however, the close proximity to the adjacent watercourse and Defra ground water maps indicates the area is susceptible to ground water flooding.

Given the high groundwater, and with the absence of ground investigations, infiltration is considered to be an unsuitable option for draining this site.

Discharge to Watercourses – There is an existing drainage ditch adjacent to the southern site boundary. OS mapping for the area surrounding the site has been inspected and it is concluded that this ditch is likely to drain to the wider catchment of the River Arun. Due to the proximity of this ditch to the site, it is likely a direct connection will be possible and therefore, will present the most sustainable solution for draining surface water runoff from the proposed development.

Discharge to Public Sewer System – Southern Water has been contacted with regard to the location of the sewer network and inspection of the data provided shows that the site is not in close proximity to any existing sewer connections. In addition, the only sewers in this area are designated for foul effluent only. Whilst there is sometimes the option to drain surface water runoff to the public foul sewer system, given a more sustainable solution is available, it is highly unlikely Southern Water will permit any surface water runoff to be discharged to the existing public sewer system. Consequently, this option has been discounted.

8.4 Sustainable Drainage Systems (SuDS)

Appropriately designed SuDS can be utilised such that they not only attenuate runoff but also provide a level of improvement to the quality of the water passed on to watercourses or into the groundwater table. This is known as source control and is a fundamental part of the SuDS philosophy.

A range of typical SuDS that can be used to improve the environmental impact of a development is listed in Table 8.4 below along with the relative benefits of each feature and the appropriateness for the subject site.

SuDS	Description	Constraints/Comments	Appropriate for Site?
Rainwater Harvesting Systems	Collection of rainwater and storage for reuse on site	There are no known constraints.	Yes
Green/Blue Roofs	Provide landscaping and planting at roof level to reduce surface water runoff rates	Proposed roof design unsuitable.	No
Infiltration Systems	Allow water to percolate into the ground at a controlled rate via natural infiltration	Potentially high groundwater and for localised silt deposits.	No
Filter Strips	Wide, gently sloping, densely planted areas promoting sedimentation and filtration	Insufficient space.	No
Filter Drains	Trenches infilled with stone/gravel providing attenuation, sedimentation and filtration	Insufficient space.	No
Swales	Broad, shallow channels that convey and store runoff, and allow infiltration	Topography	No
Bioretention Systems / Rain Gardens	A shallow landscaped depression allowing runoff to pond temporarily on the surface	There are no known constraints.	Yes
Permeable Pavements	Runoff is allowed to soak into structural paving and stored, potentially being allowed to infiltrate	Potentially high groundwater. There are no other known constraints.	Yes
Underground Storage	Below ground storage which can be used to temporarily store storm water	There are no known constraints.	Yes
Detention Basins	A landscaped depression for attenuation with a restricted runoff	Insufficient space.	No
Ponds and Wetlands	A permanent pool of water which can be used for attenuation and controlled outflows by water levels	Insufficient space.	No

Table 8.4 – An assessment into the suitability of SuDS at this site.

From Table 8.4 it can be seen that there are a number of SuDS which could potentially be suitable for use at this site. Arun District Council promotes the use of open (at source) SuDS, however, due to the location of the site in relation to the floodplain and the potential risk of flooding to the surrounding area, it is considered unlikely that this option can be achieved. The use of attenuation storage has been considered, which could be provided by installing a crate system within the rear gardens of the proposed development. Nevertheless, given the topography in this area it might not be possible to achieve the required invert levels to the adjacent drainage ditch.

Therefore, at this stage in the planning process it is envisaged that permeable paving will be used to discharge the surface water runoff at an attenuated rate into the adjacent drainage ditch.

8.5 Proposed Surface Water Management Strategy (SWMS)

The drainage strategy set out below discusses each of the different elements of the proposed scheme, along with the results of a hydraulic drainage model that has been constructed to demonstrate how the overall objectives can be achieved. This does not represent a detailed surface water drainage design; it is simply an assessment to demonstrate that the objectives and requirements of the NPPF can be met at the planning stage.

To ensure the risk of flooding is not increased by the development proposals it will be necessary to restrict the discharge of surface water runoff from the entire site under the design rainfall event.

Arun District Council requires the discharge of surface water runoff to a watercourse to be restricted to greenfield runoff rates, or where this is not feasible, runoff rates should be restricted to the existing pre-developed rates. Due to the size of the site, greenfield runoff rates are less than 0.2l/s and it is therefore deemed unfeasible to achieve greenfield runoff rates for this site. Instead, given that the existing site is defined as a brownfield site, ideally the proposed development should not increase the rate of surface water runoff from the site and where possible, provide a betterment. A minimum discharge rate of 2l/s is suggested to avoid any blockages and to provide the attenuation required for the 1 in 100 year event, including a 40% allowance for climate change as required by the EA.

Storage Parameter	Value
Return period	100 years
Climate change	40%
Impermeable area	0.033 ha
Peak discharge	2 l/s
Infiltration coefficient	0.0 m/hr
Maximum required storage	23 m ³

Table 8.5 – Summary of Causeway Flow+ software storage estimate.

Based on the above, a storage estimation tool using the Causeway Flow+ software has been used and a summary of the analysis is shown in Table 8.5 below.

Although the soil may have some level of percolation, the development site lies within an area susceptible to high groundwater. Consequently, in the absence of any infiltration testing, a conservative approach has been considered when designing the storage underneath the permeable paving and the infiltration coefficient has been set to zero. Notwithstanding this, it should

be recognised that if infiltration is considered achievable, the proposed system could be used for infiltration SuDS only instead of discharging into the adjacent drainage ditch.

The analysis has shown that a storage volume of 23m³ will be required when considering the 1 in 100 year event with a 40% increase in rainfall intensity. Based on this, the surface water runoff from the entire impermeable area can be discharged to permeable surfacing located across the driveways located at the front of the proposed development. The permeable paving will be underlain by a minimum 600mm deep open graded sub-base, used to store the water before it is discharged at a restricted rate into the adjacent drainage ditch. A summary of the derived parameters is shown in Table 8.6 below.

Parameter	Value
SuDS Feature	Permeable paving
Area draining to permeable paving	330 m ²
Area of permeable paving	120 m ²
Sub-base depth	600mm
Assumed infiltration	None
Flow control device	Orifice
Limited discharge rate	2.0l/s

Table 8.6 – Summary of SuDS parameters for the permeable paving (100 yr+40%cc).

Figure 8.2 below is an indicative drainage layout plan delineating how the proposed SuDS can be incorporated into the scheme proposals.

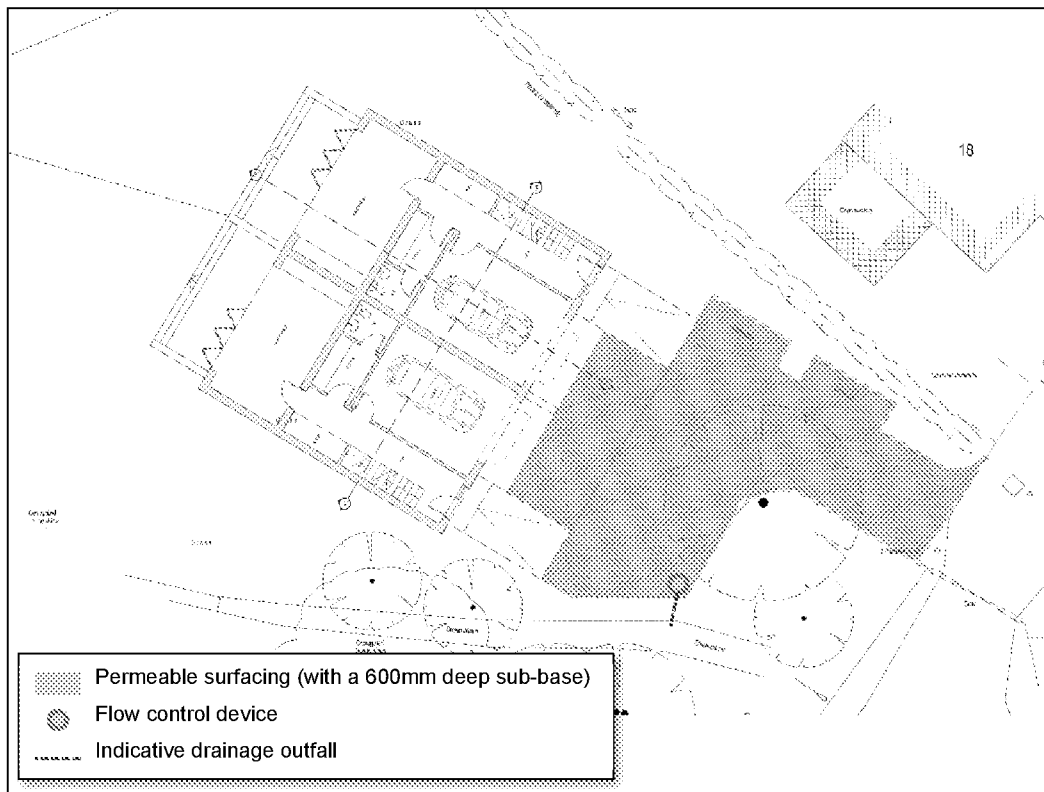


Figure 8.2 – Indicative drainage layout plan showing the proposed location of SuDS.

From the information above, it is evident that with the inclusion of permeable surfacing, there is potential to accommodate the surface water runoff from the impermeable areas up to, and including, the design rainfall event. In addition, it has been shown that the runoff rates from the proposed development can be attenuated to that of the existing site. When considering the pre-development conditions, the introduction of SuDS provides a significant betterment to surface runoff conditions, and therefore reduces the risk of flooding at the development site and surrounding area.

8.6 Sensitivity Testing and Residual Risk

It is necessary to ensure that the drainage proposals will not increase the risk of flooding if the drainage system becomes blocked, or if a rainfall event which exceeds the design rainfall event occurs.

In this case, the drainage system has been designed for a 1 in 100 year rainfall event including a 40% allowance for climate change and therefore, meets policy requirements. Notwithstanding this, there is the potential for the drainage system to become blocked, or a larger rainfall event to occur. Inspection of the site-specific topographic survey and aerial height data shows that if the permeable surfacing was to become blocked or overwhelmed following an extreme rainfall event, the sub-base of the permeable paving system will become full. Subsequently water would exit the drainage system through the surface paving and flow in a south-easterly direction towards the adjacent drainage ditch. Given the additional volume of storage provided by the proposed SuDS, it is evident

that the volume of water flowing offsite during an exceedance event will be significantly reduced when compared to the current pre-developed condition.

It is recognised that the site could be affected by flooding under a fluvial and tidal flood event. With regard to the fluvial flood event, the driveway will be elevated above the predicted design flood level and therefore, the risk is limited to the outfall becoming blocked. Further analysis has shown that if the outfall was to become blocked, the proposed drainage system would have sufficient capacity to retain rainwater from a storm event which lasts over 4 days. As such, it is anticipated that sufficient storage is available within the system to prevent an increase to the risk of flooding offsite following a fluvial flood event.

During a tidal flood event, the entire site is shown to flood and therefore, the entire drainage system would be inundated with floodwater. As a result, any rainwater would be discharged into the surrounding area at an unattenuated rate. Nevertheless, as highlighted in Section 6.1, any water displaced as a result of tidal flooding does not typically need to be compensated for. As such, it is concluded that the runoff from the proposals will not significantly contribute to the wider risk of flooding under the tidal design event and the proposed drainage system outlined within this strategy will not result in an increased risk of flooding to properties at the site or within the surrounding area.

8.7 Management and Maintenance

For any surface water drainage system to operate as originally designed, it is necessary to ensure that it is adequately maintained throughout its lifetime.

The key requirements of any management regime are routine inspection and maintenance, when the development is taken forward to the detailed design stage an 'owner's manual' will need to be prepared. This should include:

- A description of the drainage scheme,
- A location plan showing all of the SuDS features and equipment such as flow control devices etc.
- Maintenance requirements for each element, including any manufacturer specific requirements
- An explanation of the consequences of not carrying out the specified maintenance
- Details of who will be responsible for the ongoing maintenance of the drainage system.

For the SuDS features recommended by this assessment, the most obvious maintenance tasks will be the cleaning of the permeable paving and the de-silting and inspection of the flow control device.

For developments such as this that rely to some extent on the ongoing inspection and maintenance of SuDS, it will be necessary to ensure that measures are in place to maintain the system for the lifetime of the development. In this case, it is considered likely that the individual residents will be

tasked with the maintenance of the SuDS. However, it is recognised that measures will need to be put in place to ensure occupants are made aware of the maintenance schedules.

9 Conclusions

The overarching objective of this report is to appraise the risk of flooding at Queens Lane, Arundel, to ensure that the proposals for development are acceptable and that any risk of flooding to the occupants of the proposed residential units is appropriately mitigated. In addition, the NPPF also requires the risk of flooding offsite to be managed, to prevent any increase in flood risk as a result of the development proposals. This report has therefore been prepared to appraise the risk of flooding from all sources and to provide a sustainable solution for managing the surface water runoff discharged from the development site, in accordance with the National and local planning policy.

Planning permission was previously granted for an identical scheme in December 2018. However, permission has since expired and a new application has therefore been submitted. As part of the new application, a Sequential Test has been undertaken (by others) and the results show that the site can meet the requirements of the Sequential Test.

In addition to the Sequential Test, it is also necessary to consider the type of development and whether the Exception Test is applicable. From Table 2.3, it can be seen that the proposed development is situated within a Flood Zone 3 and is a development type that is classified as being 'more vulnerable'. Consequently, it has been necessary to apply the Exception Test to determine whether suitable and appropriate mitigation can be incorporated into the design of the scheme to ensure that it is sustainable in terms of flood risk.

The risk of flooding has been re-appraised for a wide range of sources, and it is only the risk of flooding from the River Arun (fluvial and tidal) that is shown to have an impact on the development.

When the fluvial risk of flooding is considered in more detail, it has been shown that under an extreme fluvial flood event with a 1 in 100 year return period (including a 25% increase in peak river flow), the proposed dwellings are located outside of the fluvial flood extents. Whilst the ground floor has been lowered due to ridge height restrictions, it has been shown that floodwater would be prevented from entering the building by the raised land levels along the crest of the driveway. It is therefore only in the unlikely event that the water level was to exceed 1.82m AODN that the ground floor could be subject to shallow flooding, with flood depths predicted to range between 150mm to 300mm. In recognition of this, the ground floor will comprise non-habitable uses, and is proposed to include flood resistance and resilience measures in order to limit the impact of such an event (i.e. exceedance or bow waves from vehicles).

To ensure that the land raising does not compromise the storage of the flood compartment, it is proposed to lower land within the rear garden, adjacent to the drainage ditch. This will ensure that the proposals will not increase the risk elsewhere as a result of floodwater being displaced by the development.

With respect to the tidal risk of flooding, it has been demonstrated that the development is currently protected under a tidal flood event with a 1 in 200 year return period. It is only when an allowance for climate change is considered (i.e. future year 2110), that the development site is shown to be affected by flooding, with flood depths predicted to reach a maximum of 1.9m at the proposed buildings. Consequently, safe access/egress to/from the site will not be achievable during the peak of a flood event. As such, it is recommended that residents sign up to the EA's Early Flood Warning to enable the site to be evacuated before floodwater reaches the development.

If insufficient time is available, the residents of the building will be able to seek safe refuge within their houses. The proposed development has been designed to only accommodate non-habitable use on the ground floor with all living and sleeping accommodation shown to be located on the first floor and above, and therefore, located well above the predicted flood level. Consequently, safe refuge will be available throughout the duration of the flood event.

In addition to appraising the risk of flooding to the development, it is also necessary to consider the impact that the proposed development could have on the surrounding area with regard to surface water runoff. The surface water drainage strategy that has been identified at this early stage shows that the objective of reducing peak discharge rates to ~2.0l/s can be achieved through the use of permeable surfacing, in conjunction with a flow control device. When considering the pre-development conditions, the introduction of SuDS provides a significant betterment to surface water runoff conditions, and therefore reduces the risk of surface water flooding at both the development site and within the surrounding area.

In conclusion, following the recommendations of this report, the occupants of the development will be safe and the development will not increase the risk of flooding elsewhere. Consequently, it has been demonstrated that the development can pass the second element of the Exception Test and will therefore meet the requirements of the NPPF.

10 Recommendations

The findings of this report conclude that the development will not increase the risk of flooding at the site, or elsewhere. However, in order to achieve this a number of recommendations are listed below. These comprise the following.

- The finished floor level for all living and sleeping accommodation shall be set at least 300mm above the design flood level, at a minimum of 4.07m AODN. Inspection of the scheme drawings shows that this has been achieved.
- The flood resilience measures outlined in Section 7.3 of this report are to be incorporated into the design of the building where possible.
- The residents of the proposed dwellings should sign up to the EA's floodline warnings. The flood warnings provide residents with the opportunity to prepare the buildings and evacuate in the unlikely event that an exceedance event should occur.
- The surface water management strategy for the development will need to be developed to a detailed design stage and this will need to take into account the requirements set out in Section 8.
- It will be necessary to undertake site-specific investigations at the detailed design stage in order to quantify the available infiltration, the groundwater level and any contamination that may be present in the soils.

With the above mitigation measures incorporated into the design of the development the proposals will meet the requirements of the NPPF and its Planning Practice Guidance and will therefore be acceptable and sustainable in terms of flood risk.

11 Appendices

Appendix A.1 – Drawings

Appendix A.2 – Environment Agency Flood Report and Correspondence

Appendix A.3 – Southern Water Asset Location Data

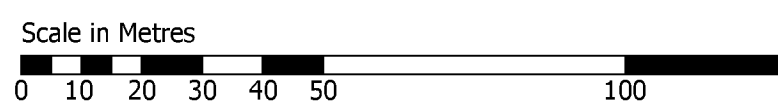
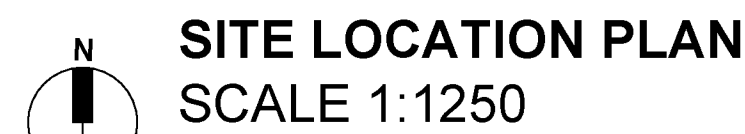
Appendix A.4 – Surface Water Management Calculations

Appendix A.5 – Maintenance Schedules

Appendix A.1 – Drawings

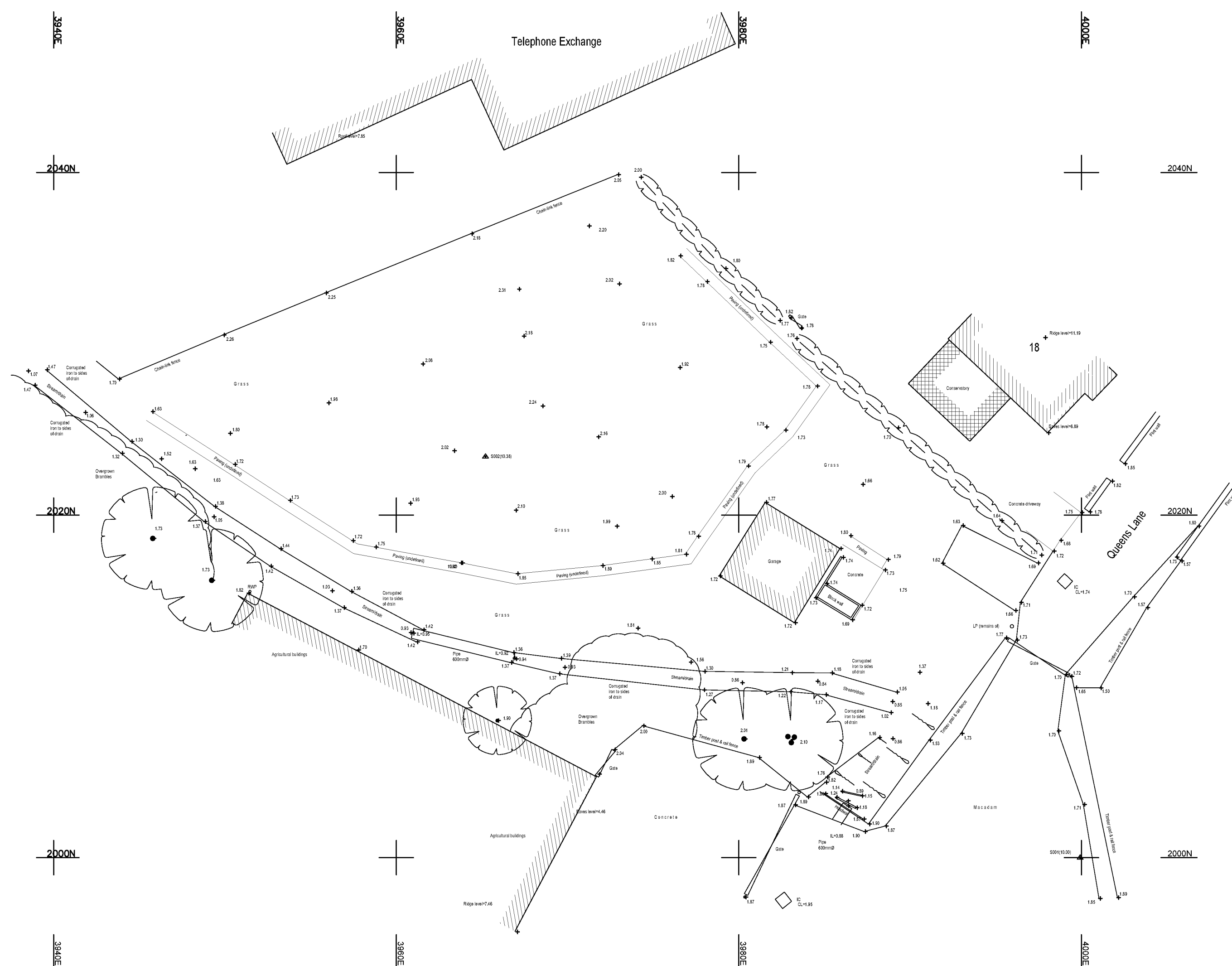
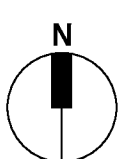
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===== ANGMERING PARK ESTATE

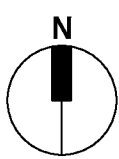


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EXISTING SITE PLAN
SCALE 1:500



TOPOGRAPHICAL SURVEY
SCALE 1:200



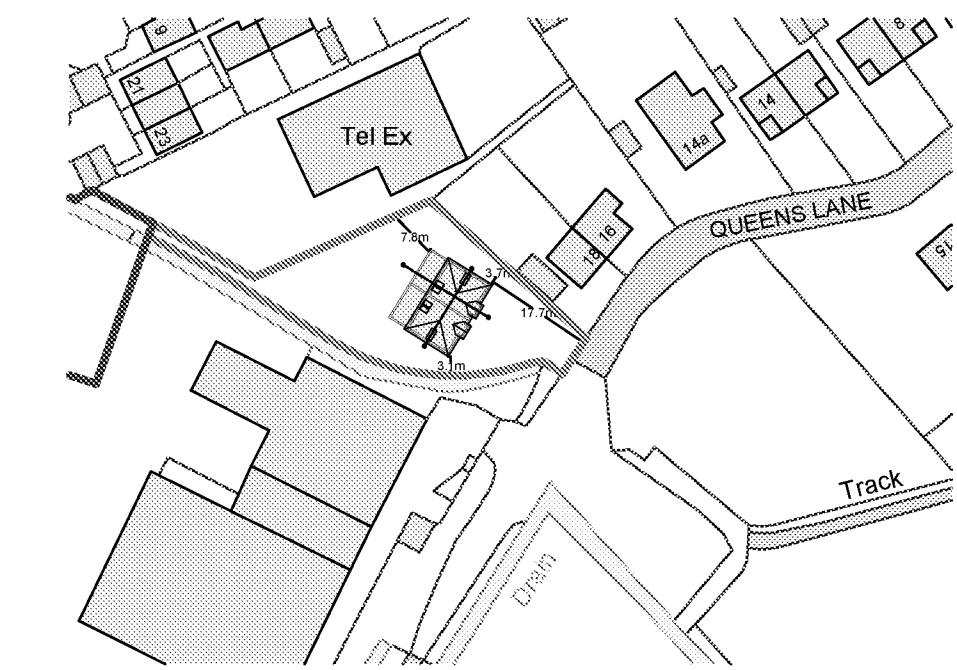
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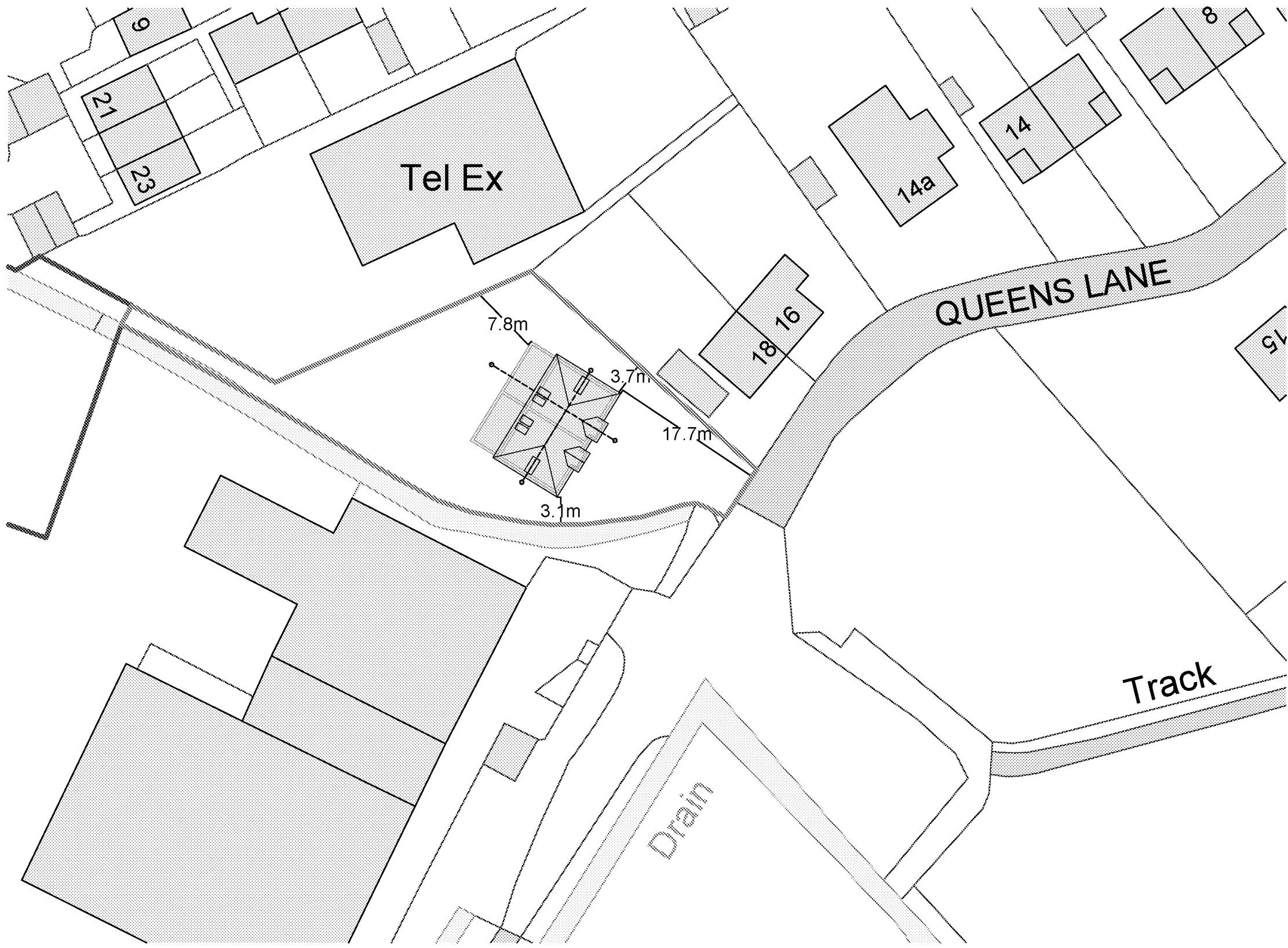
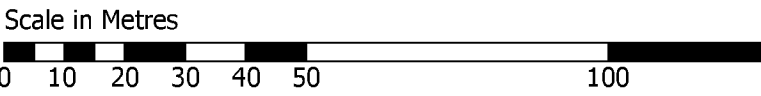
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Client Angmering Park Farms LLP			
Project Queens Lane Arundel BN18 9JN			
Drawing Title Site Plan Existing			
Scale 1:200 @ A1	Date 28/02/18	Drawn ES	Checked AB
Drawing Number 001		Rev.	Project Number PWDJ140372

KEY

- SITE BOUNDARY
- ANGMERING PARK ESTATE

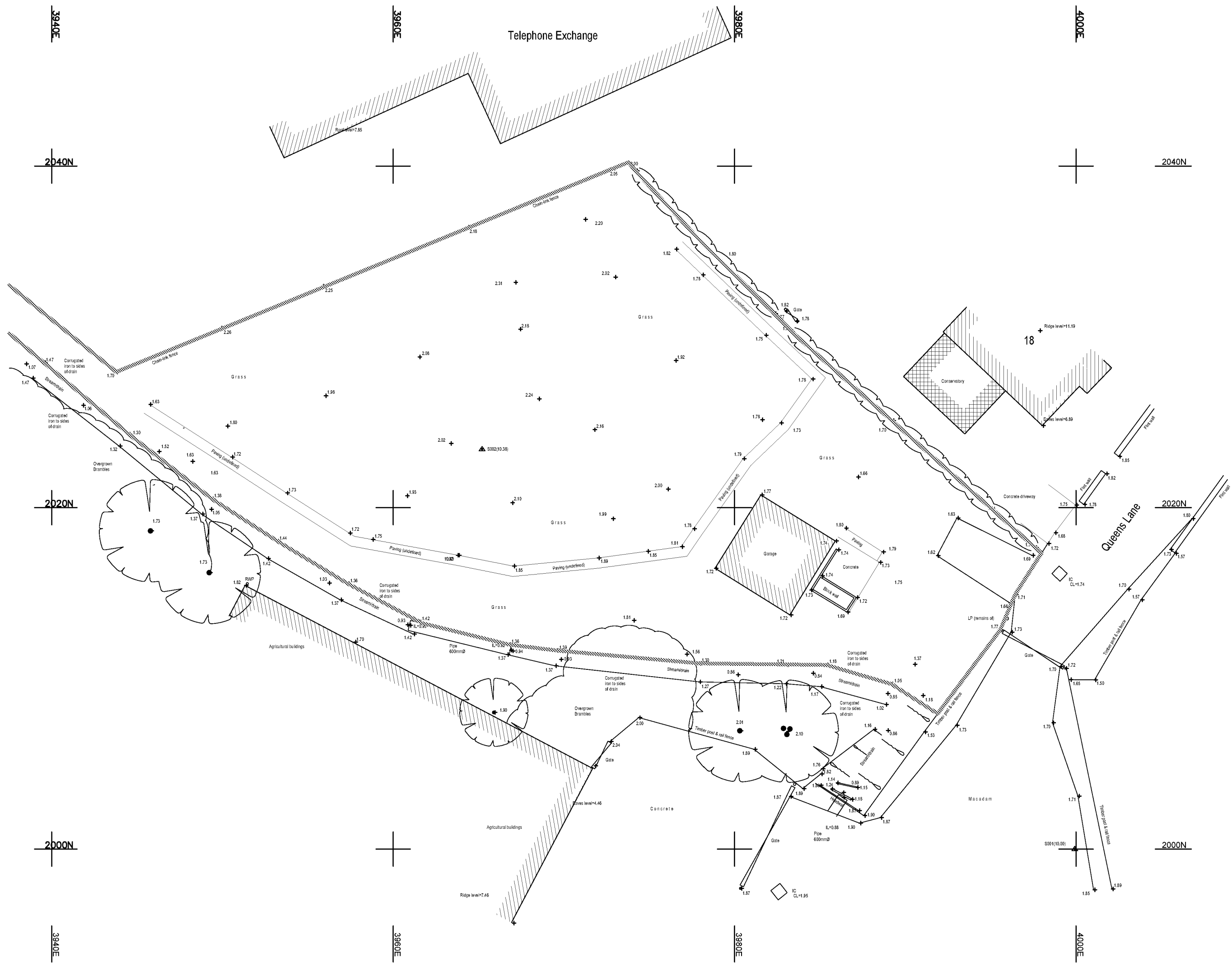


PROPOSED SITE LOCATION PLAN
SCALE 1:1250



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PROPOSED BLOCK PLAN
SCALE 1:500



TOPOGRAPHICAL SURVEY
SCALE 1:200



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A Site boundary added to topo survey A 25.07.18

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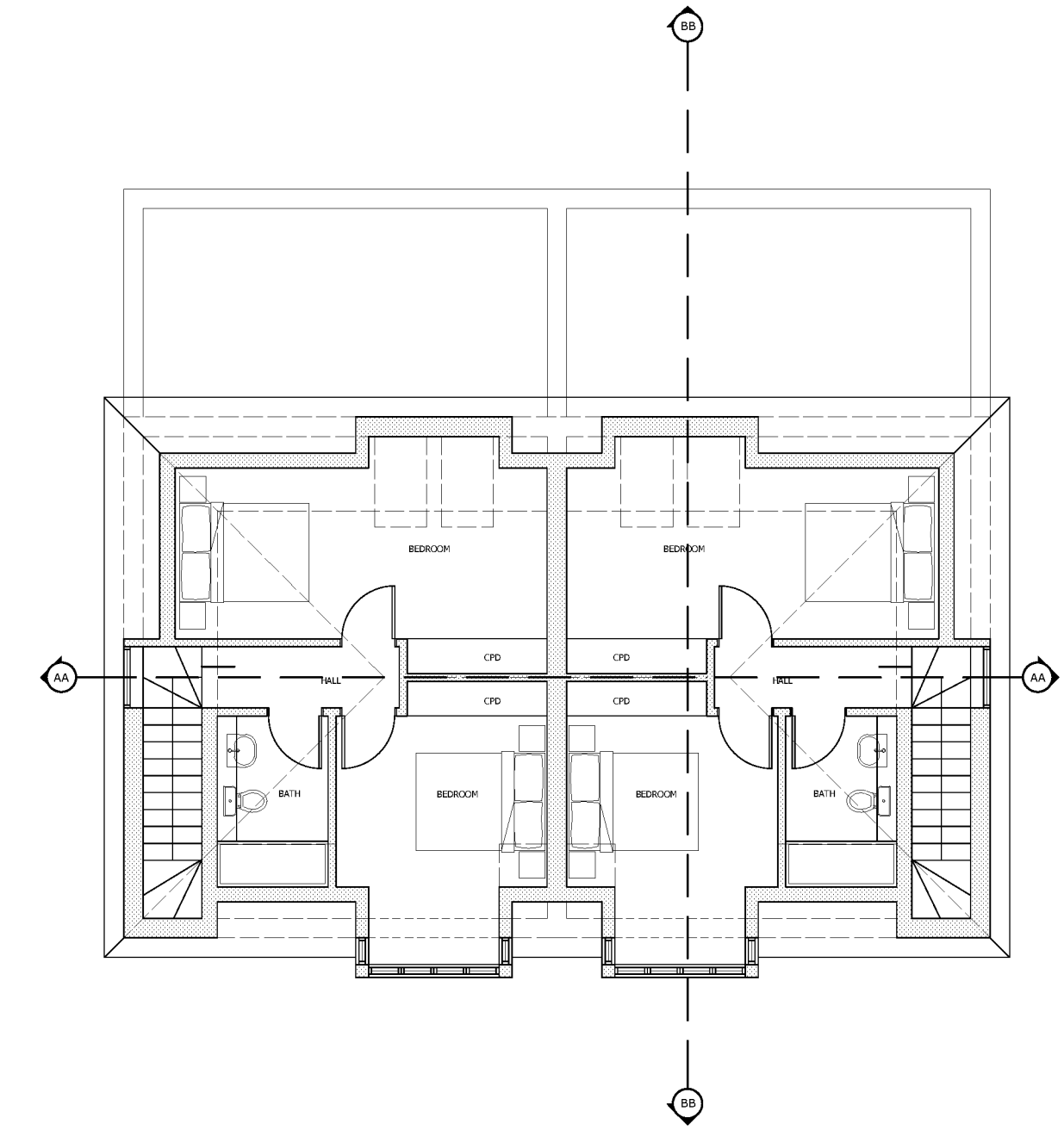
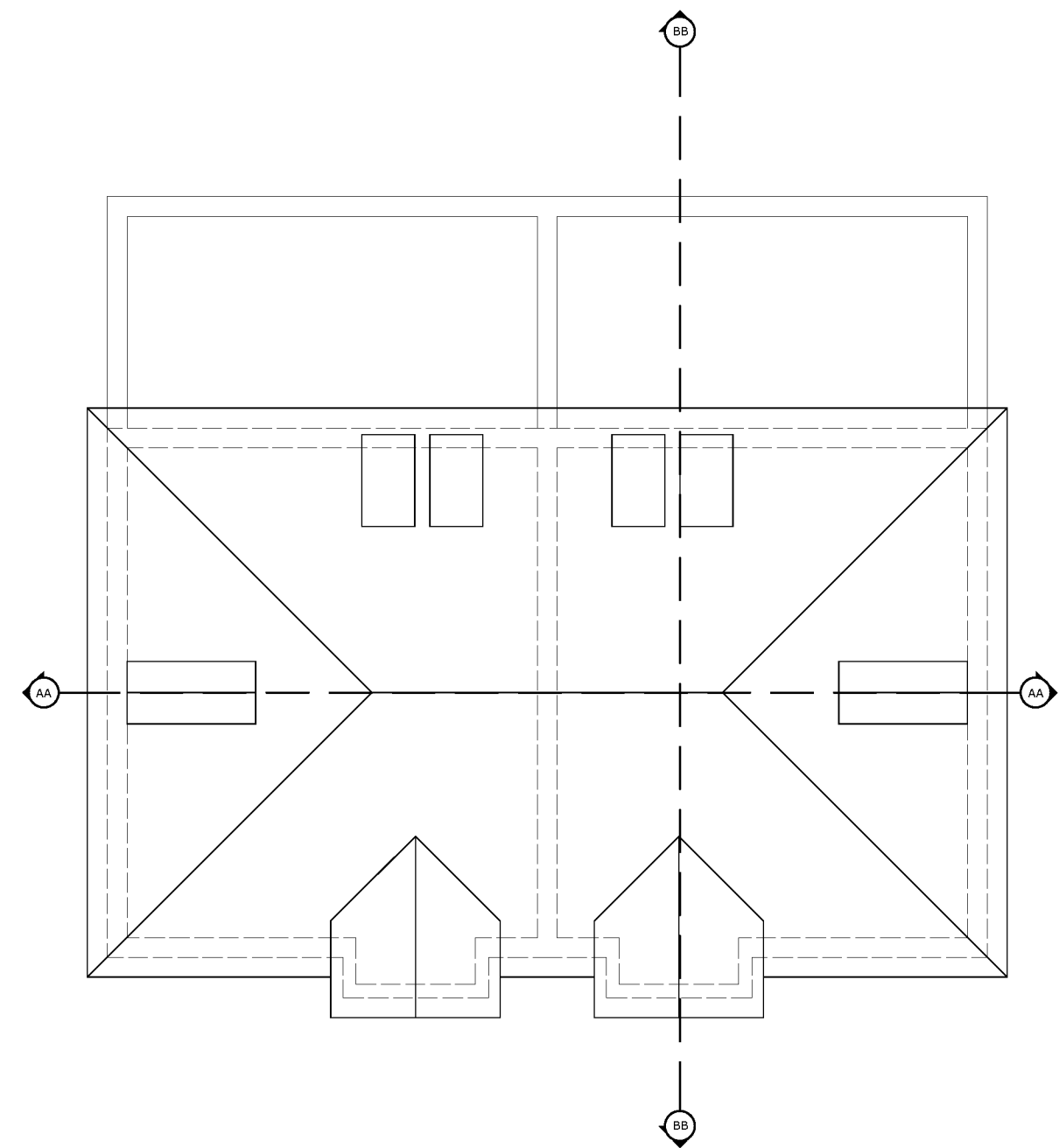
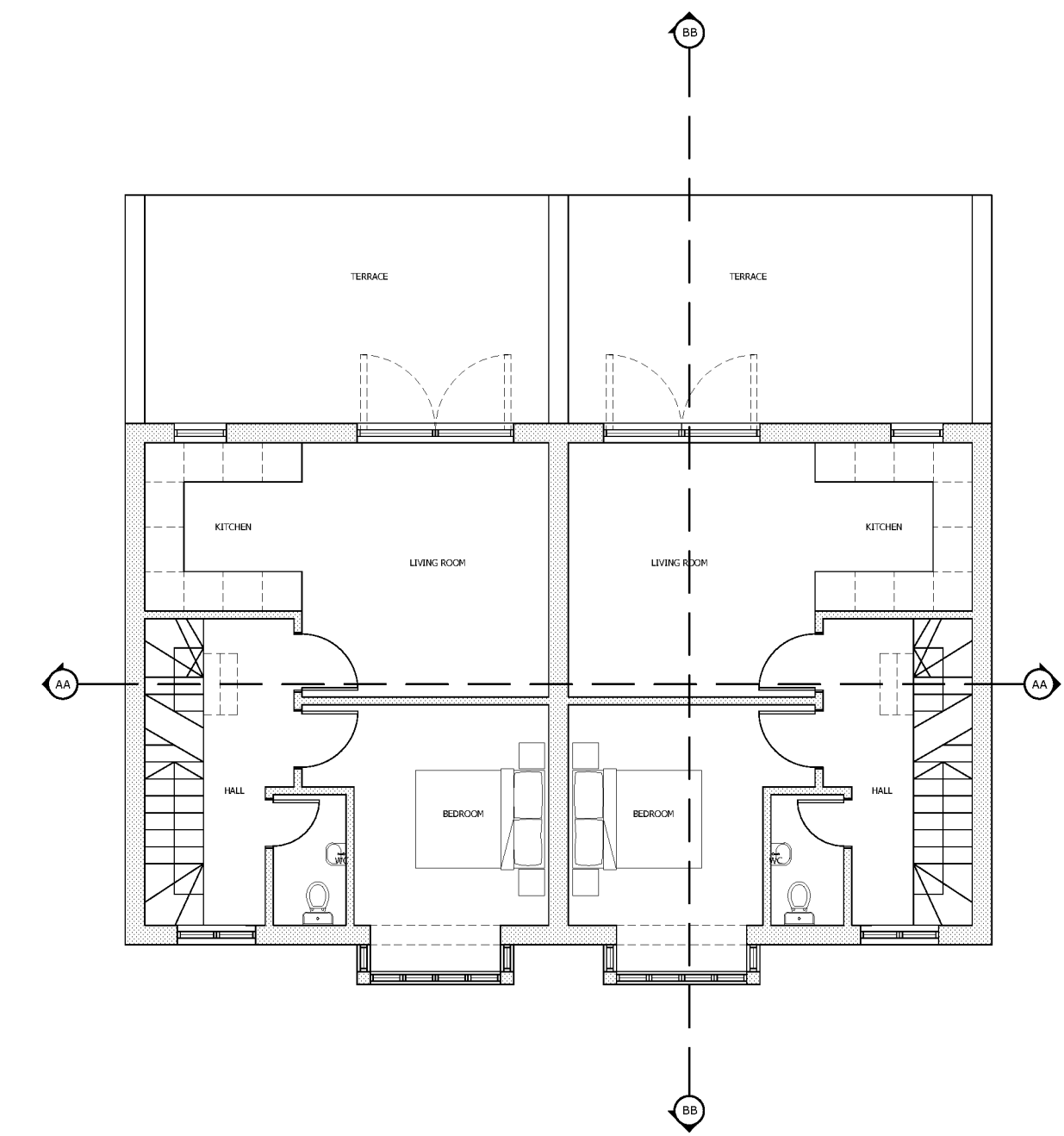
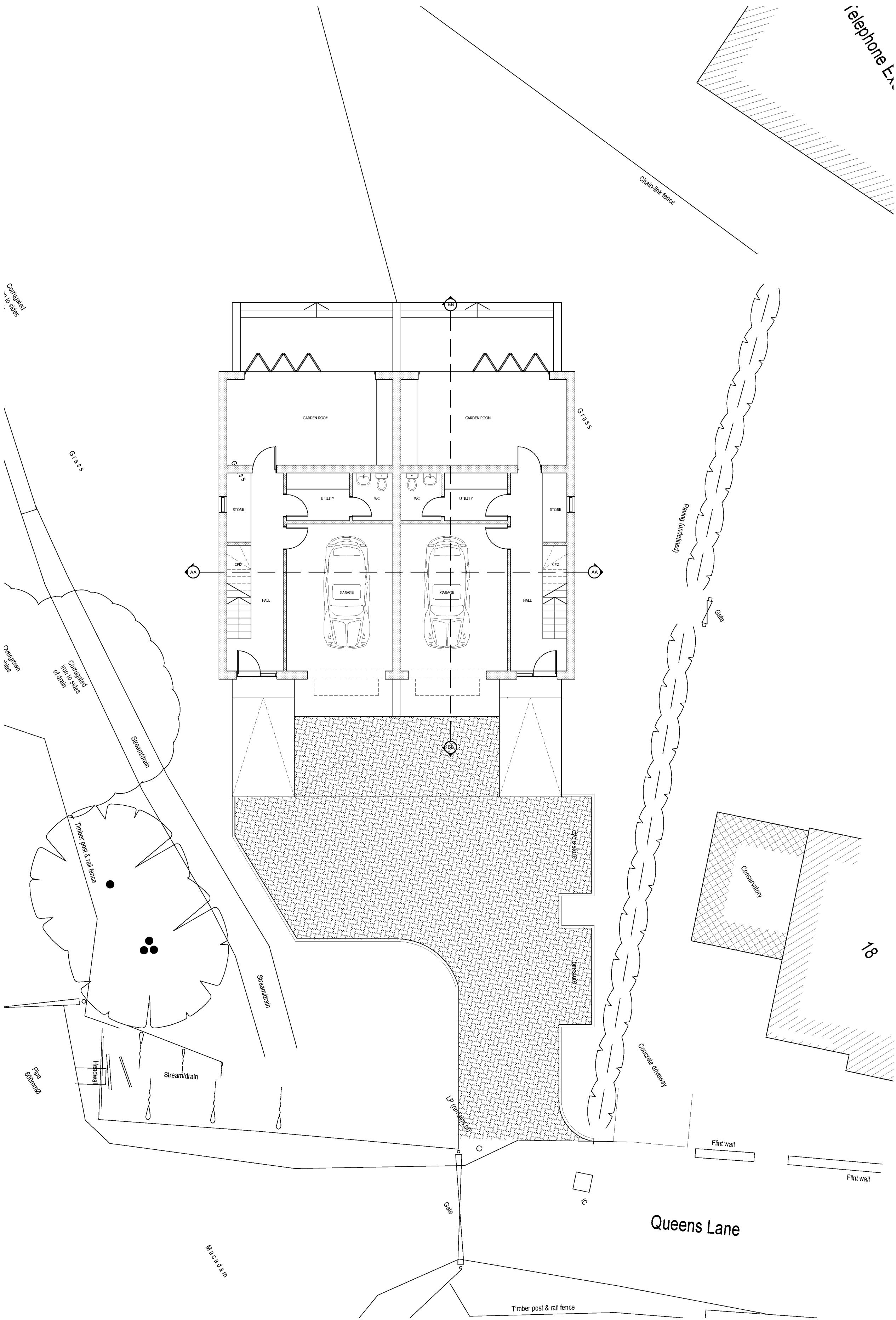
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Angmering Park Farms LLP

Project
**Queens Lane
Arundel
BN18 9JN**

Drawing Title
**Site / Block Plan
Existing**

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Drawing Number 001	Rev. A	Project Number PWDJ140372	



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GROUND FLOOR PLAN - PROPOSED
SCALE 1:100

Scale in Metres

0 1 2 3 4 5 10

FIRST FLOOR PLAN - PROPOSED
SCALE 1:100

Scale in Metres

0 1 2 3 4 5 10

ROOF FLOOR PLAN - PROPOSED
SCALE 1:100

Scale in Metres

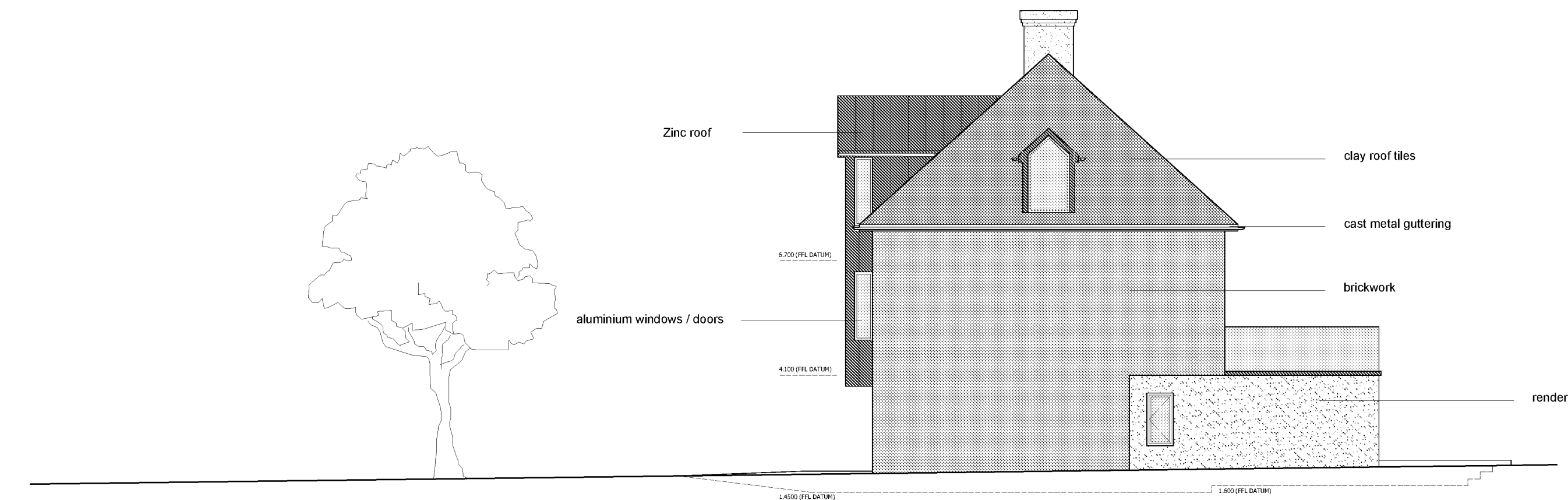
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SECOND FLOOR PLAN - PROPOSED
SCALE 1:100

Scale in Metres

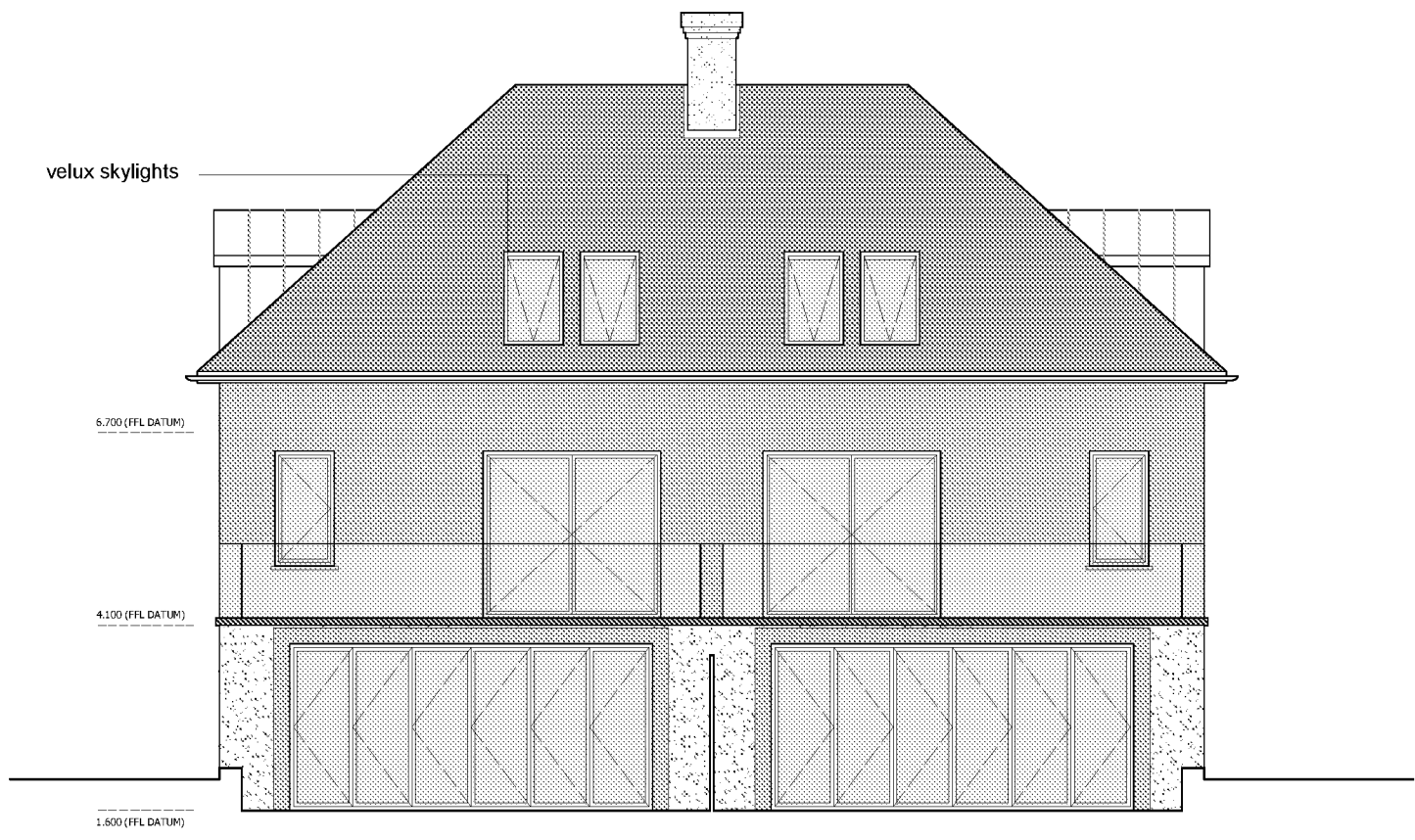
0 1 2 3 4 5 10

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Project			
Queens Lane			
Arundel			
BN18 9JN			
Drawing Title			
Floor Plans			
Proposed			
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Drawing Number	Rev.	Project Number	
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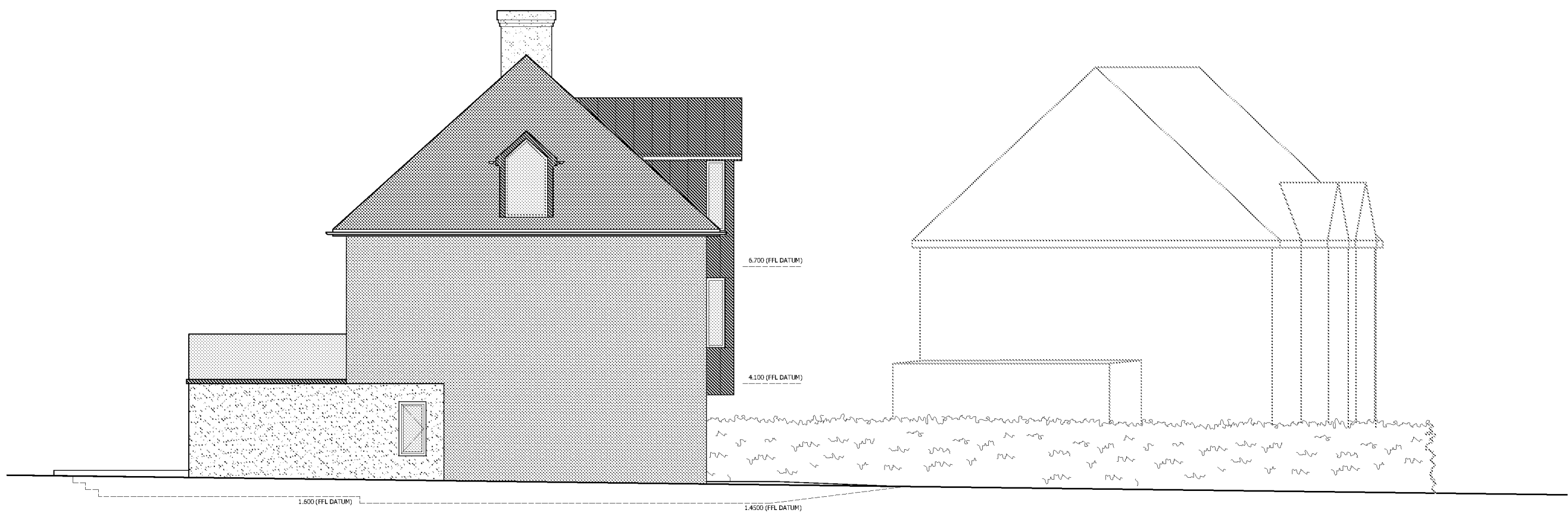
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SCALE 1:100

Scale in Metres
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WEST ELEVATION - PROPOSED
SCALE 1:100

Scale in Metres
0 1 2 3 4 5 10



SOUTH ELEVATION - PROPOSED
SCALE 1:100

Scale in Metres
0 1 2 3 4 5 10



EAST ELEVATION - PROPOSED
SCALE 1:100

Scale in Metres
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Project			
Queens Lane Arundel BN18 9JN			
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Drawing Number	Rev.	Project Number	
200		PWDJ140372	

Appendix A.2 – Environment Agency Flood Report and Correspondence

Anne Wiltshire

From: PSO West Sussex <[REDACTED]>
Sent: 04 April 2022 13:41
To: Anne Wiltshire
Subject: RE: SSD252065 Product 4 Data - Land at Queens Lane, Arundel, BN18 9JN

Hi Anne,

To explain, we still use the 2011 LTRAS model for the river Arun north of Ford. Although the 2016 Ems to Littlehampton coastal modelling is more recent than the LTRAS model, and has outputs for much of the lower Arun, we do not use this above Ford. The study area for the 2016 model is restricted to the coast but, to ensure this model accounts for the influence of the fluvial flows from the Arun, part of the lower Arun was included in the model. Although part of the Arun was included in the model, it was out of the study area and so only used low resolution ground levels and defence information.

I hope that this helps to explain and that it can help you in informing your clients. Please let me know if you have any further questions related to this.

Kind regards,

Edward Conway
Partnership and Strategic Overview West Sussex
Environment Agency | Guildbourne House, Chatsworth Road, Worthing, BN11 1LD

[REDACTED]



From: Anne Wiltshire <[REDACTED]>
Sent: 24 March 2022
To: PSO West Sussex <[REDACTED]>
Subject: RE: SSD252065 Product 4 Data - Land at Queens Lane, Arundel, BN18 9JN

Hi Edward,

Thank you for checking.

Just out of curiosity and to inform clients, could you please advise why the Emsworth to Littlehampton West Bank Coastal Modelling study from 2016 is not considered appropriate for use?

Kind Regards,

Anne Wiltshire BSc MSc MCIVEM PIEMA
Senior Flood Risk Analyst

Canterbury Office

[REDACTED] - Elham Valley Road - Canterbury CT4 8DQ

London Office

Unit 52/11, Woolyard, 52 Bermondsey Street, London, SE1 3UD

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From: PSO West Sussex <[REDACTED]>

Sent: 23 March 2022 11:24

To: Anne Wiltshire <[REDACTED]>

Subject: RE: SSD252005 Product 1 Data - Land at Queens Lane, Arundel, BN18 9JN

Hi Anne,

To confirm, the Lower Tidal Arun Strategy Study (2010) is the appropriate model for use when considering tidal flood risk in Arundel. I've spoken with our modelling lead, and they've confirmed that our current plan is to update the LTRAS model in the next financial year, potentially as early as the end of 2022 (though I can't confirm this with 100% certainty).

Please let me know if you have any further queries following on from this response.

Kind regards,

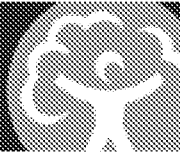
Edward Conway

Partnership and Strategic Overview West Sussex

Environment Agency | Guildbourne House, Chatsworth Road, Worthing, BN11 1LD



Creating a better place
for people and wildlife



From: Anne Wiltshire
Sent: 23 March 2022
To: PSO West Sussex
Cc: SSD Enquiries <[REDACTED]>
Subject: RE: SSD252065 Product 4 Data - Land at Queens Lane, Arundel, BN18 9JN

Hi Edward,

Thank you for sending through the P4 data.

The data still refers to the Lower Tidal River Arun Strategy Study which was completed in 2010. However, we have the Emsworth to Littlehampton West Bank Coastal Modelling study from 2016 on file which also covers the site. Whilst this only includes tidal outputs, I would expect this study to supersede the 2010 study? Could you please confirm whether this is correct or whether we still need to refer to the 2010 one?

Also, does the EA plan to update the Lower Tidal River Arun Strategy Study in the near future?

Kind Regards,

Anne Wiltshire BSc MSc MCIVEM PIEMA
Senior Flood Risk Analyst

herrington
CONSULTING LIMITED

Canterbury Office

[REDACTED] Park - Elham Valley Road - Canterbury CT4 8DQ

[REDACTED] One St. Mary's, Vintry, London, SE1 3UD

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From: PSO W [REDACTED]
Sent: 22 Mar [REDACTED]
To: Anne Wil [REDACTED]
Cc: SSD Enqu [REDACTED]
Subject: RE: SSD252005 Product 4 Data - Land at Queens Lane, Arundel, BN18 9JN

Dear Anne,

Thank you for your Product 4 request for **Land at Queens Lane, Arundel, BN18 9JN**. Please find attached the Product 4 flood risk data. Apologies for the extended delay in receiving a response to this request.

For FRA and pre-planning advice please see attached 'FRA Advisory Text' and 'SSD Pre-app advice note September 2019'.

For information on flooding from other sources such as surface water please contact the Lead Local Flood Authority, West Sussex County Council.

Guidance on climate change allowances and how to use them in Flood Risk Assessments can be found [here](#).

For future reference, detailed flood information and maps can be viewed using the [Long Term Flood Risk Information](#) service and [Flood Map for Planning](#) service. Flood and Coastal Risk Management asset information, and details of all planned maintenance activities can be viewed using the [Asset Management](#) Service.

If you have any further queries about this request, please do not hesitate to contact us at psowestsussex@environment-agency.gov.uk.

Kind regards,

Edward Conway
Partnership and Strategic Overview West Sussex
Environment Agency | Guildbourne House, Chatsworth Road, Worthing, BN11 1LD



From: Anne Wiltshire [REDACTED]
Sent: 31 January 2022 09:28
To: 'S [REDACTED]
Subject: [REDACTED]

Hello,

We have been appointed to undertake an FRA for a development at the following address:

Land at Queens Lane, Arundel, BN18 9JN

A location plan is attached and the Grid Ref is: 501859, 106816

For this FRA we will need:

- Extreme flood levels
- Plotted flood extents (if available)
- Defence data
- Historic flooding

Please could we have both residential and commercial flood levels for the site if possible.

Kind Regards,

Anne Wiltshire BSc MSc MCiWEM PIEMA
Senior Flood Risk Analyst



Canterbury Office
Units 6 & 7, Barham Business Park - Elham Valley Road - Canterbury CT4 6DQ

London Office
Unit S2.11, Woolyard, 52 Bermondsey Street, London, SE1 3UD

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Legend

 Please see page 2 for asset symbology



Point Structures

-   Borehole
-   Central Pier
-   Control Gate
-   Debris Screen
-   Draw Off Tower
-   Fish or Eel Barrier
-   Fish Pass
-   Inspection Chamber
-   Outfall
-   Ramp
-   Security Screen
-   Slipway
-   Steps
-   Stilling Basin
-   Vortex Flow Control

Linear Structures

-   Debris Boom
-   In Channel Stoplogs
-   Pier
-   Weir
-  Other type or not defined

Defences

-   Embankment
-   Wall
-   Flood Gate
-   Demountable Defence
-   Bridge Abutment
-   Engineered High Ground
-   Natural High Ground
-   Cliff
-   Promenade
-   Quay
-   Beach
-   Barrier Beach
-   Dunes
-   Spillway

Channels

-   Open Channel
-   Complex Culvert
-   Simple Culvert

Instruments

-  CCTV Camera System
-  Flood Warning System
-  Gauge Board
-  Instrumentation
-  Piezometer
-  Rain Gauge
-  Telemetry System
-  Other type or not defined

Buildings and Compounds

-  Control Building
-  Gauging Station Building
-  Pump House
-  Storage Location
-  Other type or not defined

Channel Crossings

-   Bridge
-   Utility Services Crossing
-  Other type or not defined

Beach Structures

-   Breakwater
-   Groyne

Land

-  Water Storage Area
-  Other type or not defined

Point Aids to Navigation

-   Beacon
-   Buoy
-   Dolphin
-   Navigation Signage
-  Other type or not defined

Linear Aids to Navigation

-   Navigation Boom
-  Other type or not defined

Anne Wiltshire
Herrington Consulting Limited
Units 6 & 7
Barham Business Park
Elham Valley Road
Canterbury
CT4 6DQ

Our ref: SSD252065
Date: 22/03/2022

Dear Anne Wiltshire,

Enquiry Regarding Product 4 for Flood Risk Assessment for Land At Queens Lane, Arundel, BN18 9JN.

Thank you for your enquiry which was received on 31 January 2022.

We respond to requests under the Freedom of Information Act 2000 and Environmental Information Regulations 2004. The information is attached.

The information on Flood Zones in the area relating to this address is as follows:

The site is in an area located within Flood Zone 3 as shown on our Flood Map for Planning (Rivers and Sea).

Note - This information relates to the area that the above named property is in and is not specific to the property itself as it is influenced by factors such as the height of door steps, air bricks or the height of surrounding walls. We do not have access to this information and is not currently used in our flood modelling.

Flood Zone definitions can be found at www.gov.uk/guidance/flood-risk-and-coastal-change#Table-1-Flood-Zones

Flood Defences

There is a tidal/fluvial flood defence in the form of a private embankment which is maintained by the Environment Agency (Asset ID: 155418). It has a Standard of Protection (SoP) of 1 in 200 years and an upstream/downstream crest level of 4.12mAOD.

Model Information

The model used was the Lower Tidal River Arun Strategy Study which was completed by Atkins in 2010.

Flood History

Arun Valley experienced flooding between December 1st 2013 and February 1st 2014 (Flood ID: 4421). The source of this flooding was the main river and the cause was the overtopping of defences. This event did not directly impact on this site according to our records.

Please note our records are not comprehensive and may not include all events. I recommend contacting the Lead Local Flood Authority, **West Sussex County Council** or the Local Authority, **Arun District Council** for a more comprehensive flood history check.

FRA advisory text

Name	Product 4
Description	Detailed Flood Risk Assessment Map for Land At Queens Lane, Arundel, BN18 9JN.
Licence	<u>Open Government Licence</u>
Information Warnings	Climate Change allowances for this model only show the superseded 20% increase in flows. The current allowances should be checked here: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances. The flood risk data provided is based on existing EA hydraulic models with an allowance for climate change. Please note the climate change allowances provided are not up to date. These were updated on 27 July 2021. You should refer to 'Flood risk assessments: climate change allowances' for the most up to date allowances. You will need to undertake further assessment of future flood risk using different allowances to ensure your assessment of future flood risk is based on best available evidence.
Information Warning - OS background mapping	<i>The mapping of features provided as a background in this product is © Ordnance Survey. It is provided to give context to this product. The Open Government Licence does not apply to this background mapping. You are granted a non-exclusive, royalty free, revocable licence solely to view the Licensed Data for non-commercial purposes for the period during which the Environment Agency makes it available. You are not permitted to copy, sub-license, distribute, sell or otherwise make available the Licensed Data to third parties in any form. Third party rights to enforce the terms of this licence shall be reserved to OS.</i>
Attribution	Contains Environment Agency information © Environment Agency and/or database rights. Contains Ordnance Survey data © Crown copyright 2022 Ordnance Survey 100024198.

Data Available Online

Many of our flood datasets are available online:

- Flood Map For Planning ([Flood Zone 2](#), [Flood Zone 3](#), [Flood Storage Areas](#), [Flood Defences](#), [Areas Benefiting from Defences](#))
- [Risk of Flooding from Rivers and Sea](#)

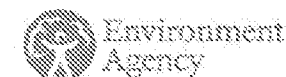
- [Historic Flood Map](#)
- [Current Flood Warnings](#)

Please get in touch if you have any further queries or contact us within two months if you'd like us to review the information we have sent.

Yours sincerely,

Edward Conway
Partnership & Strategic Overview - West Sussex
Environment Agency, Guildbourne House, Chatsworth Road, Worthing, BN11
1LD

Flood Map for Planning (Rivers and Sea). Centred BN18 9JN. Created 22/03/2022.



1: 10,000

0 Metres 250



Flood Map for Planning (Rivers & Sea)

- Defences
- Flood Storage Areas
- Areas benefiting from flood defences
- Flood Zone 3
- Flood Zone 2

Flood Map Areas (assuming no defences)

Flood Zone 3 shows the area that could be affected by flooding:

- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

Use of Environment Agency Information for Flood Risk Assessments

Important

The Environment Agency are keen to work with partners to enable development which is resilient to flooding for its lifetime and provides wider benefits to communities. If you have requested this information to help inform a development proposal, then we recommend engaging with us as early as possible by using the pre-application form available from our website:

<https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion>

We recognise the value of early engagement in development planning decisions. This allows complex issues to be discussed, innovative solutions to be developed that both enables new development and protects existing communities. Such engagement can often avoid delays in the planning process following planning application submission, by reaching agreements up-front. We offer a charged pre-application advice service for applicants who wish to discuss a development proposal.

We can also provide a preliminary opinion for free which will identify environmental constraints related to our responsibilities including flooding, waste, land contamination, water quality, biodiversity, navigation, pollution, water resources, foul drainage or Environmental Impact Assessment.

In preparing your planning application submission, you should refer to the Environment Agency's Flood Risk Standing Advice and the Planning Practice Guidance for information about what flood risk assessment is needed for new development in the different Flood Zones. This information can be accessed via:

<https://www.gov.uk/flood-risk-assessment-standing-advice>
<http://planningguidance.planningportal.gov.uk/>

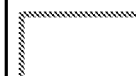
You should also consult the Strategic Flood Risk Assessment or other relevant materials produced by your local planning authority.

You should note that:

1. Information supplied by the Environment Agency may be used to assist in producing a Flood Risk Assessment (FRA) where one is required, but does not constitute such an assessment on its own.
2. This information covers flood risk from main rivers and the sea, and you will need to consider other potential sources of flooding, such as groundwater or surface water runoff. Information produced by the local planning authority referred to above may assist here.
3. Where a planning application requires an FRA and this is not submitted or is deficient, the Environment Agency may raise an objection.



Legend



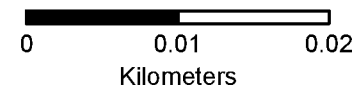
Site Boundary



Site Nodes

Annual Exceedance Probability (AEP) The probability of a flood of a particular magnitude, or greater occurring in any given year.

Scale: 1:500



Product 4 Flood Risk Data Requested by: Herrington Consulting Limited

Site: Land at Queens Lane, Arundel, BN18 9JN

Table 1: Water Levels: Fluvial Undefended

Node Ref	NGR		Modelled Flood Levels in Metres AOD			
	Eastings	Northings	Undefended Annual Exceedance Probability			
			5%	1%	1% +CC*	0.1%
1	501821	106830	2.26	2.47	3.33	2.91
2	501849	106816	-	2.47	3.33	2.91
3	501875	106825	2.26	2.47	3.33	2.91
4	501867	106809	2.26	2.47	3.33	2.91
5	501886	106808	2.26	2.47	3.33	2.91
6	501900	106807	2.26	2.47	3.33	2.91

Table 2: Water Levels: Fluvial Defended

Node Ref	NGR		Modelled Flood Levels in Metres AOD			
	Eastings	Northings	Defended Annual Exceedance Probability			
			5%	1%	1% +CC*	0.1%
1	501821	106830	-	-	-	-
2	501849	106816	-	-	-	-
3	501875	106825	-	-	-	-
4	501867	106809	-	-	-	-
5	501886	106808	-	-	-	-
6	501900	106807	-	-	1.79	1.75

Table 3: Water Levels: Tidal Undefended

Node Ref	NGR		Modelled Flood Levels in Metres AOD		
	Eastings	Northings	Undefended Annual Exceedance Probability		
			0.5%	0.5% (2110)**	0.1%
1	501821	106830	2.93	3.58	3.00
2	501849	106816	2.93	3.58	3.00
3	501875	106825	2.93	3.58	3.00
4	501867	106809	2.93	3.58	3.00
5	501886	106808	2.93	3.58	3.00
6	501900	106807	2.93	3.58	3.00

Table 4: Water Levels: Tidal Defended

Node Ref	NGR		Modelled Flood Levels in Metres AOD		
			Defended Annual Exceedance Probability		
	Eastings	Northings	0.5%	0.5% (2110)**	0.1%
1	501821	106830	-	3.50	-
2	501849	106816	-	3.50	-
3	501875	106825	-	3.50	-
4	501867	106809	-	3.50	-
5	501886	106808	-	3.50	-
6	501900	106807	-	3.50	-

Table 5: Water Depths: Fluvial Undefended

Node Ref	NGR		Modelled Flood Depths in Metres			
			Undefended Annual Exceedance Probability			
	Eastings	Northings	5%	1%	1% +CC*	0.1%
1	501821	106830	0.20	0.41	1.28	0.85
2	501849	106816	-	0.08	0.94	0.52
3	501875	106825	0.22	0.43	1.30	0.87
4	501867	106809	0.22	0.43	1.30	0.87
5	501886	106808	0.03	0.24	1.10	0.68
6	501900	106807	0.34	0.54	1.41	0.99

Table 6: Water Depths: Fluvial Defended

Node Ref	NGR		Modelled Flood Depths in Metres			
			Defended Annual Exceedance Probability			
	Eastings	Northings	5%	1%	1% +CC*	0.1%
1	501821	106830	-	-	-	-
2	501849	106816	-	-	-	-
3	501875	106825	-	-	-	-
4	501867	106809	-	-	-	-
5	501886	106808	-	-	-	-
6	501900	106807	-	-	0.10	0.16

Table 7: Water Depths: Tidal Undefended

Node Ref	NGR		Modelled Flood Depths in Metres		
			Undefended Annual Exceedance Probability		
	Eastings	Northings	0.5%	0.5% (2110)**	0.1%
1	501821	106830	0.88	1.52	0.94
2	501849	106816	0.54	1.19	0.61
3	501875	106825	0.90	1.54	0.96
4	501867	106809	0.90	1.54	0.96
5	501886	106808	0.70	1.35	0.77
6	501900	106807	1.01	1.66	1.08

Office Address: Guildbourne House, Chatsworth Road, Worthing BN11 1LD.
Customer services line: 03708 506 506. Email: enquiries@environment-agency.gov.uk
www.gov.uk/government/organisations/environment-agency

Table 8: Water Depths: Tidal Defended

Node Ref	NGR		Modelled Flood Depths in Metres		
	Eastings	Northings	Defended Annual Exceedance Probability		
			0.5%	0.5% (2110)**	0.1%
1	501821	106830	-	1.38	-
2	501849	106816	-	1.37	-
3	501875	106825	-	1.35	-
4	501867	106809	-	1.37	-
5	501886	106808	-	1.35	-
6	501900	106807	-	1.81	-

All levels taken from: Lower Tidal River Arun Strategy

Produced on: 22/03/2022

*** Climate Change allowances for this model only show the superseded 20% increase in fluvial flows. The current allowances should be checked here: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>.**

**** The flood risk data provided is based on existing EA hydraulic models with an allowance for climate change. Please note the climate change allowances provided are not up to date. These were updated on 27 July 2021.**

You should refer to <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances> for the most up to date allowances. You will need to undertake further assessment of future flood risk using different allowances to ensure your assessment of future flood risk is based on best available evidence.

There is no additional information or health warnings for these levels/depths or the model from which they have been produced.





Environment
Agency

N


Legend

-  Site Boundary
-  5% AEP (Defended Fluvial)
-  1% AEP (Defended Fluvial)
-  1% AEP Plus Climate Change (Defended Fluvial)
-  0.1% AEP (Defended Fluvial)

Annual Exceedance Probability (AEP) The probability of a flood of a particular magnitude, or greater occurring in any given year.

Scale: 1:10,000



00.2250.45
Kilometers

Ordnance Survey



Environment
Agency



N

Legend

-  Site Boundary
-  0.5% AEP (Defended Tidal)
-  0.5% AEP (2110) (Defended Tidal)
-  0.1% AEP (Defended Tidal)

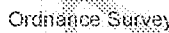
Annual Exceedance Probability (AEP) The probability of a flood of a particular magnitude, or greater occurring in any given year.

Scale: 1:10,000



00.2250.45

Kilometers



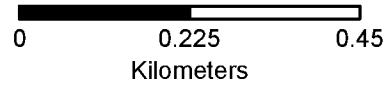


Legend

- Site Boundary
- 5% AEP (Un defended Fluvial)
- 1% AEP (Un defended Fluvial)
- 1% AEP Plus Climate Change (Un defended Fluvial)
- 0.1% AEP (Un defended Fluvial)

Annual Exceedance Probability (AEP) The probability of a flood of a particular magnitude, or greater occurring in any given year.

Scale: 1:10,000



Ordnance Survey





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▲

Legend

 Site Boundary

 0.5% AEP (Undefended Tidal)

 0.5% AEP (2110) (Undefended Tidal)

 0.1% AEP (Undefended Tidal)

Annual Exceedance Probability (AEP) The probability of a flood of a particular magnitude, or greater occurring in any given year.

Scale: 1:10,000



00.2250.45
Kilometers

Ordnance Survey

Recorded Flood Outlines. Centred BN18 9JN. Created 22/03/2022.

Legend

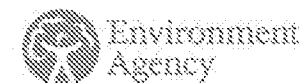
 All recorded flood outlines



1: 10,000
0 250
Metres



Risk of flooding from Surface Water. Centred BN18 9JN. Created 22/03/2022.



1: 10,000

0 Metres 250



Likelihood of flooding from Surface Water

- High ($\geq 3.3\%$)
- Medium (3.3% - 1%)
- Low (1% - 0.1%)
- Very Low

Likelihood of flooding from Surface Water

- High:** Greater than or equal to 3.3% (1 in 30) chance in any given year
- Medium:** Less than 3.3% (1 in 30) but greater than or equal to 1% (1 in 100) chance in any given year
- Low:** Less than 1% (1 in 100) but greater than or equal to 0.1% (1 in 1,000) chance in any given year
- Very Low:** Less than 0.1% (1 in 1,000) chance in any given year

This information is shown on the Risk of Flooding from Surface Water map on GOV.UK.

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Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). E-mail: enquires@environment-agency.gov.uk



Solent & South Downs Area

Pre-application Advice Note

September 2019

This document sets out the environmental issues we will consider when providing our planning application consultation advice to Local Councils. It can be used by applicants, developers and consultants at the pre-planning stage.

Fluvial Flood Risk

Development must be safe and should not increase the risk of flooding.

You can view a site's flood zone on the Flood Map for Planning on our website: <https://flood-map-for-planning.service.gov.uk>

If your proposed development is located within flood zone 2 or 3 you should consult the Flood Risk and Coastal Change pages of the National Planning Policy Guidance (NPPG)

<http://planningguidance.communities.gov.uk/blog/guidance/flood-risk-and-coastal-change/>

Here you can determine whether the flood risk vulnerability of your proposed development and the flood zone are compatible. You can also establish if there are flood risk sequential test and exception test requirements for your proposed development. In the first instance we recommend the developer/applicant liaises with the Local Planning Authority (LPA) to undertake the Sequential Test in accordance with the National Planning Policy Framework (NPPF).

If your proposed development is located within flood zone 2 or 3 and its vulnerability and flood zone are considered acceptable under the NPPG then a site specific Flood Risk Assessment (FRA) is required to support any subsequent planning application. This is required by paragraph 163 of the NPPF: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/60777/2116950.pdf

Guidance on the content of a site specific FRA can be found in the NPPG and online: <https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications>

More detailed flood risk modelling data is available to help you produce a FRA please contact our Customers and Engagement team at SSDenquiries@environment-agency.gov.uk.

Climate Change Allowances

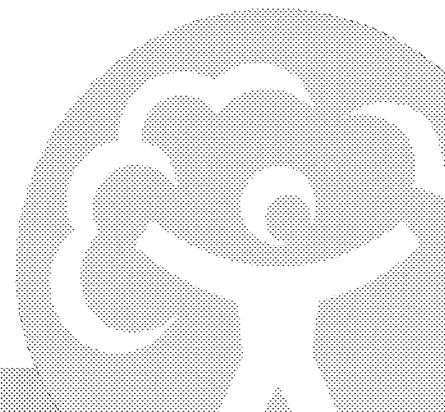
On 19 February 2016, we published new guidance for planners and developers on how to use climate change allowances in a site-specific FRA: <https://www.gov.uk/guidance/flood-risk-assessments-climatechange-allowances>

Groundwater Quality

Development must not cause pollution to the water environment.

Source Protection Zones

We have defined Source Protection Zones (SPZs) for 2000 groundwater sources such as wells, boreholes and springs used across the country for public drinking water supply. These zones are more sensitive to contamination from activities that might cause pollution in the area. The closer the activity, the greater the risk.



SPZ1s are the areas designated as most at risk from contamination and development activities and in these areas we may consider it inappropriate for development to discharge foul or surface water into the ground.

To see if your proposed development is located within a Source Protection Zone, please use our online map: <https://magic.defra.gov.uk/>

Contaminated Land

The NPPF takes a precautionary approach to land contamination. Before the principle of development can be determined, land contamination should be investigated to see whether it could preclude certain development due to environmental risk or cost of remediation. Where contamination is known or suspected, a desk study, site investigation, remediation and other works may be required to enable safe development.

Pollution

If the proposed development use has the potential to pollute ground or surface water receptors then an assessment to establish whether the risk of pollution is acceptable or can be mitigated will be required within any planning application.

Foul Drainage

When drawing up wastewater treatment proposals for any development, the first presumption is to provide a system of foul drainage discharging into a public sewer to be treated at a public sewage treatment works (those provided and operated by the water and sewerage companies). This should be done in consultation with the sewerage company of the area prior to the submission of a formal planning application.

If connection to a public sewage treatment plant is not feasible, a package sewage treatment plant may be considered. If you would like further advice please call 03708 506 506.

Cemeteries

The development of new cemeteries in areas where groundwater vulnerability is high should be avoided, except where the thickness and nature of the unsaturated zone, or the impermeable formations beneath the site, protect groundwater; or where the long-term risk is mitigated by appropriate engineering methods.

Main Rivers

Ecology

In accordance with the National Planning Policy Framework (NPPF), any development proposal should avoid significant harm to biodiversity and seek to protect and enhance it. Opportunities to incorporate biodiversity in and around the development will be encouraged.

Your scheme should be designed with a naturalised buffer zone of at least 8 metres from the main river to protect and enhance the conservation value of the watercourse and ensure access for flood defence maintenance.

This buffer zone should be managed for the benefit of biodiversity for example by the planting of locally appropriate, UK native species. The buffer zone should be undisturbed by development with no fencing, footpaths or other structures. This buffer zone will help provide more space for flood waters, provide improved habitat for local biodiversity and allows access for any maintenance requirements.

To identify any Main Rivers in proximity to your proposed development please see our Main Rivers Consultation Map: <http://apps.environment-agency.gov.uk/wivby/151293.aspx>

customer service line
03708 506 506

incident hotline
0800 80 70 60

floodline
0345 988 1188

www.gov.uk/environment-agency

Culverting

The Environment Agency is likely to oppose culverting as it is damaging to the ecological integrity of the river channel and its corridor and acts as a barrier to the movement of wildlife, including fish and may also increase flood risk. If the proposal will impact an existing culvert the Environment Agency may oppose planning consent for development either over, or within 8 metres of an existing culvert. Wherever possible, existing culverts should be removed and the river channel and bankside habitat reinstated to restore the ecological continuity of the river channel and its corridor.

Water Framework Directive (WFD)

Any marine works below MHWS require an assessment of possible impacts on Water Framework Directive (WFD). The assessment should include all elements of the works that fall within, or have the potential to affect, a WFD water body and any of the protected areas therein (including Bathing Waters and Shellfish Waters).

The WFD assessment should follow the 'Clearing the Waters for All' guidance available at <https://www.gov.uk/guidance/water-framework-directive-assessment-estuarine-and-coastal-waters>

Where appropriate, a WFD Assessment should assess any potential impacts and demonstrate that the required enhancements will be delivered. In some cases the requirements of a WFD assessment can be incorporated into an Environmental Impact Assessment (EIA). Any development that has the potential to cause deterioration in classification under WFD or that precludes the recommended actions from being delivered in the future is likely to be considered unacceptable to us.

Permits & Consents

Environmental Permitting Regulations

To see if your proposed development requires an Environmental Permit under the Environment Permitting Regulations please refer to our website: <https://www.gov.uk/guidance/check-if-you-need-an-environmental-permit>

From 6 April 2016 an Environmental Permit is required for any proposed works or structures, in, under, over or within 8 metres of the top of the bank of designated Main River, and within 16 metres of a tidal defence.

Ordinary Watercourse Consent

The prior written consent of the relevant Lead Local Flood Authority is required for the erection of any flow control structures, culverting or diversion of ordinary watercourses, including streams, land drains and ditches.

Marine Licence

A marine licence may be required for any activities at the mean high water spring tide up to the territorial limit. This also includes the waters of every estuary, river or channel where the tide flows at mean high water spring tide.

Any development must demonstrate how adverse impacts on migratory fish, bathing waters, shellfish waters, designated sites, protected and priority species and habitats will be avoided, minimised, mitigated and if necessary compensated for. Works within or affecting a Water Framework Directive (WFD) waterbody will need to demonstrate that compliance with WFD objectives will be achieved. 'Clearing the Waters for All' provides guidance on how the impacts on WFD should be addressed, and should be used when preparing an assessment, including the screening and scoping of activities. <https://www.gov.uk/guidance/water-framework-directive-assessment-estuarine-and-coastal-waters>

Further pre-application options

The information provided above details generic information which may or may not be applicable to your development. We are able to provide more detailed and bespoke advice and answer technical questions for a charged fee of £100 per person per hour +VAT.

If you are interested in finding out more about this service, please email:

planningssd@environment-agency.gov.uk

We can explain this service and provide you with a bespoke quote for further pre-application advice that you may require please see .gov - <https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion>

Please note

Please note that the view expressed in this letter by the Environment Agency is in response to the enquiry only and does not represent our final view in relation to any future planning application made in relation to this site.

We reserve the right to change our position in relation to any such application.

As part of this preliminary response we have not technically reviewed any documents. This opinion is based on the information submitted and current planning policy and guidance.

If you have any questions please contact the Solent & South Downs Sustainable Places team:

planningssd@environment-agency.gov.uk

To make a request for data

Please submit your request for data to ssdenquiries@environment-agency.gov.uk. You should get the information within 20 working days. We will tell you when to expect the information if we need more time.

There are many datasets available online at www.data.gov.uk including flood maps, historic landfill, waste exemptions, consented discharges to controlled waters, and much more.

customer service line
03708 506 506

incident hotline
0800 80 70 60

floodline
0345 988 1188

www.gov.uk/environment-agency

Appendix A.3 – Southern Water Asset Location Data



Herrington Consulting Limited
Unit 6
Barham Business Park
Barham
CT4 6DQ

Your ref RB/2004
Our ref 279167
Date 06 February 2018
Contact searches@southernwater.co.uk
Tel 0845 272 0845
0330 303 0276
Fax 01634 844514

Attention: Herrington Consulting

Dear Customer

Re: Provision of public sewer and water main record extract

Location: Land at Queens Lane, Arundel, Kent, BN18 9JN

Thank you for your order regarding the provision of extracts of our sewer and/or water main records. Please find enclosed the extracts from Southern Water's records for the above location.

We confirm payment of your fee in the sum of £49.92 and enclose a VAT receipt for your records.

Customers should be aware that there are areas within our region in which there are neither sewers nor water mains. Similarly, whilst the enclosed extract may indicate the approximate location of our apparatus in the area of interest, it should not be relied upon as showing that further infrastructure does not exist and may subsequently be found following site investigation. Actual positions of the disclosed (and any undisclosed) infrastructure should therefore be determined on site, because Southern Water does not accept any responsibility for inaccuracy or omission regarding the enclosed plan. Accordingly it should not be considered to be a definitive document.

Should you require any further assistance regarding this matter, please contact the LandSearch team.

Yours faithfully

LandSearch

VAT receipt

Ordered by:

Herrington Consulting Limited
Barham Business Park
Barham
CT4 6DQ

VAT registration number

Order reference:

Your reference:

Receipt for provision of an extract from the public sewer and/or water main records.

Location	Costs
Land at Queens Lane Arundel Kent BN18 9JN	£41.60
Net total	£41.60
VAT	£8.32
Total	£49.92
Paid	Paid in full

Thank you for your payment:

Received on: 2 February 2018

For enquiries regarding the information provided in this receipt, please contact the LandSearch team:

LandSearch
Southern Water Services
Southern House
Capstone Road
Chatham
Kent
ME5 7QA

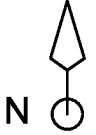


SEWER RECORDS PAGE 1 OF 2

106973



106685

501642	O.S. REF. TQ0106NE	Drawn by: yadavs	The positions of pipes shown on this plan are believed to be correct, but Southern Water Services Ltd accept no responsibility in the event of inaccuracy. The actual positions should be determined on site. WARNING: BAC pipes are constructed of Bonded Asbestos Cement WARNING: Unknown (UNK) materials may include Bonded Asbestos Cement Based upon Ordnance Survey Digital Data with the permission of the controller of H.M.S.O. Crown Copyright Reserved Licence No. WU 298530.	 N	
	Title: 279167_Land at Queens Lane, Ar	Scale: 1:1250			
		Date: 06/02/2018			

502113

SEWER RECORDS PAGE 2 OF 2

Node	Cover	Invert	Size	Material	Shape	Node	Cover	Invert	Size	Material	Shape	Node	Cover	Invert	Size	Material	Shape	Node	Cover	Invert	Size	Material	Shape
0801X	2.26		150	VC	CIRC																		
0802X	2.2		150	VC	CIRC																		
0803X	2.74	0.44	150	VC	CIRC																		
0804X	2.71		150	VC	CIRC																		
0805X			UNK	UNK	CIRC																		
0806X			UNK	UNK	CIRC																		
0807X			UNK	UNK	CIRC																		
0902X	3.01	0.75	150	VC	CIRC																		
0906X			150	VC	CIRC																		
1701X	1.68	0.74	150	VC	CIRC																		
6701X	1.76	-0.27	150	VC	CIRC																		
6902X	3.43	2.29	150	VC	CIRC																		
6903X	3.24	1.92	375	VC	CIRC																		
6904X	3.32	1.83	375	VC	CIRC																		
6906X			375	VC	CIRC																		
6911X			100	VC	CIRC																		
6912X			100	VC	CIRC																		
693DX			150	VC	CIRC																		
694DX			150	VC	CIRC																		
69ADX			375	VC	CIRC																		
7801X	2.99	-1.13	225	VC	CIRC																		
7802X	3.01	-1.27	225	VC	CIRC																		
7803X	3.18	-1.43	225	VC	CIRC																		
7804X	2.06	-0.94	150	VC	CIRC																		
780PX	2.79	2.78	100	CI	CIRC																		
7902X	3.19	2.24	200	VC	CIRC																		
7903X	3.65	2.08	375	VC	CIRC																		
7904X	3.17	1.98	375	VC	CIRC																		
7906X	3.5	2.38	375	VC	CIRC																		
7909X			UNK	UNK	CIRC																		
7910X			UNK	UNK	CIRC																		
7911X			UNK	UNK	CIRC																		
7912X			100	VC	CIRC																		
7913X			100	VC	CIRC																		
8801X	3.03	1.66	150	VC	CIRC																		
8802X	3.14	-0.88	225	VC	CIRC																		
8804X	3.12	1.52	150	VC	CIRC																		
8906X	3.45	1.7	150	VC	CIRC																		
8909X			100	VC	CIRC																		
8910X			100	VC	CIRC																		
9801X	2.33		225	VC	CIRC																		
9802X	2.42		225	VC	CIRC																		
9803X	2.66		150	VC	CIRC																		
9804X	2.56		150	VC	CIRC																		
9805X	2.69		150	VC	CIRC																		
9806X	2.74	1.96	150	VC	CIRC																		
9807X	2.675		225	VC	CIRC																		
9808X	2.635	0.01	250	DI	CIRC																		
9809X	2.545	0.03	225	VC	CIRC																		
980DX			UNK	UNK	UNK																		
9810X	2.535	0.06	225	VC	CIRC																		
9901X	3.54		150	VC	CIRC																		
9903X	3.01	-0.51	225	VC	CIRC																		
990PY	3.38	3.37	100	PVC	CIRC																	*	
990PX	3.38	3.37	150	CI	CIRC																	*	

LINE STYLES / COLOURS

Brown	-----Foul
	-----Foul Syphon Sewer
	-----Foul Vacuum Main
	-----Foul Rising Main
Red	-----Combined
	-----Combined Syphon Sewer
	-----Combined Rising Main
Orange	-----Lateral Drain
	-----Building Over Agreement Area
Dark Blue	-----Treated Effluent
Purple	-----Sludge
	-----Sewer Catchment
	-----Section 104 Area
Light Blue	-----Surface Water
	-----Surface Water Rising Main
Yellow	-----Private
Green	-----Access Shaft
	-----Decommissioned

MATERIALS

AK	Alkaline
BAC	Bonded Asbestos Cement
BRC	Brick (Common)
BRE	Brick (Engineering)
CC	Concrete Box Culvert
CI	Cast Iron
CO	Concrete (In-Situ)
CP	Concrete (Pre-Cast)
CSB	Concrete Segments (bolted)
CSU	Concrete Segments (unbolted)
DI	Ductile Iron
GRC	Glass Reinforced Concrete
GRP	Glass Reinforced Plastic
MAC	Masonry in regular Courses
MAR	Masonry in random Courses
PE	Polyethylene
PF	Pitch Fibre
PP	Polypropylene
PVC	Polyvinyl Chloride
RPM	Reinforced Plastic Matrix
SI	Spun Iron
ST	Steel
VC	Vitrified Clay
XXX	Other
ZZZ	Unknown

Manhole (SW)
Manhole (F&C)
Lamp hole (SW)
Lamp hole (F&C)
Pumping Station (SW)
Pumping Station (F&C)
Side entry manhole (SW)
Side entry manhole (F&C)
Blind shaft (SW)
Blind shaft (F&C)
Ejector station (SW)
Ejector station (F&C)
Watertight door (SW)
Watertight door (F&C)
Flushing ch. Min-s (SW)
Flushing ch. Min-s (F&C)
Flushing ch. No-s (SW)
Flushing ch. No-s (F&C)
Damascation Chamber

LEGEND - SEWERS

Washout (SW)
Washout (F&C)
Rodding Eye (SW)
Rodding Eye (F&C)
Gauging point (SW)
Gauging point (F&C)
Intercept chamber (SW)
Intercept chamber (F&C)
Storm Tank (SW)
Storm Tank (F&C)
Vortex chamber (SW)
Vortex chamber (F&C)
Label ellipse
Dummy/S24 manhole
Outfall
Penstock chamber
Demiboards
Storm Overflow
Backdrop manhole

Other (s)
Other
Change in sewer (s)
Change in sewer
Reflex valve
Flap valve
Cascade
Anode
Valve
Closed Valve
Air Valve
Hatch box (SW)
Hatch box (F&C)
Direction arrow
Emptying valve
Catchpit
Soakaway
Intol
Balancing Pond

SHAPES (S)

A	Arched	R	Rectangular
B	Barrel	S	Square
C	Circular	T	Trapezoidal
E	Egg	U	U Shape
H	Horseshoe	X	Other

NODE REFERENCING SYSTEM

1st digit:	hundred metre easing identifier
2nd digit:	hundred metre nothing identifier
3rd digit:	sewer type identifier
4th digit:	next sequential node

Drawn by: yadavsava

Title: 279167_Land at Queens Lane, Ar

Date: 06/02/2018



106950



106708

501636

LEGEND - MAINS

- | | | | |
|--|--|--|------------------------------------|
| | Distribution Main / Communication pipe | | Clockwise closing valve |
| | Trunk Main | | Fire Hydrant |
| | Raw water main | | Washout |
| | Non potable | | Washout hydrant |
| | Abandoned main | | Meter |
| | Proposed Main | | Capped end |
| | Fire main | | Emptying plug |
| | Non SWS | | Stopcock |
| | Sluice valve | | Leak Noise Correlator Survey Point |
| | Closed valve | | Anode |
| | Air valve | | Telemetry cable |
| | Butterfly valve | | Access point / hatchbox |
| | Pressure reducing valve | | |
| | Reflux valve | | |
| | Motorised valve | | |

WARNING: BAC pipes are constructed of Bonded Asbestos Cement

MATERIALS

- | | | | |
|--|----------------------------|--|------------------------------------|
| | Dialysis machine | | Alkathene |
| | Break pressure tank | | Cast iron |
| | Change node | | Spun (grey) iron |
| | Pumping station | | Concrete |
| | Booster station | | Ductile iron |
| | Insertion Flow Meter Point | | Bonded Asbestos Cement |
| | Water tower | | Glass reinforced plastic |
| | Service reservoir | | Glass reinforced epoxy |
| | Water Supply Works | | (Unplasticised) Polyvinyl chloride |
| | Bore hole / Well | | Polyethylene |
| | Intake | | Steel |
| | Customer site | | Concrete segments bolted |
| | Swab insertion point | | Concrete segments unbolted |
| | | | Galvanised iron |
| | | | Ductile sleeve |
| | | | Concrete pre-stressed |
| | | | High performance polyethylene |
| | | | Unknown |

WARNING: Unknown (UNK) materials may include Bonded Asbestos Cement

- | | | |
|-----|--|------------|
| AK | Drawn by: | yadavs |
| CI | Scale: | 1:1250 |
| SI | Date: | 06/02/2018 |
| CO | <p>The positions of pipes shown on this plan are believed to be correct, but Southern Water Services Ltd. accept no responsibility in the event of inaccuracy. The actual positions of pipes should be determined on site.</p> | |
| DI | | |
| BAC | <p>Based upon Ordnance Survey Digital Data with the permission of the controller of H.M.S.O. Crown Copyright Reserved Licence No. WU 298530.</p> | |
| GRP | | |
| GRE | | |
| PVC | | |
| PE | | |
| ST | | |
| CSB | | |
| CSU | | |
| GI | | |
| DS | | |
| CPS | | |
| HPE | | |
| ?? | | |

O.S.Ref: TQ0106NE

TITLE: 279167_Land at Queens Lane, Ar

502118

Appendix A.4 – Surface Water Management Calculations

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	100	Maximum Rainfall (mm/hr)	200.0
Additional Flow (%)	20	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Inverts
M5-60 (mm)	23.400	Minimum Backdrop Height (m)	0.200
Ratio-R	0.400	Preferred Cover Depth (m)	1.200
CV	1.000	Include Intermediate Ground	✓
Time of Entry (mins)	4.00	Enforce best practice design rules	✓

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
E.Paved	0.033	4.00	9.500	1200	120.000	100.000	1.950
E.Paved Outlet			9.000	1200	150.000	100.000	1.950

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
E.Pipeline	E.Paved	E.Paved Outlet	10.000	0.060	7.550	7.050	0.500	20.0	150	4.02	164.8
P.Pipeline	P.Paved	P.Paved Outlet	10.000	0.060	7.550	7.050	0.500	20.0	150	4.02	164.8

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
E.Pipeline	2.929	51.8	23.6	1.800	1.800	0.033	0.0	71	2.867
P.Pipeline									

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
E.Pipeline	10.000	20.0	150	Circular	9.500	7.550	1.800	9.000	7.050	1.800

P.Pipeline	10.000	20.0	150			7.550			7.050	
------------	--------	------	-----	--	--	-------	--	--	-------	--

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
E.Pipeline	E.Paved	1200	Manhole	Adoptable	E.Paved Outlet	1200	Manhole	Adoptable

P.Pipeline

Manhole Schedule

Node	Eastng (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
E.Paved	120.000	100.000	9.500	1.950	1200				
						0	E.Pipeline	7.550	150
E.Paved Outlet	150.000	100.000	9.000	1.950	1200		1	E.Pipeline	7.050
						1	E.Pipeline	7.050	150

Simulation Settings

Rainfall Methodology	FSR	Analysis Speed	Normal
FSR Region	England and Wales	Skip Steady State	x
M5-60 (mm)	23.400	Drain Down Time (mins)	240
Ratio-R	0.400	Additional Storage (m ³ /ha)	20.0
Summer CV	1.000	Check Discharge Rate(s)	x
Winter CV	1.000	Check Discharge Volume	x

Storm Durations

15	60	180	360	600	960	2160	4320
30	120	240	480	720	1440	2880	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
30	0	0	0
100	0	0	0
100	20	0	0
100	30	0	0
100	40	0	0

Node E.Paved Online Orifice Control

Flap Valve	x	Design Depth (m)	0.600	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Design Flow (l/s)	2.0		
Invert Level (m)	7.550	Diameter (m)	0.035		

Node E.Paved Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.01000	Safety Factor	2.0	Invert Level (m)	7.550
Side Inf Coefficient (m/hr)	0.01000	Porosity	1.00	Time to half empty (mins)	0

Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)
0.000	120.0	0.0	0.600	120.0	0.0	0.601	0.0	0.0

Results for 1 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m ³)	Flood (m ³)	Status
480 minute summer	E.Paved	304	7.594	0.044	1.2	5.3454	0.0000	OK
15 minute summer	E.Paved Outlet	1	7.050	0.000	0.2	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Discharge Vol (m ³)
480 minute summer	E.Paved	Orifice	E.Paved Outlet	0.4	7.8
480 minute summer	E.Paved	Infiltration		0.0	

Results for 30 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m ³)	Flood (m ³)	Status
240 minute summer	E.Paved	172	7.646	0.096	4.4	11.6093	0.0000	OK
15 minute summer	E.Paved Outlet	1	7.050	0.000	0.5	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Discharge Vol (m ³)
240 minute summer	E.Paved	Orifice	E.Paved Outlet	0.7	12.8
240 minute summer	E.Paved	Infiltration		0.0	

Results for 100 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m ³)	Flood (m ³)	Status
240 minute winter	E.Paved	188	7.676	0.126	3.8	15.2656	0.0000	OK
15 minute summer	E.Paved Outlet	1	7.050	0.000	0.6	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Discharge Vol (m ³)
240 minute winter	E.Paved	Orifice	E.Paved Outlet	0.8	16.1
240 minute winter	E.Paved	Infiltration		0.0	

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
360 minute summer	E.Paved	256	7.703	0.153	5.1	18.5426	0.0000	SURCHARGED
15 minute summer	E.Paved Outlet	1	7.050	0.000	0.7	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Discharge Vol (m³)
360 minute summer	E.Paved	Orifice	E.Paved Outlet	0.9	21.8
360 minute summer	E.Paved	Infiltration		0.0	

Results for 100 year +30% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute winter	E.Paved	168	7.717	0.167	6.2	20.2918	0.0000	SURCHARGED

15 minute summer	E.Paved Outlet	1	7.050	0.000	0.7	0.0000	0.0000	OK
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Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Discharge Vol (m³)
180 minute winter	E.Paved	Orifice	E.Paved Outlet	1.0	17.6
180 minute winter	E.Paved	Infiltration		0.0	

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute summer	E.Paved	188	7.731	0.181	8.0	22.0232	0.0000	SURCHARGED
15 minute summer	E.Paved Outlet	1	7.050	0.000	0.8	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Discharge Vol (m³)
240 minute summer	E.Paved	Orifice	E.Paved Outlet	1.0	20.7
240 minute summer	E.Paved	Infiltration		0.0	

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	100	Maximum Rainfall (mm/hr)	200.0
Additional Flow (%)	20	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Inverts
M5-60 (mm)	23.400	Minimum Backdrop Height (m)	0.200
Ratio-R	0.400	Preferred Cover Depth (m)	1.200
CV	1.000	Include Intermediate Ground	✓
Time of Entry (mins)	4.00	Enforce best practice design rules	✓

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
E.Paved	0.033	4.00	9.500	1800	120.000	100.000	1.950
E.Paved Outlet			9.000	1800	150.000	100.000	1.950

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
E.Pipeline	E.Paved	E.Paved Outlet	10.000	0.060	7.550	7.050	0.500	20.0	750	4.02	164.8
P.Pipeline	P.Paved	P.Paved Outlet	10.000	0.060	7.550	7.050	0.500	20.0	750	4.02	164.8

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
E.Pipeline	2.878	3480.2	23.6	1.200	1.200	0.033	0.0	42	2.397

P.Pipeline

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
E.Pipeline	10.000	20.0	750	Circular	9.500	7.550	1.200	9.000	7.050	1.200

P.Pipeline	10.000	20.0	750			7.550			7.050	
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Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
E.Pipeline	E.Paved	1800	Manhole	Adoptable	E.Paved Outlet	1800	Manhole	Adoptable

P.Pipeline

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
E.Paved	120.000	100.000	9.500	1.950	1800				
							0 E.Pipeline	7.550	750
E.Paved Outlet	150.000	100.000	9.000	1.950	1800				
							1 E.Pipeline	7.050	750

Simulation Settings

Rainfall Methodology	FSR	Analysis Speed	Normal
FSR Region	England and Wales	Skip Steady State	x
M5-60 (mm)	23.400	Drain Down Time (mins)	240
Ratio-R	0.400	Additional Storage (m³/ha)	20.0
Summer CV	1.000	Check Discharge Rate(s)	x
Winter CV	1.000	Check Discharge Volume	x

Storm Durations

15	60	180	360	600	960	2160	4320
30	120	240	480	720	1440	2880	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
30	0	0	0
100	0	0	0
100	20	0	0
100	30	0	0
100	40	0	0

Results for 1 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m ³)	Flood (m ³)	Status
15 minute summer	E.Paved	10	7.576	0.026	7.7	0.0740	0.0000	OK
15 minute summer	E.Paved Outlet	10	7.074	0.024	7.7	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m ³)	Discharge Vol (m ³)
15 minute summer	E.Paved	E.Pipeline	E.Paved Outlet	7.7	1.806	0.002	0.0427	3.0

Results for 30 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m ³)	Flood (m ³)	Status
15 minute summer	E.Paved	10	7.590	0.040	19.0	0.1143	0.0000	OK
15 minute summer	E.Paved Outlet	10	7.087	0.037	19.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m ³)	Discharge Vol (m ³)
15 minute summer	E.Paved	E.Pipeline	E.Paved Outlet	19.0	2.281	0.005	0.0833	7.4

Results for 100 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	E.Paved	10	7.596	0.046	24.8	0.1313	0.0000	OK
15 minute summer	E.Paved Outlet	10	7.091	0.041	24.8	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	E.Paved	E.Pipeline	E.Paved Outlet	24.8	2.446	0.007	0.1014	9.7

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m ³)	Flood (m ³)	Status
15 minute summer	E.Paved	9	7.600	0.050	29.8	0.1449	0.0000	OK
15 minute summer	E.Paved Outlet	10	7.095	0.045	29.8	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m ³)	Discharge Vol (m ³)
15 minute summer	E.Paved	E.Pipeline	E.Paved Outlet	29.8	2.573	0.009	0.1160	11.6

Results for 100 year +30% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m ³)	Flood (m ³)	Status
15 minute summer	E.Paved	9	7.602	0.052	32.2	0.1507	0.0000	OK
15 minute summer	E.Paved Outlet	10	7.097	0.047	32.2	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m ³)	Discharge Vol (m ³)
15 minute summer	E.Paved	E.Pipeline	E.Paved Outlet	32.2	2.634	0.009	0.1230	12.5

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m ³)	Flood (m ³)	Status
15 minute summer	E.Paved	9	7.604	0.054	34.7	0.1565	0.0000	OK
15 minute summer	E.Paved Outlet	10	7.099	0.049	34.7	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m ³)	Discharge Vol (m ³)
15 minute summer	E.Paved	E.Pipeline	E.Paved Outlet	34.7	2.676	0.010	0.1299	13.5

Appendix A.5 – Maintenance Schedules

Operation and Maintenance Schedule – Pervious paving / surfacing		
Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Brushing and vacuuming (for driveways this can be a standard cosmetic sweep over whole surface).	At minimum once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – particular attention must be paid to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment.
Occasional maintenance	Stabilise and mow contributing and adjacent areas.	As required.
	Removal of weeds or management using a suitable weed killer which will not adversely affect water quality. Weed killer should be applied directly into the weeds by an applicator rather than spraying.	As required – once per year on less frequently used pavements.
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving / surfacing.	As required when damage or erosion is detected following inspection. For block paving systems jointing material to be replaced shortly after installation and subsequently when required.
	Remedial work to any depressions. Rutting and cracked or broken blocks and replace lost jointing material (where block paving is used).	
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

General Maintenance Requirements for Permeable Surfacing (additional requirements may apply depending on type of surfacing material used).