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Client: J Jones Esq

Flood Risk Assessment for the
Proposed Development at Willop Close,
Dymchurch, Romney Marsh, Kent

October 2016

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Romney Marsh, Kent

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1 Background and Scope of Appraisal

Flooding is a major issue in the United Kingdom. The impacts can be devastating in terms of the cost of repairs, replacement of damaged property and loss of business. The objectives of the Flood Risk Assessment are therefore to establish the following:

- whether a proposed development is likely to be affected by current or future flooding from any source
- whether the development will increase flood risk elsewhere within the floodplain
- whether the measures proposed to deal with these effects and risks are appropriate
- whether the site will be safe to enable the passing of the Exception Test (where appropriate).

Herrington Consulting has been commissioned by J Jones Esq to prepare a Flood Risk Assessment (FRA) for the proposed development at **Willop Close, Dymchurch, Romney Marsh, Kent, TN29 0HU**.

This appraisal has been undertaken in accordance with the requirements of the National Planning Policy Framework (March 2012) and the accompanying Planning Practice Guidance Suite. To ensure that due account is taken of industry best practice, it has been carried out in line with the CIRIA Report C624 'Development and flood risk - guidance for the construction industry'.

Reference is also made to the National Planning Practice Guidance Suite (March 2014) 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.

2 Development Description and Planning Context

2.1 Site Location and Development

The site is located at OS coordinates 611856, 131144, off Willop Close in Dymchurch, Kent. In total the site covers an area of approximately 0.08 hectares and currently comprises undeveloped land. The location of the site in relation to the surrounding area, the Willop Basin and the coastline is shown in Figure 2.1.

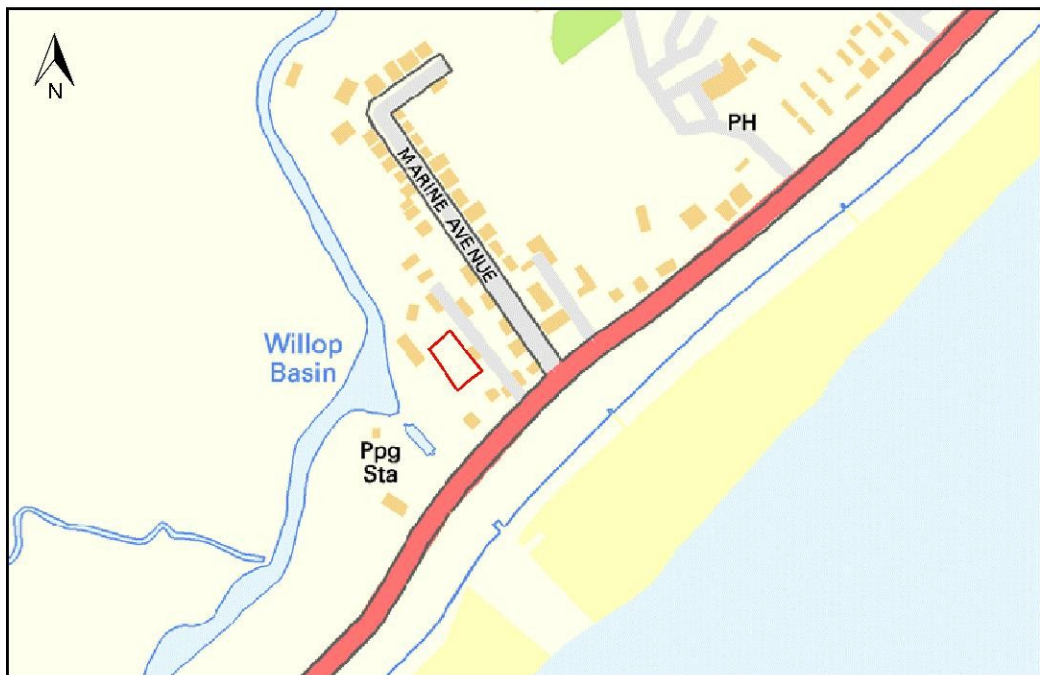


Figure 2.1 – Location map. Site outlined in red. (Contains Ordnance Survey data © Crown copyright and database right 2016)

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

The proposals for development comprise the construction of 2 no. two-storey detached residential dwellings. The proposals also include two garages and an area of car parking in front of the properties, with private gardens/amenity space to the rear.

Drawings of the proposed scheme are included in Appendix A.1 of this report.

2.3

The Sequential Test

Local Planning Authorities (LPA) are encouraged to take a risk-based approach to proposals for development in areas at risk of flooding through the application of the Sequential Test. The objectives of this test are to steer new development away from high risk areas towards those areas at lower risk of flooding. However, in some areas where developable land is in short supply there can be an overriding need to build in areas that are at risk of flooding. In such circumstances, the application of the Sequential Test is used to ensure that the lower risk sites are developed before the higher risk ones.

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 flood zone maps. 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.

The location of the site is shown on the Environment Agency's flood zone map in Figure 2.2 and the information provided by this map has been interrogated and summarised in Table 2.2 below.

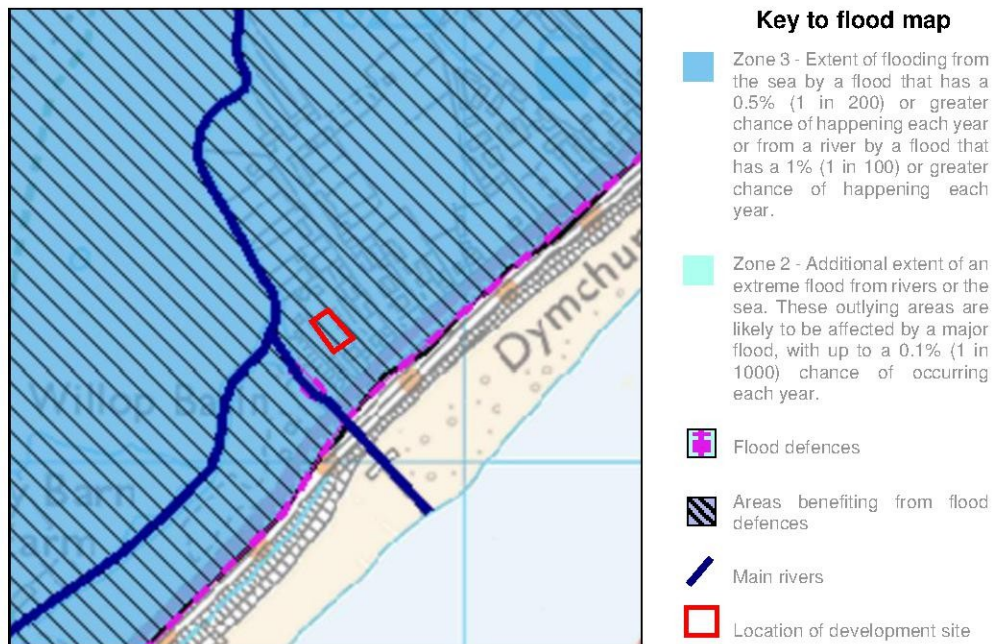


Figure 2.2 – Flood zone map showing the location of the development site (© Environment Agency)

The above mapping shows the development site to be located within Flood Zone 3 and is shown to be benefiting from existing flood defences that have been constructed in the last 5 years. 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 functional floodplain is defined by the NPPF as land where water has to flow or be stored in times of flood during events that have a probability of occurrence of 1 in 20 (5%) or greater in any one year. The Planning Practice Guidance goes on to further clarify this by adding 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. 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.

Based on information provided by the Environment Agency and that derived as part of this appraisal, the following functional floodplain test is applied:

Do predicted flood levels show that the site will be affected by an event having a return period of 1 in 20 years or less?	X
Is the site defended by flood defence infrastructure that prevents flooding for events having a return period of 1 in 20 years or greater?	✓
Does the site provide a flood storage or floodwater conveyance function?	X
Does the site contain areas that are 'intended' to provide transmission and storage of water from other sources?	X
Is site within the functional floodplain (Zone 3b)	No

Table 2.1 – Functional floodplain test

The flood zone mapping and associated information has been summarised in Table 2.2 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%	Coastal	Yes
Zone 3b	0%		
(*) The flood zone maps only recognise defences constructed within the last 5 years			

Table 2.2 – Flood zone classification

The NPPF states that the 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.

This requires a comprehensive knowledge of development sites within the district and is generally applied as part of the Local Development Framework (LDF) process. However, when applying the Sequential Test to sites that have not been assessed as part of the LDF it is necessary to apply a bespoke test, and the Flood Risk Assessment can help to provide additional evidence to better quantify the true risk of flooding, enabling an informed judgement to be made.

E-mail correspondence, held between the applicant and a Senior Planning Officer at Shepway District Council (dated 30th October 2015), has been considered. In their email, the Planning Officer acknowledges residential development of the site is acceptable in principle (in planning policy terms), given the site is located within the defined settlement of Dymchurch.

Reference to the recently revised hazard maps (2015), contained within Shepway District Council's Strategic Flood Risk Assessment (SFRA), identifies that the site is located within a 'Significant' flood hazard zone (refer to Figure 2.3). The only classification in which planning policy prohibits residential development is an 'Extreme' classification and as such, this type of development is considered acceptable in terms of policy. However, the LPA may request a Sequential Test assessment is prepared to demonstrate that there are no other developable sites available within the search area that are shown to be at a lower (i.e. 'Low' or 'Moderate') risk of flooding.

Nevertheless, inspection of the wider hazard mapping reveals that nearly all of Dymchurch and the surrounding area is classified as either 'Significant' or 'Extreme', and therefore (depending on the required search area) identifying an available site of a similar size that falls within a lower flood hazard location may prove difficult.

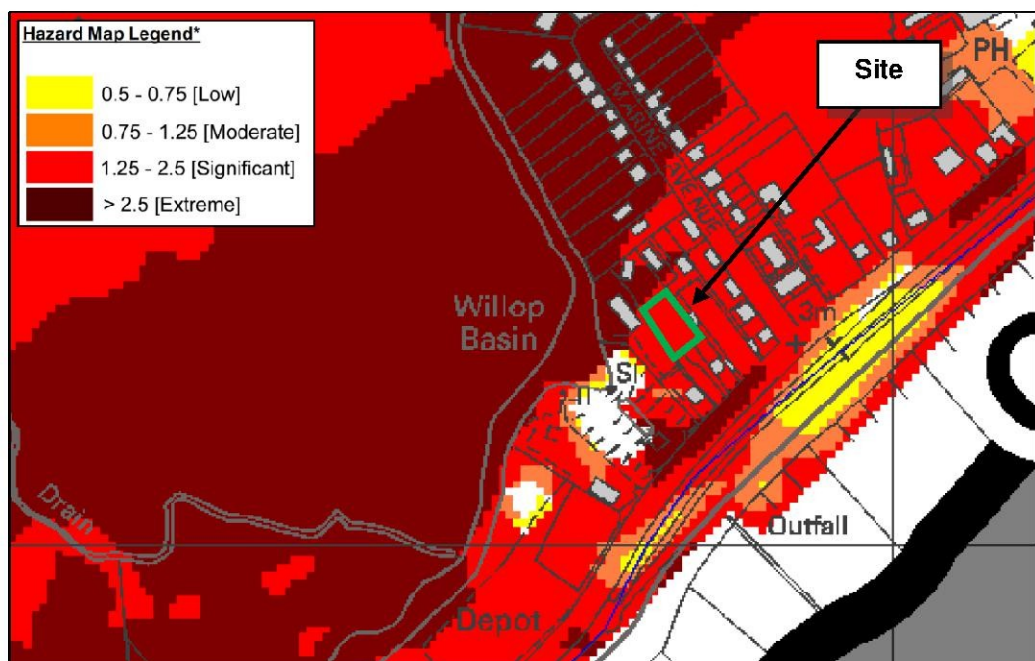


Figure 2.3 – Extract from the Shepway District Council SFRA (2015) Hazard Map for 1 in 200 year (plus 100 years of climate change) return period event. Site outline in green.

The extract above provides a snapshot of flood hazard based on the results of a combination of breach scenarios, and assumes that all of the coastal defences along the entire Shepway coastline have failed at a number of locations. Given that the occurrence of such an event falls under the classification of 'residual' risk (i.e. breach/failure of the defences in combination with an extreme tidal surge event), an alternative flood hazard map (Figure 2.4) has been referenced in

order to consider a more realistic representation of risk. This additional hazard map identifies the risk of flooding as a result of waves overtopping the defences.

This risk is generally considered to be more realistic as there is no reliance on a failure in the sea defence infrastructure for flooding to occur, and it is typically referred to as 'actual' risk.

Reference to the overtopping flood hazard map (below) identifies that the development site is located within an area classified as having a 'Low' risk of flooding from this source. When compared to the surrounding area, the majority of which is classified as having a 'Significant' risk of flooding from wave overtopping, the subject site is in fact shown to be sequentially preferable.

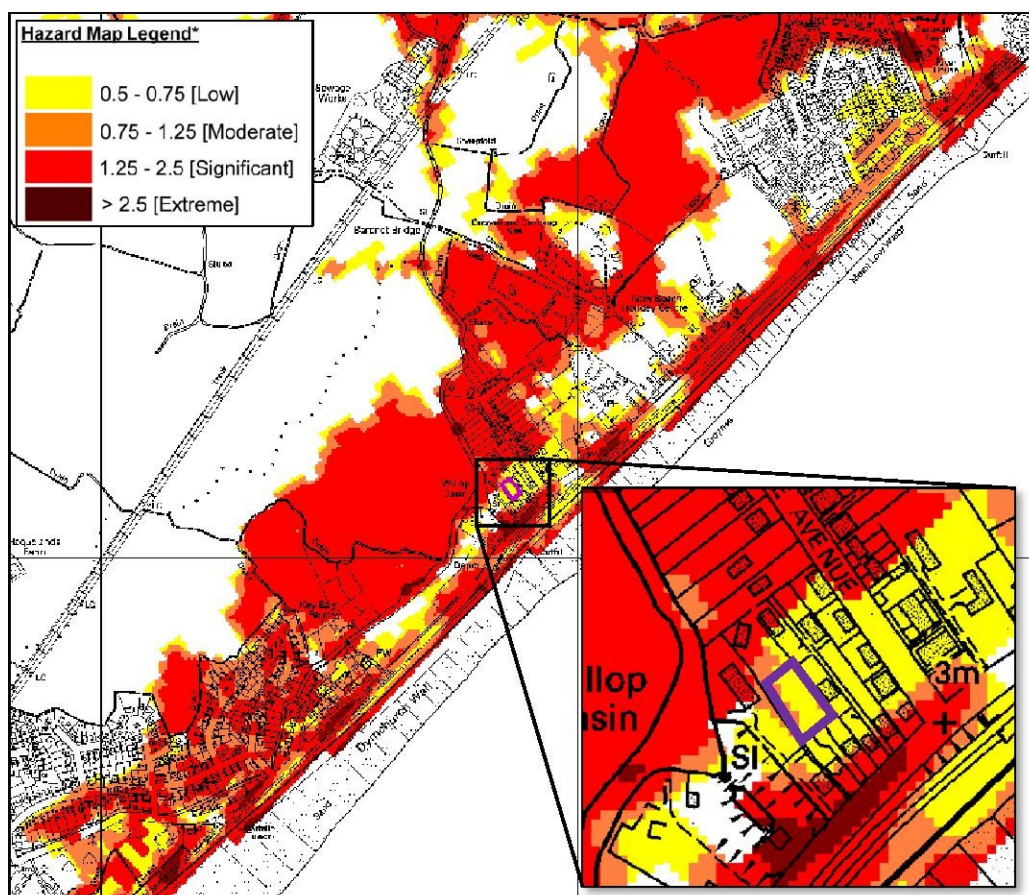


Figure 2.4 – Hazard Map for 1 in 200 year (plus 100 years of climate change) return period event when considering the 'actual' risk of flooding. Site outline in purple.

Consequently, considering the impact of flooding from an extreme wave overtopping event in isolation, it can be concluded that the site is in a sequentially preferable location when compared to other sites within the immediate urban area.

2.4

The Exception Test

According to the NPPF, if following the application of the Sequential Test it is not possible, consistent with wider sustainability objectives, for the development to be located in zones of lower probability of flooding, the Exception Test can be applied.

As part of this process it is necessary to consider the type and nature of the development. The Planning Practice Guidance: Flood Risk and Coastal Change defines the type and nature of different development classifications in the context of their flood risk vulnerability. This has been summarised in Table 2.3 below.

Flood Risk Vulnerability Classification	Zone 1	Zone 2	Zone 3a	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 2.3 – Flood risk vulnerability and flood zone compatibility

From Table 2.3 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 there are two criteria that must be satisfied and these are listed below:

- it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment where one has been prepared; and
- a site-specific flood risk assessment must demonstrate that 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 elements 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 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 the second element of the Exception Test.

3 Definition of Flood Hazard

3.1 Site Specific Information

In addition to the high level flood risk information shown in the Environment Agency (EA) flood zone maps, additional data from detailed studies, topographic site surveys and other information sources is referenced. This section summarises the additional information collected as part of this FRA.

Site specific flood level information contained within the SFRA – The Shepway District Council SFRA (2015) contains detailed mapping of flood extents from 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. Their response is included in Appendix A.3.

Site specific topographic surveys – A site-specific topographic survey has not been undertaken at this stage, however, inspection of OS mapping and LiDAR data records show that the land levels of the site vary between 1.18m and 2.20m Above Ordnance Datum Newlyn (AODN). The centre of the site is elevated and the levels slope away to the surrounding area.

Geology – Reference to the Geological Survey map shows that the underlying solid geology in the location of the subject site is Tonbridge Wells Sand Formation. Overlying this are Tidal Flat Deposits consisting of clay and silt.

Historic flooding – The Shepway District Council SFRA highlights areas of historic flooding within the district. This reveals that fluvial flooding from the Willop Sewer affected properties on nearby Marine Avenue in either 1995 or 1997. The SFRA also highlights another incident of flooding on Marine Avenue in Jan/Feb 2001 resulting from multiple sources (fluvial, surface water and surcharging sewers). However, there is no record of any event affecting the subject site itself.

3.2 Potential Sources of Flooding

The main categories of flooding have been assessed as part of this appraisal. The specific issues relating to each one and its impact on this particular 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 the Sea – The site lies within a coastal Flood Zone (3a) as shown on the Environment Agency'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. The fact that the site lies within Flood Zone 3a means that the risk of flooding from this source is examined in more detail in this FRA.

Flooding from Rivers (Fluvial) and Ordinary or Man-made Watercourses – The site lies within close proximity to the Willop Sewer, a man-made watercourse which forms part of a network of channels draining the Romney Marsh. The primary role of these artificial watercourses is to reduce the groundwater level within the surrounding land, with pumps or tidal sluices being used to discharge flows to the sea. These watercourses are maintained by various agencies and the water levels are carefully managed. Extreme rainfall, the failure of a pumping station or the tide-locking of the tidal outlet can prevent the system discharging, which may result in increased water levels in the network of drains and ditches.

The elevation of the site is approximately 0.1m below the embankment of the Willop Sewer and therefore, there is a risk of flooding from this source. However, there is no known water level data for this man-made watercourse, so it is not possible to quantify the risk of flooding accurately from this source. Nevertheless, due to the large and relatively flat nature of the land that is drained, the consequence of such an event is likely to be water logging of the ground and shallow flooding in the lower-lying areas.

The numerous channels within the Romney Marsh are rarely full to capacity and therefore there is a significant amount of redundant storage available within the overall drainage network. This additional storage would naturally be utilised during a flood scenario, thus reducing the flood risk from this source during an extreme event.

Consequently, the risk of flooding from this source is significantly less than from a coastal flood event with the same magnitude. As such, the mitigation measures discussed in later section 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.

Flooding from Land (overland flow and surface water run-off) – 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 flooding mechanism can occur almost anywhere, but is likely to be of particular concern in any topographical low spot, or where the pathway for run-off is restricted by terrain or man-made obstructions.

However, the prediction of flooding from surface water can be difficult, as it is hard to forecast the exact intensity and extent of rainfall of a storm. Under the Flood Risk Regulations 2009, the Environment Agency was therefore tasked with producing and publishing flood maps for surface water.

Maps showing the risk of flooding, and the associated approximate depth and velocity have been produced using information from Lead Local Flood Authorities, such as drainage rates, percentage run-off rates and critical storm durations. The maps pick out natural drainage channels, rivers, low areas within the floodplain and flow paths between buildings. In addition, the maps also consider the influence of buildings, roads and other structures within the floodplain which could obstruct flows, and account for a reduction in rainfall due to drains, sewers and infiltration. They do not,

however, take into account individual property threshold heights and assume a single drainage rate for all urban areas.

Consequently, the surface water maps and the associated information are intended for guidance only, and cannot provide details for individual properties. They do, however, provide high level information and indicate areas in which surface water flooding issues should be investigated further. The risk categories are classified as follows:

- Very low probability of flooding – This zone is assessed as having less than a 1 in 1000 annual probability of surface water flooding.
- Low probability of flooding – This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of surface water flooding.
- Medium probability of flooding - This zone comprises land assessed as having between a 1 in 30 and 1 in 100 annual probability of surface water flooding.
- High probability of flooding – This zone is assessed as having greater than a 1 in 30 annual probability of surface water flooding.

Figure 3.1 below is an extract of the Environment Agency's 'Risk of Flooding from Surface Water' map and identifies the location of the site. This map has been interrogated to assist in this review, helping to identify whether the site is located in an area at specific risk of surface water flooding.

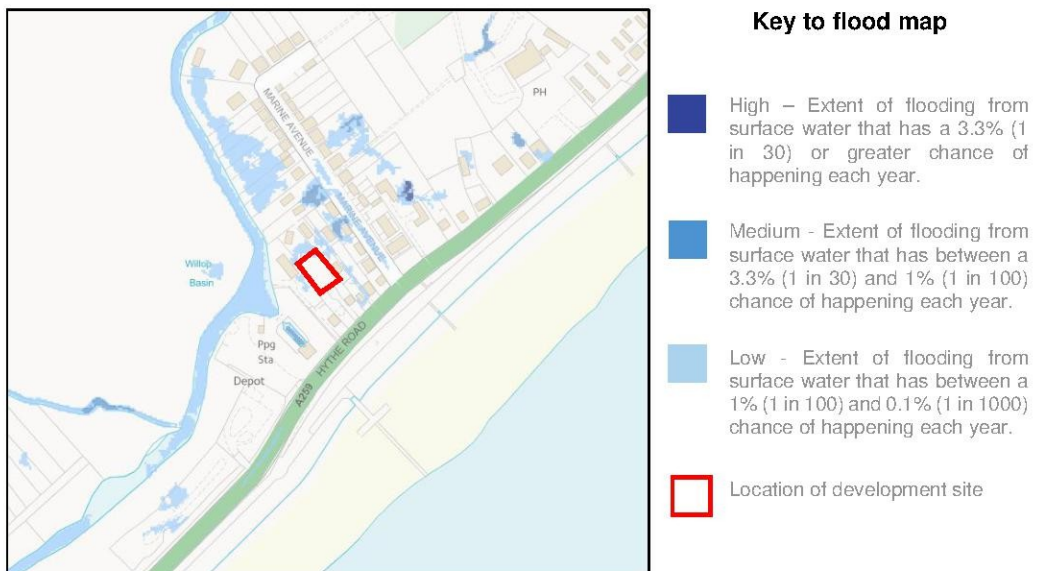


Figure 3.1 – Surface water flooding map showing the location of the development site
(© Environment Agency)

The above mapping identifies the subject site is 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 of the site and its surrounding area shows that the existing land levels fall naturally away from the centre of the site. The LiDAR data confirms that there are no topographical depressions at the site which could otherwise encourage water to pond. Furthermore, the historic records delineated in the Shepway SFRA identify that there are no historical records of surface water flooding at the site. Consequently, the site specific risk of surface water flooding is considered to be 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). Where land that is prone to groundwater flooding has been built on, the effect of a flood can be very costly, and because groundwater responds slowly compared with rivers, floods can last for weeks or months. Groundwater flooding generally occurs in rural areas although it can also occur in more urbanised areas where the process known as groundwater rebound can cause localised flooding of basements. This increase in the water table level is occurring as a result of the decrease in groundwater extraction that has taken place since the decline in urban aquifer exploitation by heavy industry.

The detailed mapping on groundwater emergence provided as part of the Defra Groundwater Flood Scoping Study (May 2004), which shows areas where groundwater flooding has occurred in the past and areas that are potentially vulnerable to groundwater emergence has also been referenced as part of this FRA. This shows that no groundwater flooding events were recorded during the very wet periods of 2000/01 or 2002/03 and that the site itself is not located within an area where groundwater emergence is predicted.

Given the low-lying nature of this area and the proximity to the Willop Sewer, there is potential for this location to become waterlogged and for the groundwater table to become elevated. However, LiDAR elevation data shows that the centre of the site is elevated. Additionally, the land drainage network in this area will ensure that groundwater levels remain below ground level. Furthermore, there are no historic records identified in the Shepway SFRA of groundwater flooding in this location. Consequently, it is considered that the site specific risk of groundwater flooding is low.

Flooding from Sewers – In urban areas, rainwater is frequently 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 is of inadequate capacity; this will continue until the water drains away. When this happens to combined sewers, there is a high risk of land and property flooding with water contaminated with raw sewage as well as pollution of rivers due to discharge from combined sewer overflows.

The sewers in this area are foul only, which greatly reduces the probability of the sewers surcharging in this area during an extreme rainfall event. In addition, there are no known records of flooding from sewers at the subject site and therefore 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, operational and redundant industrial processes including mining, quarrying and sand and gravel extraction, as they may increase floodwater depths and velocities in adjacent areas. The potential effects of flood risk management infrastructure and other structures also need to be considered. 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. This is supported by the Environment Agency's 'Risk of Flooding from Reservoirs' website which shows that the site is not within an area considered to be at risk of flooding from reservoirs.

3.3 Summary of Flood Hazard

From the analysis undertaken in Section 3.2, it can be seen that the risk of flooding from river, ordinary watercourses, sewers, groundwater and reservoirs is low. Nevertheless, this analysis has also revealed that the primary source of flooding is from the sea and therefore, the potential risk of flooding from this source will be discussed further in Section 5 of this report.

3.4 Existing Flood Risk Management Measures

A significant amount of capital investment has been made in improving the sea defences in this area over the past few years. A formal seawall structure now exists between the Dymchurch Redoubt and Littlestone, approximately 6km south of Dymchurch. This structure has been in place for several years, however, the entire frontage has undergone a series of improvements to the existing defence infrastructure in recent years.

The current defence in the Dymchurch region comprises a high embankment, with a stepped concrete revetment. The crest is protected by an asphaltic concrete pavement and there is a rear return wall with a crest of approximately 7m AODN (Figure 3.2). The rear wall has a number of flood gates to enable access to the beach, and the landward face consists of a steep embankment. The sea defence infrastructure at Dymchurch provides a standard of protection of 1 in 200 years.

Due to the flat and low-lying nature of the land behind the seawall, the site is at risk from flooding from a breach in this structure almost anywhere along its 9km length, or an open floodgate during an extreme event. Obviously, the magnitude of the impact on the site will be significantly greater if the breach or overtopping occurs in close proximity to the site, however, as part of this appraisal it is necessary to consider the risk of flooding from all potential sources.

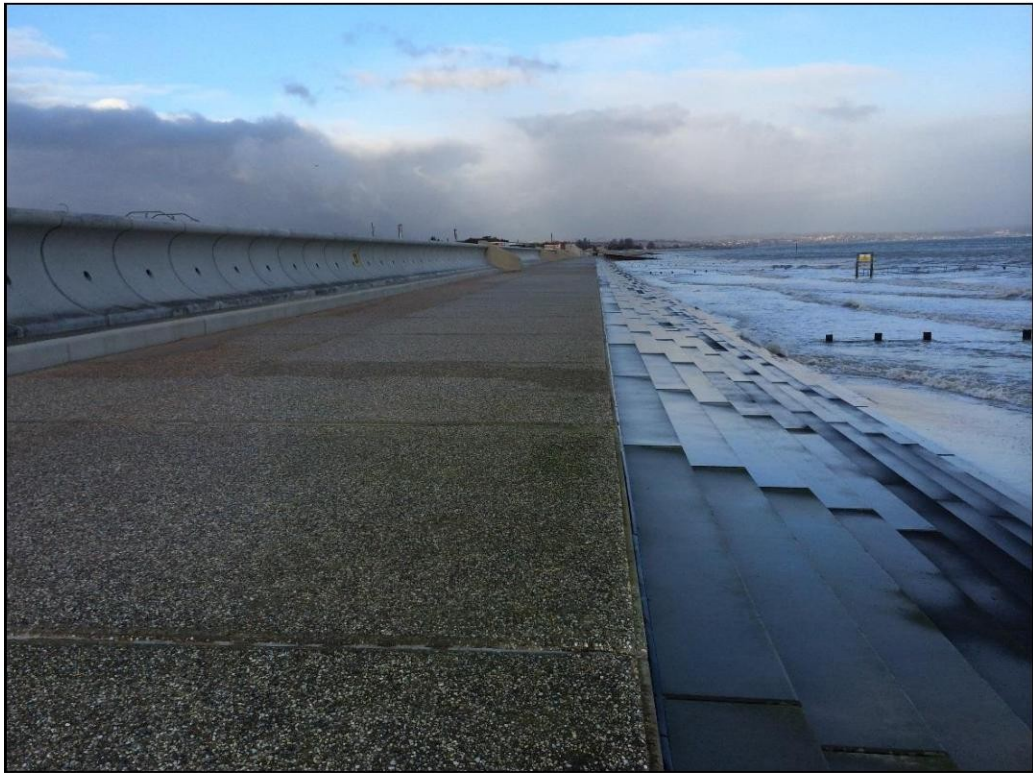


Figure 3.2 – An example of the Dymchurch stepped revetment and rear wall

To the east of the Dymchurch Redoubt there is defended length of shoreline which is referred to as the Hythe Ranges frontage and the defences along this section comprise of timber groynes and a rock revetment. These defences are currently in poor condition and provide a standard of protection typically less than 1 in 20.

The other section of sea defence that provides tidal flood protection to the area surrounding Dymchurch is the natural shingle bank that extends along the south facing shoreline of the Dungeness peninsula. This is currently managed by the Environment Agency; however, it only provides a low standard of protection against breaching. Whilst this part of the sea defences is a long way from the subject site, if the shingle bank were to breach during an extreme storm event there is a potential for a significant inundation and this could reach as far as inland Dymchurch.

4 Climate Change

When the impact of climate change is considered it is generally accepted that the standard of protection provided by current defences will reduce with time. 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 of the type responsible for the recent UK flooding 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 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. The accompanying Planning Practice Guidance Suite to the NPPF provides allowances for the regional rates of relative sea level rise and these are shown in Table 4.1.

Administrative Region	Net Sea Level Rise (mm/yr) Relative to 1990			
	1990 to 2025	2026 to 2055	2056 to 2085	2086 to 2115
East of England, East Midlands, London, SE England (south of Flamborough Head)	4.0	8.5	12.0	15.0
South West	3.5	8.0	11.5	14.5
NW England, NE England (north of Flamborough Head)	2.5	7.0	10.0	13.0

Table 4.1 – Recommended contingency allowances for net sea level rise

From these values it can be seen that the extreme flood level at the site will change with time and that this change is not linear. The 1 in 200 year flood level at the site has therefore been calculated for four time steps between the current day and the year 2115 and these values are shown in Table 4.2 below.

Year	1 in 200 year extreme water level (m AODN)
Current day (year 2008)	4.75
2025	4.82
2055	5.07
2075	5.31
2085	5.43
2115	5.88

Table 4.2 – Climate change impacts on extreme flood levels

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. The development that is the subject of this FRA is classified as residential and therefore the extreme sea level is taken as 5.88m AODN.

Peak Rainfall Intensity

The recommended allowances for increases in peak rainfall intensity were also updated in February 2016 and the allowance is 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)

From Table 4.3 above, it can be seen that the recommended climate change allowance for this site is a **20%** increase for peak rainfall intensity.

All of the above recommended allowances for climate change should be used as a guideline and can be superseded if local evidence supports the use of other data or allowances. Additionally, in the instance where flood mitigation measures are not considered necessary at present, but will be required in the future (as a result of changes in climate), a “managed adaptive approach” may be adopted whereby development is designed to allow the incorporation of appropriate mitigation measures in the future.

4.2 Impacts of Climate Change on the Development Site

The increase in tidal extremes that results from rising sea levels is significant and therefore needs to be taken into account to ensure that flood risk is appropriately mitigated over the lifetime of the development. The design flood level used to inform the recommendations for mitigation discussed in Section 7 of this report therefore includes an appropriate allowance for climatic changes.

In addition to the impact of tidal flooding at the site, climatic changes will also impact on the way in which the proposed development affects the risk of flooding elsewhere. These impacts are primarily linked to the surface water discharge from the site; therefore potential increases in future rainfall need to be taken into account when designing surface water drainage systems.

For a residential development a design life of 100 years is assumed and therefore an increase of 20% in peak rainfall intensity has been used in the calculations in the outline surface water management strategy (refer to Section 8).

5 Probability and Consequence of Flooding

5.1 Existing Likelihood of Flooding

When appraising the risk of flooding to new development it is necessary to assess the impact of the 'design flood event' to establish depths, velocities and the rate of rise of floodwater under such conditions. 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 that event will occur in any given year, or Annual Exceedance Probability (AEP). The design flood event is taken as either the 1 in 100 year (1% AEP) event for fluvial flooding or the 1 in 200 year (0.5% AEP) event for sea or tidal flooding.

In 2015, the whole Romney, Walland and Denge Marsh area was numerically modelled using TUFLOW hydrodynamic numerical modelling software as part of the SFRA (2015) commissioned by SDC. In order to ascertain the risks associated with coastal flooding, 13 scenarios were modelled taking into consideration the protection provided by defence infrastructure currently in place. These scenarios comprise 7 breach and 6 wave overtopping events.

Commensurate with planning horizons, the model outputs delineate the risk of flooding for three time epochs; 2015, 2075, and 2115 – yielding 39 scenarios in total. As well as representing the risk of flooding under current day conditions, the outputs represent the risk of flooding over the lifetime of both commercial and residential development. This development is classified as residential, and therefore the outputs for the year 2115 have been used within this report.

The outputs from the SFRA indicate that the subject site is affected by two of these scenarios (B7 and OT4). This modelling process and setup is described in detailed within the SFRA report, however, in summary Breach 7 (B7) represents a breach in the coastal defences at the Hythe Ranges and Overtopping 4 (OT4) represents the wave overtopping scenario along the Hythe Ranges frontage.

These two scenarios have therefore been investigated further as part of this FRSA in order to examine the impacts on the study site from both the 'actual' (OT4) and 'residual' (B7) risk events. A brief description of the two scenarios, their consequence in terms of flood extent and depth of flooding at the study site, as well as the likelihood of occurrence are described in the following sections.

5.2 Actual Risk – Wave Overtopping Scenario (OT4)

Three of the scenarios modelled as part of the SFRA strategic modelling identified the impact of wave overtopping on the Romney Marsh. This type of flood event is classified as 'actual risk' as there is no reliance on the failure of the sea defences for flooding to take place. Of particular relevance to the development site is Overtopping Scenario 4 (OT4), which represents overtopping along the Hythe Ranges frontage.

Figure 5.1 shows the predicted extent of the flooding at the development site and surrounding area that would occur as a result of this wave overtopping scenario. Due to the nature of the modelling, flood depths below 5mm have been filtered to show the true extent of flooding at the site.

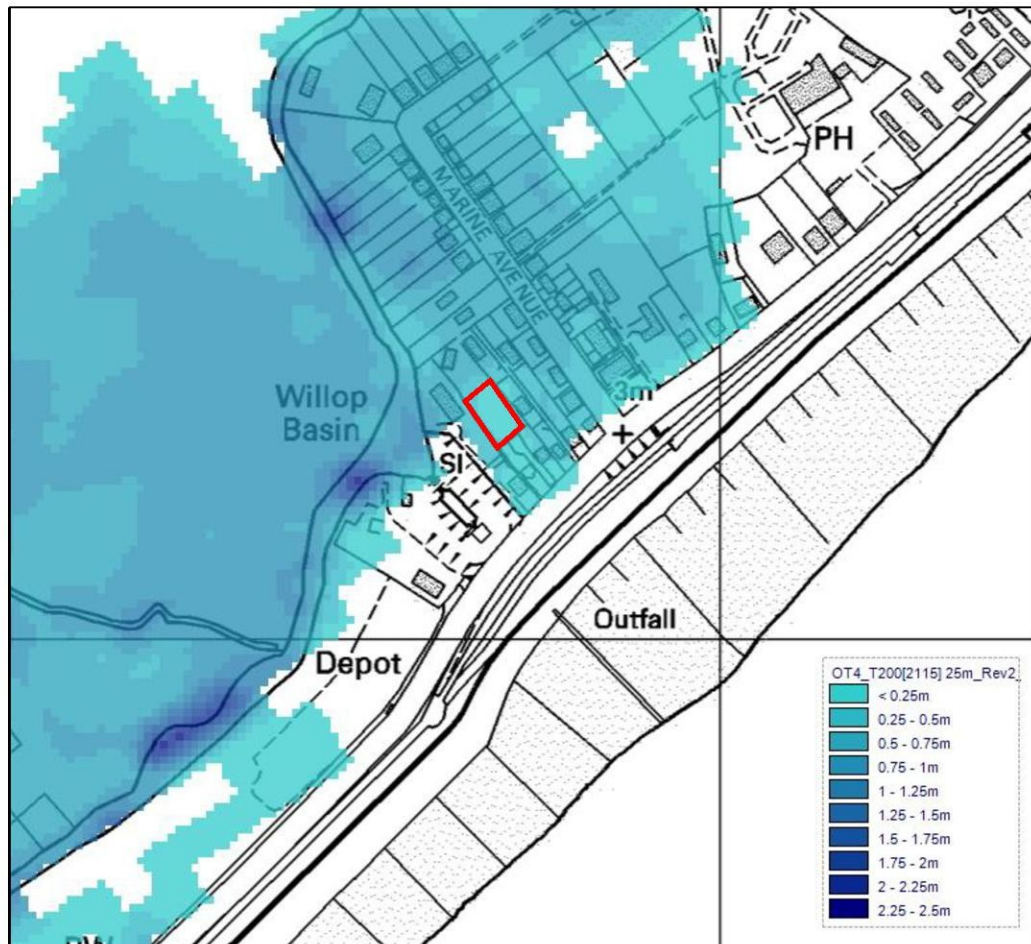


Figure 5.1 – Predicted flood extents from Overtopping Scenario 4: 1 in 200yr +cc scenario (Contains Ordnance Survey data © Crown copyright and database right 2016).

From the above flood extents map it can be seen that the entire subject site is predicted to be affected by shallow flooding under this actual risk scenario. The predicted surface water elevation under this event is **2.05m AODN**. This equates to a depth of flooding across the site of less than 250mm. However, it is recognised that the model does not include the allowance for any localised drainage systems, which could reduce the depth of flooding at this location.

5.3 Residual Risk – Breach Scenario (B7)

When considering the residual risk of flooding, the results of 7 single breach scenarios (tested as part of the SFRA modelling) have been interrogated. The results identify that a breach along the Hythe Ranges would potentially have the greatest impact on the development site.

Figure 5.2 (below) shows the predicted extent of the flooding that would occur as a result of a breach in the flood defences at Hythe Ranges (modelled Scenario 7). From Figure 5.2 below it can

be seen that the site is shown to be located within the modelled breach extents. The predicted surface water elevation under this worst-case residual risk scenario is shown to be **3.14m AODN**.

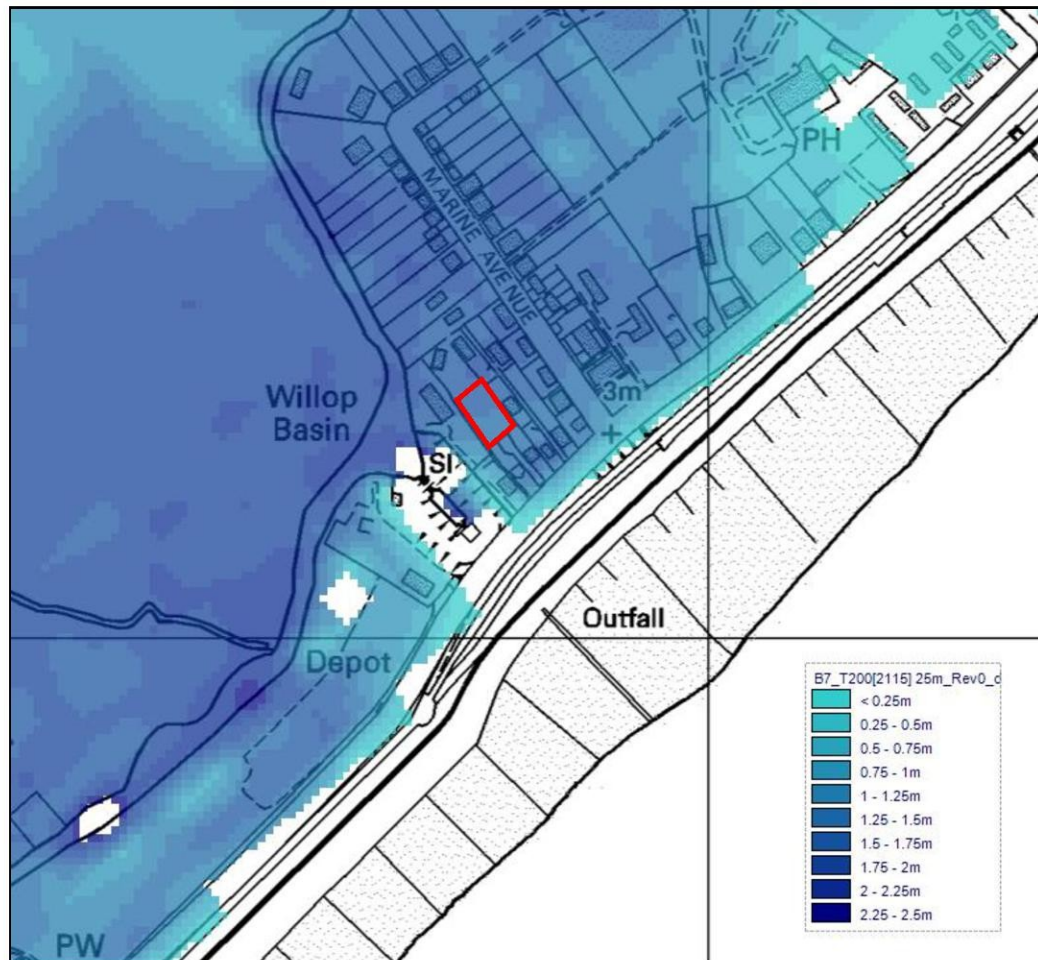


Figure 5.2 – Predicted flood extents from Breach Scenario 7: 1 in 200yr +cc scenario. Site outlined in red. (Contains Ordnance Survey data © Crown copyright and database right 2016).

It is recognised that the defences along the Hythe Ranges frontage are currently in poor condition and at present provide a low standard of protection (generally less than 1 in 20). Therefore, despite its classification as 'residual risk', it is considered that the likelihood of a breach occurring in the defence infrastructure along this frontage is moderate. Consequently, the recommendations of this report are based on this residual risk scenario.

5.4 Depth and Velocity of Flooding

Both the overtopping and breach scenarios represent a 1 in 200 year event with a 100 year allowance for climate change (i.e. design flood conditions for residential development). Interrogation of the results reveals that the subject site is shown to be flooded to a maximum depth of 250mm under the overtopping scenario (OT4). Under the breach scenario (B7), the depth of flooding at the site could reach 1.3m.

Further interrogation of the model results from the SFRA provides information on the velocity of floodwater under each scenario. The velocity of floodwater predicted under the overtopping scenario is relatively low (generally less than 0.1m/s). Under the residual risk (breach) scenario, floodwater velocities are shown to be significantly greater, reaching a maximum of 1.3m/s.

From the above analysis, it is considered that the principal risk of flooding to the subject site is as a result of waves overtopping the defences at Hythe Ranges, as there is no reliance of the failure of sea defences for floodwater to reach the site.

5.5 Rate of Rise of Floodwater

As well as the source of flooding, the size and nature of the flood compartment has a major influence on the rate of rise of the floodwaters. For a small, steep sided compartment, the rate of rise will be rapid, whereas for a compartment that is relatively large with respect to the source of flooding and has shallow sloping sides, the rate of rise will be more gradual. The flood compartment in which the development site is located fits the description of the latter.

However, in this instance, the most important factor to take into consideration is that the site is located only 75m inland of the Dymchurch sea defences and therefore, there will only be a short delay between the defences being overtopped/breached and the floodwater reaching the site and surrounding area.

The onset of flooding from a breach in the sea defence infrastructure will, by its nature happen quickly and considering the distance from the coastline it is likely that floodwater could reach the site within a short period of time. Interrogation of the model outputs for the SFRA reveal that floodwater could reach the site within 1 hour 20 minutes from the breach. Due to the nature of a breach the rate of rise of floodwater could be rapid.

The SFRA model simulates a breach duration of 56 hours, during which the breach remains fully open. Consequently, floodwater continues to enter and leave the flood compartment as the tide rises and falls. The simulation stops at hour 56 and at this point floodwater is shown to remain within the boundaries of the site. Assuming that after 56 hours the breaches are repaired, it would still be a significant amount of time before all floodwater could be evacuated from the Marsh.

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 from that area and to increase flood risk elsewhere by raising flood levels. Whilst the impact of a single development within a large floodplain such as this is negligible, it is the cumulative effect of all development in the area that the NPPF seeks to prevent. It achieves this by requiring any displacement that has the potential to increase risk elsewhere to be compensated for as part of a compensatory flood storage scheme.

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

6.2 Public Safety and Access

The NPPF states that, where required, safe access and escape is available to/from new developments in flood risk areas. The Practice Guide goes on to state that access routes should be such that occupants can safely access and exit their dwellings in design flood conditions and that vehicular access to allow the emergency services to safely reach the development will also normally be required.

Based on the information provided by the SFRA it is possible to conclude that the subject site could be flooded in the event that if the existing sea defences were to fail or be overtopped. The hazard mapping shown in Figure 2.3 identifies that safe access would not be available from the proposed dwellings or the site in the event of a failure in the defence infrastructure. Consequently, the occupants of the dwellings will have to seek safe dry refuge on the upper floor of the development.

Notwithstanding this, under the actual risk event (wave overtopping), Figure 2.4 shows safe access will be available within the site itself meaning occupants of the proposed dwellings will not be confined to their homes during an overtopping event and will be able to provide assistance to each other. Whilst residents will have safe and dry refuge throughout the design flood event, it is imperative that they sign up to the free Flood Warning Service provided by the EA.

6.3 Proximity to Flood Defence Structures

Under the Water Resources Act 1991 and Land Drainage Byelaws, any proposals for development in close proximity to sea defence infrastructure would need to take into account the Environment Agency's requirement for a 16m buffer zone between the toe of the defences on the landward side and any permanent construction such as buildings or car parking etc.

Inspection of OS mapping reveals that the development site is located approximately 90m from the defences and as such will not compromise any of the Environment Agency's or LPA's maintenance or access requirements.

6.4

Impact on Coastal Morphology and Impedance of Flood Flows

Whilst the development site is located 90m from the sea wall, the proposals will not have any influence over sediment transport or coastal processes and will therefore not directly affect coastal morphology. In addition, this frontage is not shown by the Shoreline Management Plan to have either a No Active Intervention or Managed Realignment Policy and therefore the policy in this location is to maintain the seawall in its current position and alignment.

In terms of the way in which the development would interact and modify flood flows, its location and size with respect to the flood risk area and the flow path has to be considered. However, given the size of the proposed development, and its location with respect to the source of flooding, it is unlikely to significantly impede floodwater flows during an extreme event.

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

Up to this point in the report the risks to the site have been appraised and the consequences of these risks occurring have been broadly considered. The following table highlights the mitigation measures that are considered most appropriate for this site. At this stage the recommended mitigation measures are indicative only, but will need to be considered in greater detail as part of the site specific FRA.

Mitigation Measure	Appropriate	Comment
Careful location of development within site boundaries (i.e. Sequential Approach)	X	Refer to Section 7.1
Raising floor levels	✓	Refer to Section 7.2
Land raising	X	Refer to Section 7.2
Compensatory floodplain storage	X	Not required
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
Management of development run-off	✓	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.

The entire site is located within the modelled flood extents under both actual and residual risk scenarios; therefore, there is limited opportunity to apply the Sequential Approach.

7.2 Raising Floor Levels and Land Raising

Internal flooding can result in damage to the property and its contents. Flooded properties are often un-usable for long periods after they are flooded while the property dries and repairs are carried out. By setting the floor levels above the estimated floodwater levels, the risk of internal flooding is reduced and the impacts upon the occupants are minimised. Where this is not feasible, justification must be provided and floor levels set as high as possible. In addition, flood-proofing measures should be considered, up to the design flood level.

The previous analysis has identified that the subject site could be affected by flooding under two scenarios: either as a result of waves overtopping the sea defences at Hythe Ranges (actual risk) or a breach in the defence infrastructure along the same frontage (residual risk).

Although the likelihood of the defence infrastructure breaching is extremely low, to prevent the ingress of floodwater into the proposed dwellings under such an event, the finished floor levels will be raised above the design flood level for the residual risk scenario stated in section 5.3 (breach in the Hythe Ranges defence infrastructure).

The Environment Agency normally recommends that the minimum floor level of buildings at risk of flooding should be 300mm above the design flood level. The Environment Agency's guidance also requires that all sleeping accommodation be raised a minimum of 600mm above the design flood level. The design flood level under this residual risk scenario is 3.14m AODN. As such, the requirements for finished floor levels are as follows:

Living accommodation = 3.44m AODN

Sleeping accommodation = 3.74m AODN

Inspection of the scheme drawings for the site identify that the ground floor of the proposed dwellings has been set to 3.44m AODN (living accommodation), with all sleeping accommodation situated on the first floor and above (5.50m AODN). Consequently, the required finished floor levels under the residual risk scenario have been achieved.

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.

Flood proofing measures which can be implemented to reduce the damage to buildings and property are becoming more common in areas that are subject to flooding. Typical examples of flood resilience measures which may be appropriate for the development site include (but are not limited to) the following:

- Raising the floor slab level further
- 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
- Solid stone or concrete floors with no voids underneath
- Covers for doors and airbricks
- Non-return valves on new plumbing works
- Avoidance of studwork partitions on 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.

7.4 Flood Warning

The Environment Agency 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.

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 Environment Agency to predict the onset of flood events the opportunity now exists for all residents within the flood risk area to receive early flood warnings.

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 Environment Agency's Floodline Service is contacted to find out if it is possible to register for Floodline Warnings Direct, which is a free service that provides flood warnings direct by telephone, mobile, fax or pager.

Reference to the Environment Agency's website shows that the site is located within two flood warning areas as shown in Table 7.2 below;

Flood Warning Area	Quickdial number
Coast from Folkestone to St Marys Bay	0125112
Coast from Sandgate to Dungeness	01251

Table 7.2 - Environment Agency Flood Warning Areas and Quickdial numbers.

For further details call Floodline on 0345 988 1188, select Option 1 and enter either quickdial number.

8 Surface Water Management Strategy

The general surface water management requirement for all new development is to ensure that the peak discharge rate and the discharge volume of surface water run-off does not exceed that of the existing site. Additionally, surface water run-off up to the 100 year return period event should preferably be contained within the site at designated temporary storage locations unless it can be shown to have no material impact in terms of nuisance or damage, or increase river flows during periods of river flooding (Preliminary rainfall run-off management for developments - EA/DEFRA W5-074/A).

The requirements for managing rainfall run-off from developments depends on the pre-developed nature of the site. For undeveloped greenfield sites, the impact of the proposed development will require mitigation to ensure that the run-off from the site replicates the natural drainage characteristics of the pre-developed site.

In the case of brownfield sites, drainage proposals will be measured against the existing performance of the site, although it is preferable for solutions (where practical) to provide run-off characteristics that are similar to greenfield behaviour.

In addition, the proposed development is not subject to the requirements of the National Technical Standards for SuDS. Nonetheless, reference to the standards has been made throughout the following sections, in line with best practice.

8.1 Surface Water Management Overview

The main characteristics of the site and the proposed development relating to the surface water drainage are summarised in Table 8.1 below.

Site Characteristic	Value
Total area of site	810 m ²
Impermeable area (existing)	0 m²
Impermeable area (proposed)	Roof area = 150 m ² Hardstanding = 130 m ² Total = 280 m²
Current site condition	Greenfield site
Greenfield run-off rate (QBar)	1.8 l/sec/ha (based on IoH Report 124 methodology)
Greenfield run-off rate (Q100)	5.8 l/sec/ha (based on IoH Report 124 methodology)
Infiltration coefficient	0.01 m/hr (assumed based on underlying geology and typical soil conditions)
Standard Percentage Run-off (SPR)	27.0%
Current surface water discharge method	No formal drainage
Is there a watercourse within close proximity to site?	Yes
Is site within groundwater Source Protection Zone?	No

Table 8.1 – Site characteristics affecting rainfall run-off

Synthetic rainfall data has been derived using the variables obtained from the Flood Studies Report (FSR) and the routines within the Micro Drainage Source Control software. The peak surface water flows generated on site for the existing and post-development conditions have been calculated by using the Modified Rational Method. Run-off rates have been calculated for a range of annual return probabilities including the 100 year return period event with a 20% increase in rainfall intensity to account for future climatic changes.

These values are summarised in Table 8.2 for a range of return periods. The critical storm duration is shown in brackets.

Return period (years)	Peak run-off (l/sec)	
	Existing site	Developed site
1	Undeveloped	5 (15 mins)
30	Undeveloped	13 (15 mins)
100	Undeveloped	16 (15 mins)
100 + 20%	Undeveloped	19 (15 mins)

Table 8.2 - Summary of peak run-off.

The total volume of water discharged from the site from the 100 year 6 hour event (including for a 20% increase for climate change) is summarised in Table 8.3 below for both the existing and proposed site conditions.

Site condition	Total volume discharged
Existing site	Undeveloped
Proposed development (before mitigation)	22 m ³

Table 8.3 – Total volume discharged from the 100 yr+20%cc 6 hour event

Reference to the tables above show the proposed development will increase the percentage of impermeable area within the boundaries of the site and consequently, this will increase the volume of surface water run-off from the site. It will therefore be necessary to provide mitigation measures to ensure the rate of run-off discharged from the site is not increased as a result of the proposed development.

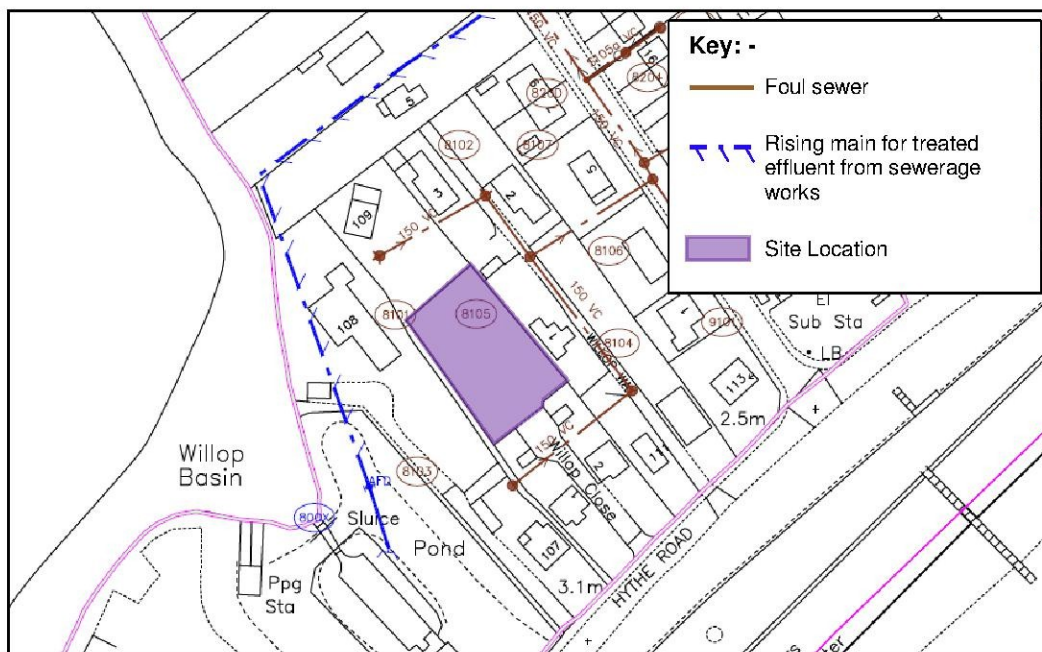
Furthermore, the potential use of sustainable drainage techniques within the proposed development will be considered in order to assess the practicality of better replicating greenfield behaviour, in accordance with best practice and S3 and S5 of the National Technical Standards for SuDS.

A detailed surface water drainage design has not been undertaken, however, it is necessary for the FRA to demonstrate that the surface water from the proposed development can be discharged safely and sustainably. The following calculations have therefore been undertaken to demonstrate that this is achievable. The proposed method of surface water discharge and the associated constraints are described below.

8.2 Existing Drainage

The existing undeveloped site is assumed to have no existing drainage connections to the Willop Sewer or public sewer system. Surface water run-off at the site is therefore discharged informally via a combination of infiltration and overland flow.

Asset location mapping has been obtained from Southern Water to identify the location of public sewers in close proximity to the development site. The only mapped sewers within the area around the site are designated for foul waste only. A rising main conveying treated effluent from a nearby sewerage treatment plant is also located near to the development site. The sewers and rising main can be seen on Figure 8.1 below.



8.3

Opportunities to Discharge Surface Water Run-Off

Building regulations part H states that the preferred option for discharging surface water run-off from the site is to **infiltrate** water into the ground as this deals with the water at source, and serves to replenish groundwater. If this is not viable (due to a high water table, local impermeable soils, contamination issues including source protection zones etc.), then the next option of preference is for the run-off to be discharged into a **watercourse**. Only if neither of these options is possible should the water be conducted into the **public sewer** system.

Infiltration – Whilst site-specific ground investigations have not been carried out at this stage in the development process, the Standard Percentage Run-off (SPR) value has been established for this site from the Flood Estimation Handbook (FEH) database. This parameter is used to indicate the percentage of rainfall which becomes direct response run-off to a watercourse. A higher run-off percentage means that less rainfall is infiltrated into the soil, indicating lower permeability soil.

The SPR for this site is 27.0%, suggesting that the soils have relatively moderate to poor permeability. This is partially supported by the geology and soil characteristics for this area, which show the site to be located on superficial deposits of sand, underlain by a bedrock of Tonbridge Wells Sandstone.

The percolation rate of the soils in this area could therefore be sufficient for some infiltration techniques to be utilised. For the purpose of this assessment an infiltration rate of 0.01m/hr has been assumed for the superficial drift deposits at the site.

Whilst it is assumed that the infiltration rate at the site will be sufficient for the use of infiltration SuDS it is still necessary to take a number of other factors into consideration. These are listed below:

- Infiltration SuDS shall not be constructed through contaminated material.
- Any infiltration SuDS should not normally be located within 5.0 metres of any existing, or proposed (adjacent) buildings and roads. For features constructed in low density chalk deposits, geotechnical investigations are often required to determine suitability and this buffer zone is extended to 10m.
- The depth of any infiltration basin or soakaway should normally not exceed 2.0 metres and under no circumstances shall be permitted to intersect the water table.
- A minimum of a 1.0 metre unsaturated zone shall be maintained between the base of any infiltration SuDS and the maximum seasonal water table for that site.
- Soakaways designed to receive clean roof water should be kept separate from those receiving surface water run-off from adoptable highway or parking areas.

- The use of borehole soakaways is always subject to written agreement from the Environment Agency.
- If infiltration SuDS features are used to discharge surface water from the site, it will be necessary to demonstrate that the design rainfall event (100 year+20%cc) can be managed on site. It may not, however, be practical to design features to accommodate the design event. In which case an alternative method of managing surface water run-off, which maximises the potential for infiltration whilst also providing the required storage will be necessary.

Discharge to Watercourses – Although the site is in close proximity to the Willop Sewer, a direct connection from the site to this watercourse is not available. Consequently, there is no opportunity to utilise a direct connection to an existing watercourse as a means of managing surface water run-off from the proposed development.

Discharge to Public Surface Water Sewer & Existing Connections – It has been assumed that there are no existing connections from the site to the public sewer system. A new connection to the public sewer system will only be possible if all other, more preferential solutions for managing surface water run-off from the site are not available.

Nonetheless, if a new connection is required, there are two potential options available. These are outlined in further detail below.

Option 1 – Connection to the existing foul / combined sewer network

If there is sufficient capacity within the existing foul / combined sewers in close proximity to the site, then there may be the opportunity to discharge surface water run-off at an attenuated rate into the existing public sewer system. A connection agreement and confirmation from the sewerage undertaker will be required to ensure surface water run-off from the proposed development does not increase the risk of sewer flooding in this area.

Option 2 – Requisition a new surface water sewer to discharge surface water run-off from the site.

If Southern Water confirms a connection to the existing foul / combined sewer system will not be possible, then there is still the opportunity to requisition a new surface water sewer through a Section 98 application. If this option is taken it is recognised that some of the costs to implement this new sewer would be charged to the developer.

If a connection to the public sewer system is required, further investigations will be needed at the detailed design stage, to determine which of these two options will be the most feasible. This could potentially include capacity checks on the existing sewerage system and undertaking pre-development liaison with Southern Water with regard to the preferred solution.

8.4 Constraints and Further Considerations

As the permeability of the soils and geology in this location has not yet been confirmed there is a chance that infiltration testing will reveal soil conditions to be less permeable than expected. To ensure a solution for draining the proposed development is available it will therefore be necessary to provide an alternative strategy for managing surface water run-off from the site which does not rely on any infiltration being available.

In order to determine whether infiltration will be appropriate at the site, infiltration testing will be required at the detailed design stage in order to refine the outline designs put forward as part of this surface water management strategy. At this 'strategic' stage the surface water management strategy has been based upon an assumed infiltration rate of 0.01 m/hr.

It may also be necessary to confirm the exact level of groundwater table, to determine the depth below ground level.

Inspection of the site and scheme layout shows that whilst there are opportunities for the inclusion of Sustainable Drainage Systems (SuDS), there is very little open space in which to incorporate SuDS features that require significant areas of land such as large wetland areas. The SuDS options are discussed in more detail in the following section.

8.5 Sustainable Drainage Systems (SuDS)

Appropriately designed SuDS can be utilised such that they not only attenuate run-off 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 components 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 Feature	Environmental benefits	Water quality improvement	Suitability for low permeability soils (k<10-6)	Ground-water recharge	Suitable for small/confined sites?	Site-specific restrictions	Appropriate for subject site?
Wetlands	✓	✓	✓	x	x	Insufficient space	No
Retention ponds	✓	✓	✓	x	x	None	Yes
Detention basins	✓	✓	✓	x	x	Insufficient space	No
Infiltration basins	✓	✓	x	✓	x	Insufficient space	No
Soakaways	x	✓	x	✓	✓	Limited by moderate to poor infiltration.	Likely only suitable for shallow large soakaways / infiltration blankets
Underground storage	x	x	✓	x	✓	None	Yes
Swales	✓	✓	✓	✓	x	None	Yes
Filter strips	✓	✓	✓	✓	x	None	Yes
Rainwater harvesting	x	✓	✓	✓	✓	None	Yes
Permeable paving	x	✓	✓	✓	✓	None	Yes
Water butts	✓	x	✓	x	✓	None	Yes
Green roofs	✓	✓	✓	x	✓	Dependant on proposed roof construction	Unknown at this stage

Table 8.4 – Suitability of SuDS

From Table 8.4, it can be seen that there are a number of SuDS elements that are potentially suitable for this site. However, at this stage in the planning process, it is envisaged that the preferred solution will be to discharge surface water run-off to the ground via a combination a large infiltration blanket and permeable paving.

8.6 Proposed Surface Water Management Strategy (SWMS)

The SWMS for each of the different elements of the scheme is set out below along with the calculations that have been undertaken to demonstrate how the overall objectives have been 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.

The preferred option for discharging run-off from the site would be via infiltration (Option 1). However, as this option could be restricted by poor soil conditions, a second option for discharging surface water run-off from the site has also been proposed. This second option (Option 2) utilises cellular storage to store additional surface water run-off before discharging to the public sewer system at a controlled rate.

The two potential options have been outlined in further detail below:

Option 1: To discharge the run-off from the entire site via infiltration.

Permeable Paving

For the car parking and hardstanding areas, it is possible to incorporate permeable paving. Provided that this is laid onto a minimum of a 0.3m thick open-graded sub-base, this will provide sufficient storage for the run-off before discharging via infiltration such that the 100 year+20%cc event can be fully discharged. This is based upon an infiltration rate of 0.01 m/hr.

A summary of the Micro Drainage analysis for permeable paving is shown in Table 8.5 below.

Parameter	Value
SuDS Feature	Permeable Paving
Area draining to permeable paving	130 m ²
Area of permeable paving	100 m ²
Critical storm duration	360 minutes
Maximum filtration	0.1 l/sec
Half drain time	459 minutes
Required sub-base depth	0.3m

Table 8.5 – Summary of Micro Drainage analysis for the permeable paving (100 yr+20%cc)

Infiltration Blanket

The surface water run-off from the roofs of the buildings (and hardstanding if required) can be discharged by a large infiltration blanket, this is based upon an infiltration rate of 0.01 m/hr.

A summary of the Micro Drainage analysis for the infiltration blanket is shown in Table 8.6 below.

Parameter	Value
SuDS Feature	Infiltration blanket
Area draining to Infiltration Blanket	150 m ²
Assumed Infiltration Rate	0.01 m/hr
Maximum Filtration	0.1 l/sec
Critical storm duration	480 minutes
Half drain time	612 minutes
Required Volume	81m ² x 0.4m (deep)

Table 8.6 – Summary of Micro Drainage analysis for the infiltration blanket (100 yr+20%cc)

Figure 8.2 (below) is an indicative drainage layout plan delineating how the proposed infiltration blanket and permeable paving can be incorporated into the scheme proposals.

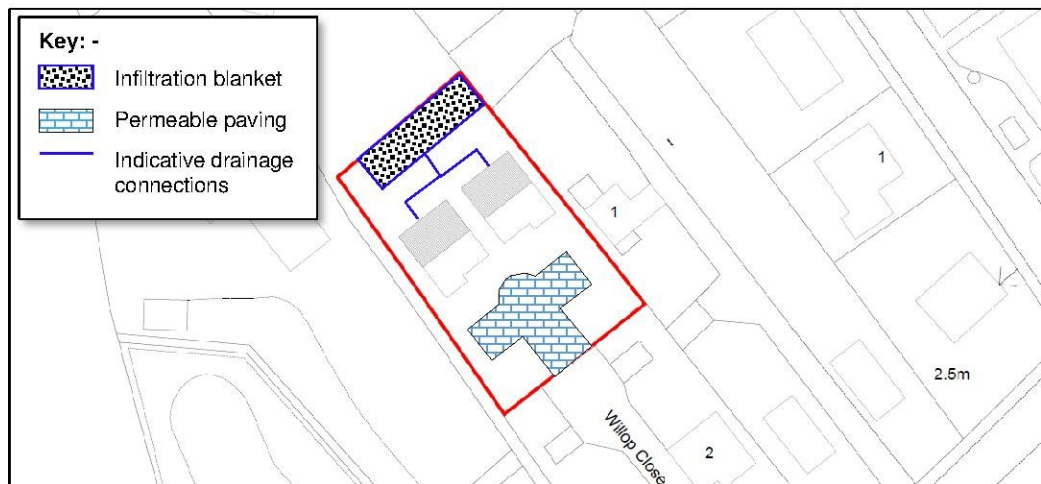


Figure 8.2 – Indicative drainage layout showing the potential location for an infiltration blanket and permeable paving.

Option 2: To discharge the run-off from all parts of the site to the public sewer via a cellular storage system located beneath the car parking / hardstanding area to the front of the properties.

It is recognised that, if the infiltration rates determined through site specific infiltration testing are confirmed to be lower than expected, it may still be possible to incorporate permeable paving into the scheme by increasing the depth of the sub-base accordingly; to account for the additional time required to discharge run-off into the ground.

However, if infiltration is found to be negligible the sub-base could simply be used as additional storage, which would be connected to the overall surface water drainage system. The surface water from this storage would subsequently be discharged into the surface water sewer at a restricted rate.

For the purpose of this assessment, the additional attenuation provided by run-off filtering through permeable paving has not been taken into account, this provides a worst case scenario giving the maximum required crate size for run-off from all roofs and hardstanding surfaces.

Ideally, run-off discharged from the site to either the public sewer should be restricted to the greenfield run-off rate, however, in order to minimise the risk of flooding through a failure in the local drainage system (i.e. as a result of blockage), a discharge rate of 5.0 l/s for orifice plates and 2.0 l/s for Hydro-Brakes is typically used. In this instance, the use of a Hydro-Brake to limit the discharge rate to 2.0 l/s is likely be acceptable on this basis.

Cellular Storage System

The surface water run-off from the roof of the proposed building can be discharged to the public sewer at an attenuated rate, via a cellular storage system, utilising a Hydro-Brake flow control device to restrict the discharge rate to 2.0 l/s. This is based upon an assumed negligible infiltration rate.

A summary of the Micro Drainage analysis for the hardstanding and roof areas is shown in Table 8.7 below.

Parameter	Value
SuDS Feature	Cellular Storage Crates
Area draining to attenuation system	280 m ²
Assumed infiltration	None
Flow control device	Hydro-Brake
Maximum allowable rate of discharge	2.0 l/sec
Peak discharge for 100yr+cc event	2.0 l/sec
Critical storm duration	60 minutes
Half drain time	40 minutes
Required storage	35m ² x 320mm (deep)

Table 8.7 – Summary of Micro Drainage analysis for the cellular storage system (100 yr+20%cc)

Figure 8.3 (below) is an indicative drainage layout plan delineating how the proposed cellular storage can be incorporated into the scheme proposals.

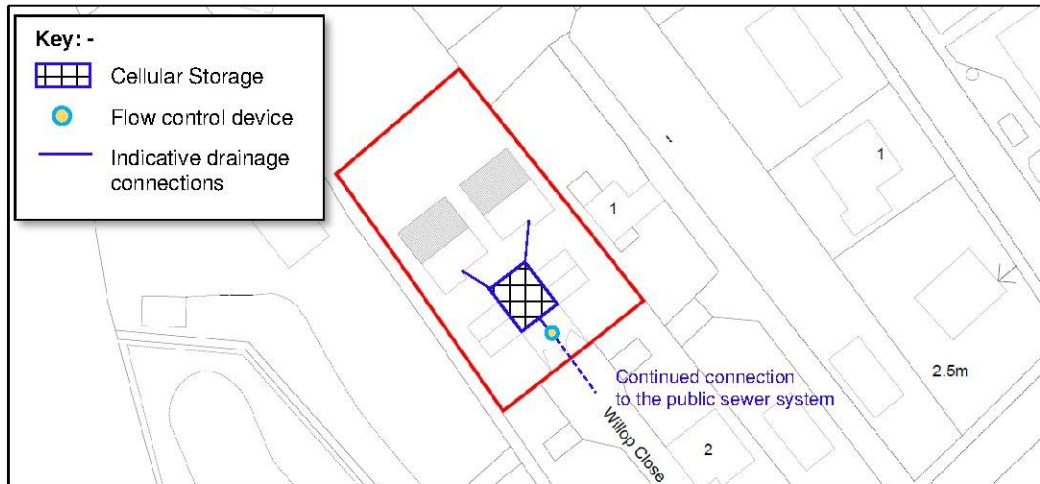


Figure 8.3 – Indicative drainage layout showing the potential location for cellular storage.

8.7 Management and Maintenance

In order for any surface water drainage system to operate as originally designed, it is necessary to ensure that it is adequately maintained throughout its lifetime. Over the lifetime of a development there is a strong possibility that the system could either fail or its performance be reduced if it is not correctly maintained. This is even more important when SuDS form a part of the surface water management system, as these require a more onerous maintenance regime than a typical piped network.

The key requirement of any management regime is routine inspection and maintenance and therefore at the stage when the development is taken forward to the detailed design stage an 'owner's manual' will need to be prepared. This will 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
- An explanation of the consequences of not carrying out the specified maintenance

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 of the infiltration blanket or the underground storage areas. For the latter, it is important to ensure that the design must recognise the need for this operation and thus incorporate silt traps and easy access for emptying.

At this point in time there are no formal arrangements for SuDS to be adopted; however, for developments such as this that rely to some extent on the ongoing inspection and maintenance of the SuDS features, it will be necessary to ensure that measures are in place.

One option would be to task a management company responsible for maintaining the rest of the site with the inspection and maintenance of the SuDS elements. As the site is relatively small another option could be to task the individual residents with the maintenance responsibilities for their individual property and the associated drainage features. However, measures will need to be put in place to ensure occupants are made aware of maintenance schedules.

8.8

Residual Risk

The proposed drainage system outlined in Section 8.7 above has been designed for an extreme rainfall event with a return period of 1 in 100 years, including a 20% increase in peak rainfall intensity (to account for the impacts of climate change). Notwithstanding this, in line with the precautionary principle promoted by the NPPF, it is necessary to consider the impact of an event which exceeds the design event. This is referred to as residual risk.

Evaluating the response of the proposed drainage system under an event greater than the 1 in 100 year event with a 20% allowance in climate change will assess the sensitivity of the system to changes in peak rainfall intensity, and represents any uncertainty in calculating the rainfall hydrograph or climate change allowance.

Based on the EA's climate change guidance, an Upper End climate change allowance of 40% has been used to test the proposed drainage system. This climate change scenario represents the 90th percentile therefore although it is more improbable, a 40% increase in peak rainfall intensity is still possible.

Sensitivity analysis has been undertaken for both options outlined within the surface water management strategy. A summary of these sensitivity tests has been outlined below.

Sensitivity analysis undertaken for the proposed infiltration SuDS has shown that under the 1 in 100 year return period event a small volume of flood water (less than 0.2m²) could surcharge from the proposed SuDS resulting in flooding across the site.

Inspection of land levels, from topographic LIDAR data and the proposed section drawings, suggests that under a surcharge scenario floodwater is likely to be directed away from the proposed buildings following the natural contours of the land. Based on this information, Figure 8.4 (below) shows the development site and areas where any floodwater could pond. As the proposed properties are to be raised above these areas, the internal risk of flooding as a result of surcharged system is considered to be low.

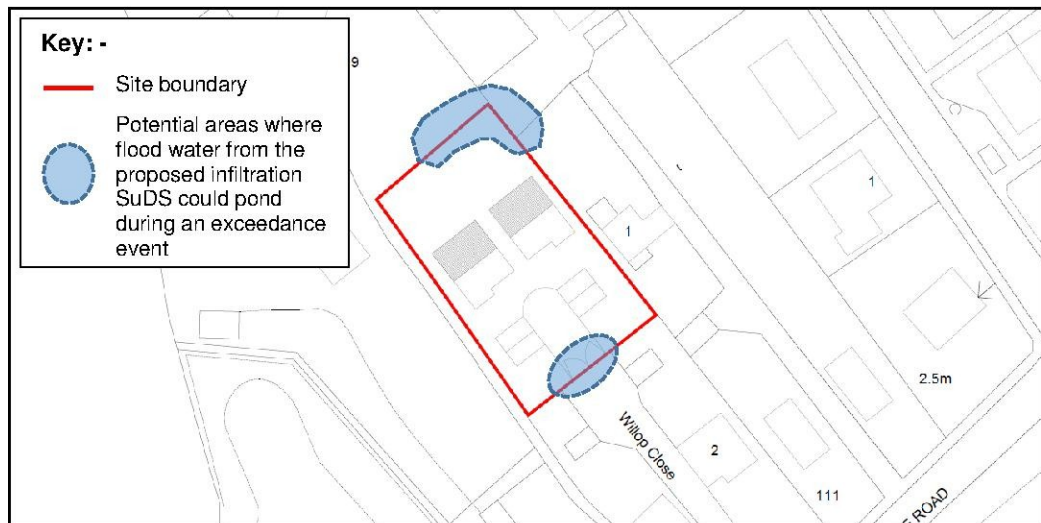


Figure 8.4 – Indicative site plan showing the potential location floodwater could pond during an exceedance event.

A second sensitivity test has been undertaken to establish what impact a 40% increase in rainfall would have on the cellular storage system. The results of the sensitivity test demonstrate that the proposed cellular storage system has sufficient capacity to accommodate surface water run-off under the design rainfall event with a 40% increase in rainfall intensity.

In addition to assessing the impact a 40% increase in rainfall intensity may have on the proposed SuDS, with any drainage network, there is always the potential for blockage to occur within the system.

In this case, if blockage were to occur within the proposed infiltration SuDS then the system is likely to surcharge resulting in flooding in the same areas as seen on Figure 8.4 (above). Nonetheless, if the cellular storage system was to surcharge (as a result of blockage) it is only likely to result in flooding across the driveway and the entrance to the site. In both cases, it is evident that any flooding that would result from blockage of the proposed SuDS is not likely to increase the risk of flooding to the proposed properties at the site.

To further reduce the risk of surcharge and subsequent flooding, and if a connection to the combined/foul sewer network is required, it is recommended that a non-return valve is located between the flow control device and public sewer system.

In conclusion, the risk of internal flooding to both the proposed properties and the existing properties in the surrounding area is unlikely to increase as a result of the proposed SuDS. Furthermore, the additional storage provided by the SuDS in both options is likely to reduce the risk of flooding at the site and surrounding area.

8.9

Summary of Proposed Surface Water Management Strategy

The overarching objective of a SWMS is to identify a sustainable surface water drainage system that reduces the peak rate and volume of run-off from the site to a value that is less than would be experienced with the existing site condition. This helps to reduce the amount of surface water discharged from the site and passed onto systems further downstream and thus in doing so helps to reduce the risk of flooding.

This strategy recommends that the development utilises infiltration as much as is reasonably possible, which is in line with the hierarchical approach promoted by current best practice.

The preferred strategy that has been identified at this early stage in the development design process achieves the aspirational objective of reducing peak discharge rates to the greenfield run-off value by utilising a combination of permeable paving and an infiltration blanket to discharge all surface water run-off from across the site to the ground.

A second strategy has also been identified, in the event ground conditions are unsuitable for the use of infiltration SuDS, this solution utilises cellular storage in conjunction with a Hydro-Brake flow control device to discharge all surface water run-off at an attenuated rate into the public sewer system.

However, before progressing the proposed strategy further, it is suggested that site-specific ground investigations be undertaken in order to quantify the available infiltration, the groundwater level and the level of contamination that may be present in the soils. The results of such investigations will help to establish whether or not infiltration would be the most appropriate (and sustainable) solution for managing surface water run-off from the development as opposed to discharging to the public sewer system.

The above calculations are indicative only and whilst they do not comprise a detailed drainage scheme, they do at this stage demonstrate that the proposed strategy for managing surface water run-off is achievable.

9

Conclusions

The key aims and objectives for a development that is to be sustainable in terms of flood risk are summarised in the following bullet points:

- the development should not be at a significant risk of flooding, and should not be susceptible to damage due to flooding.
- the development should not be exposed to flood risk such that the health, safety and welfare of the users of the development, or the population elsewhere, is threatened
- normal operation of the development should not be susceptible to disruption as a result of flooding and safe access to and from the development should be possible during flood events
- the development should not increase flood risk elsewhere
- the development should not prevent safe maintenance of watercourses or maintenance and operation of flood defences by the Environment Agency
- the development should not be associated with an onerous or difficult operation and maintenance regime to manage flood risk; the responsibility for any operation and maintenance required should be clearly defined
- the development should not lead to degradation of the environment
- the development should meet all of the above criteria for its entire lifetime, including consideration of the potential effects of climate change

In determining whether the proposals for development at Willop Close are sustainable in terms of flood risk and are compliant with the NPPF and its Planning Practice Guidance, all of the above have been taken into consideration as part of this FRA.

It has been recognised that it may be necessary for the planning authority to demonstrate that the development can pass the Sequential Test. As discussed in Section 2.3, without having comprehensive knowledge of the land that is available for development in the district it is not possible for this FRA to comment in detail on the Test.

Nevertheless, reference to Section 2.3 shows the overtopping flood hazard map (Figure 2.4) identifies that the development site is located within an area classified as having a 'Low' risk of flooding from this source. When compared to the surrounding area, the majority of which is classified as having a 'Significant' risk of flooding resulting from wave overtopping, the subject site

is in fact shown to be sequentially preferable. Consequently, based on the information provided it can be concluded that the Sequential Test (if applied) is likely to be passed.

In addition to the Sequential Test it is also necessary to consider the type and nature of the development and whether the Exception Test is applicable. From Table 2.3 it can be seen that the proposed development is situated within a Zone 3a flood risk areas 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 therefore been considered across a wide range of sources and it is only the risk of coastal flooding that has been shown to have any bearing on the development. However, when this risk is examined in detail, it has been demonstrated that with appropriate mitigation, the development will be safe. Mitigation measures for this development include raising the finished floor levels above the design flood level, and incorporating flood resistant and resilient construction techniques.

In addition to the above, this FRA has also demonstrated that the development will not increase the risk of flooding elsewhere. The preferred Surface Water Drainage Strategy that has been identified at this early stage utilises a combination of Infiltration SuDS to discharge all surface water run-off to the ground.

A second potential option which incorporates a cellular storage system and Hydro-Brake flow control device to attenuate the discharge of run-off into the public sewer system has also been outlined in the event ground conditions are unsuitable for the proposed infiltration SuDS.

Consequently, it has been shown 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 flood risk at the site, or elsewhere. There are, however, a number of mitigation measures and recommendations that are required to reduce the risk to the development and other areas within the floodplain.

- The finished floor level for all living accommodation shall be set at least 300mm above the design flood level, at a minimum of 3.44m AODN.
- The finished floor level for all sleeping accommodation shall be set at least 600mm above the design flood level, at a minimum of 3.74m AODN.
- 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 owner and occupants of the proposed dwelling should sign up to the Environment Agency's floodline warnings.
- 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 8.1 and 8.2.
- To determine the most suitable solution for managing surface water run-off from the site, it will be necessary to undertake site-specific investigations in order to quantify the available infiltration, the groundwater level and the level of contamination that may be present in the soils.
- If a connection to the public sewer system is required, it will be necessary to contact the sewerage undertaker and confirm the available capacity in the existing sewer system. Before construction it will be necessary to confirm that the proposed connection will be acceptable.
- The use of appropriate SuDS techniques as discussed in Section 8 should be considered for incorporation into the scheme design. SuDS should be incorporated in accordance with building regulations including the SuDS hierarchy, prioritising the use of infiltration.

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.

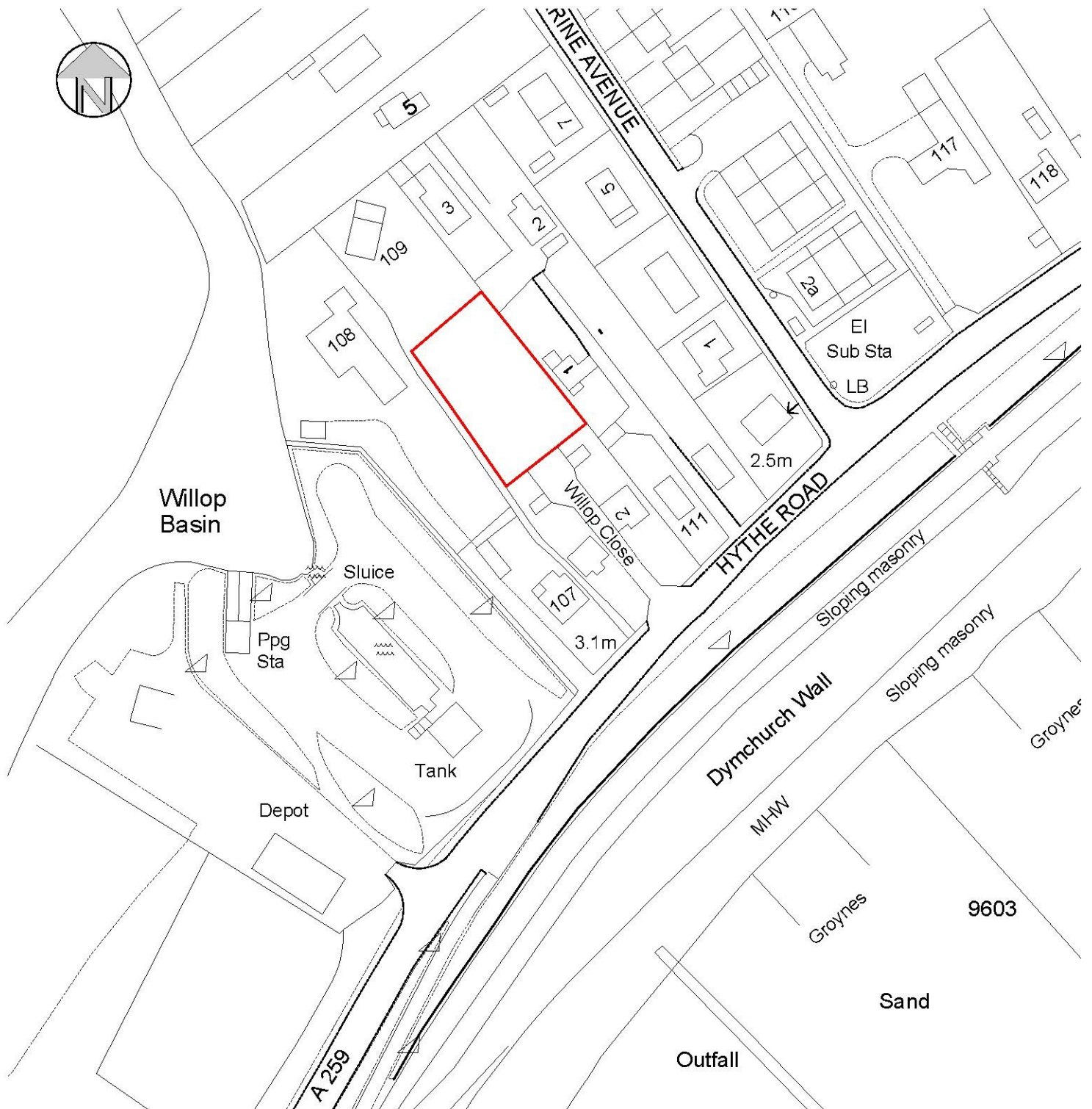
11 Appendices

Appendix A.1 – Drawings

Appendix A.2 – Southern Water Asset Location Data

Appendix A.3 – Surface Water Management Calculations

Appendix A.1 – Drawings



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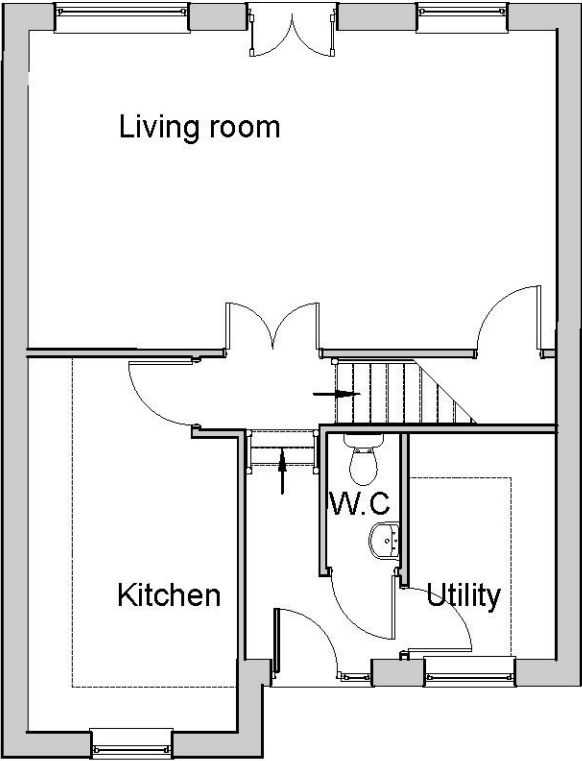


Client: J Jones Esq Project: Willop Close, Dymchurch Title: Sie Location Plan	Mark	Revision	Date
	Drawing Issue Status		Rev.
	PLANNING		P
	A4 Scale	Date	Drawing Number
	1:1250	01/10/2015	15.143.01---
		Project	Sheet
RDA Architects : Chartered Architects © RDA Consulting Architects (Kent) Ltd. Evegate Park Barn, Evegate, Smeeth, Ashford, Kent. TN25 6SX Company No. 09363947 Tel: 01303 814455 e-mail: projects@rdaarchitects.co.uk Web: www.rdaarchitects.co.uk			

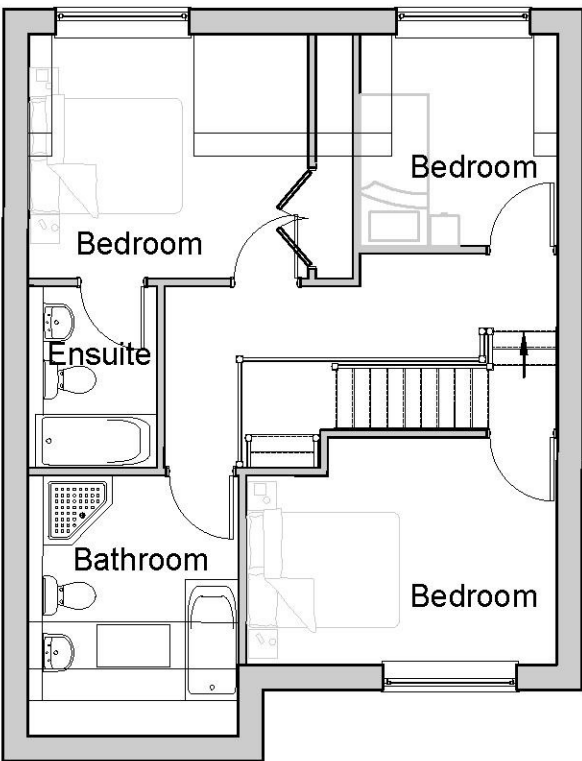


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	Client:	J Jones Esq	Mark	Revision	Date	
	Project:	Willop Close, Dymchurch	Drawing Issue Status			PLANNING
	Title:	Block Plan	A4 Scale	Date	Drawing I	
			1:500	August 2016	15.143.03	
		RDA Architects : Chartered Architects © RDA Consulting Architects (K) Evegate Park Barn, Evegate, Smeeth, Ashford, Kent. TN25 6SX Company No. 09363947 Tel: 01303 814455 e-mail: projects@rdaarchitects.co.uk Web: www.rdaarchitects.co.uk				

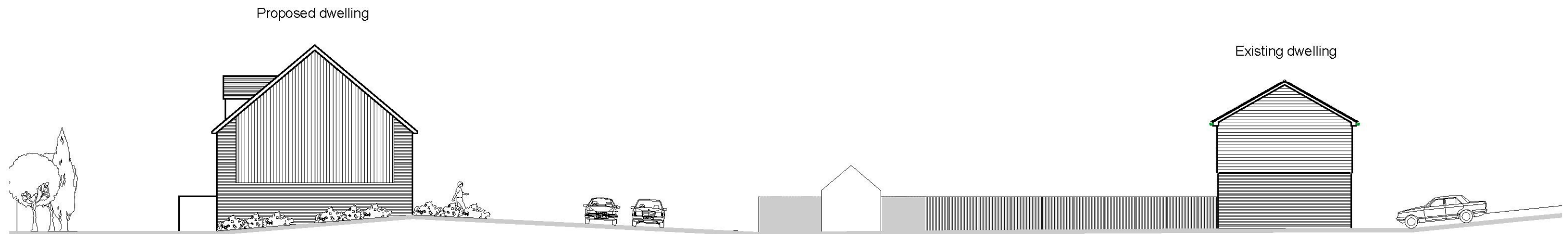


GROUND FLOOR PLAN
Scale 1:100

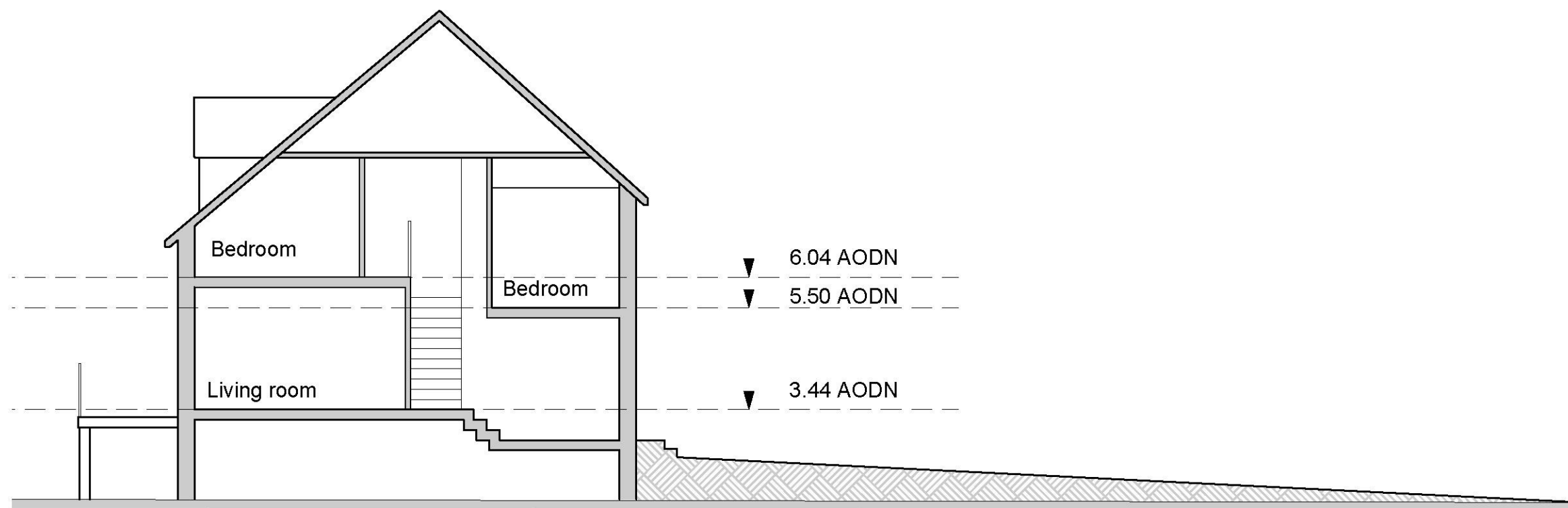


FIRST FLOOR PLAN
Scale 1:100

	Client:	J Jones Esq	Mark	Revision	Date
	Project:	Willop Close, Dymchurch	Drawing Issue Status		
	Title:	Floor Plans	PLANNING		
			A4 Scale	Date	Drawing I
			1:100	August 2016	15.143.04
			RDA Architects : Chartered Architects		
			Evegate Park Barn, Evegate, Smeeth, Ashford, Kent. TN25 6SX Company No. 09363947 Tel: 01303 814455 e-mail: projects@rdaarchitects.co.uk Web: www.rdaarchitects.co.uk		



SECTION THROUGH SITE
Scale 1:200



SECTION THROUGH HOUSE
Scale 1:100



Client:	J Jones Esq	Mark	Revision	Date
Project:	Willop Close, Dymchurch	Drawing Issue Status PLANNING		
A4 Scale	1:100	Date	August 2016	15.143.06
Title:	Section	Project	She	
RDA Architects : Chartered Architects Evegate Park Barn, Evegate, Smeeth, Ashford, Kent TN25 6SX Company No. 09363947 Tel: 01303 814455 e-mail: projects@rdaarchitects.co.uk Web: www.rdaarchitects.co.uk				

Appendix A.2 – Southern Water Asset Location Data



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

Your ref NH/1432
Our ref 226025
Date 17 October 2016
Contact searches@southernwater.co.uk
Tel 0845 272 0845
0330 303 0276
Fax 01634 844514

Attention: Dominic Mulford

Dear Customer

Re: Provision of public sewer record extract

Location: Willop Close, Dymchurch, Kent, TN29 0HU

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: 813 0378 56

Order reference: 226025

Your reference: NH/1432

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

Location	Costs
Willop Close Dymchurch Kent TN29 0HU	£41.60
Net total	£41.60
VAT	£8.32
Total	£49.92
Paid	Paid in full

Thank you for your payment:

Received on: 11 October 2016

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

Tel: 0845 270 0212
0330 303 0276 (individual consumers)

Email: searches@southernwater.co.uk

Web: www.southernwater.co.uk

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





TR1131SE

N

 Southern Water

E42003

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
0201X	2.37	0.73	150	VC	CIRC																		
8101X	1.33	0.14	150	VC	CIRC																		
8102X	1.34	-0.17	150	VC	CIRC																		
8103X	1.61	0.384	150	VC	CIRC																		
8104X	1.59	-0.08	150	VC	CIRC																		
8105X	1.29	-0.47	150	VC	CIRC																		
8106X	1.5	-0.65	150	VC	CIRC																		
8107X	1.5	-0.74	150	VC	CIRC																		
8201X	1.55	-0.56	150	VC	CIRC																		
8202X	1.47	-1.14	150	VC	CIRC																		
8203X			UNK	VC	CIRC																		
8204X			UNK	VC	CIRC																		
820DX			150	VC	CIRC																		
9101X	1.56	0.07	150	VC	CIRC																		
9102X	1.6	0.1	150	VC	CIRC																		
9103X	1.65	0.77	100	VC	CIRC																		
9104X	1.62	0.91	100	VC	CIRC																		
9201X	1.47	-0.12	150	VC	CIRC																		
9202X	1.7	0.44	150	VC	CIRC																		
9203X	1.68	0.15	150	VC	CIRC																		
9204X	1.64	-1.62	150	VC	CIRC																		
9205X	1.57	-0.13	150	VC	CIRC																		

LINE STYLES / COLOURS

Brown	---	Real
	---	Real Siphon Sewer
	---	Real Vacuum Main
	---	Real Rising Main
Red	---	Combined
	---	Combined Siphon Sewer
	---	Combined Rising Main
Orange	---	Lateral Drain
	---	Building Over Agreement Area
Dark Blue	---	Treated Effluent
Purple	---	Sludge
	---	Sewer Discharge
	---	Sanction 104 Area
Light Blue	---	Surface Water
	---	Surface Water Rising Main
Yellow	---	Private
Green	---	Access Shaft
	---	Decommissioned

MATERIALS

AK	Asphalt
BAC	Bonded Asbestos Cement
BRD	Brick (Common)
BRG	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
GRG	Glass Reinforced Concrete
GRP	Glass Reinforced Plastic
MAC	Masonry in regular Courses
MAR	Masonry in random Courses
PE	Polyethylene
PP	Polypropylene
PVC	Polyvinyl Chloride
RPM	Reinforced Plastic Mesh
SI	Spun Iron
ST	Steel
VC	Victrol 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)	Waterlight door (SW)	Waterlight door (F&C)	Flushing ch. No-4 (SW)	Flushing ch. No-4 (F&C)	Flushing ch. No-4 (SW)	Flushing ch. No-4 (F&C)	Demonstration 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 all pipe	Dummy/S24 manhole	Paraback chamber	Demoboard	Storm Overflow	Backdrop manhole
--------------	---------------	------------------	-------------------	--------------------	---------------------	------------------------	-------------------------	-----------------	------------------	---------------------	----------------------	----------------	-------------------	------------------	-----------	----------------	------------------

Other (s)	Other	Change in sewer (s)	Change in sewer	Reflex valve	Reap valve	Cascade	Anode	Valve	Closed Valve	Air Valve	Hatch box (SW)	Hatch box (F&C)	Direction arrow	Emptying valve	Catchpit	Soakaway	Inlet	Blanking Pond
-----------	-------	---------------------	-----------------	--------------	------------	---------	-------	-------	--------------	-----------	----------------	-----------------	-----------------	----------------	----------	----------	-------	---------------

	Wastewater treatment works
	Marine treatment works
	Outfall headworks
	Vent
	Vent column
	Tidal storage tank
	Blank end
	Head of Public Sewer
	Micro Pumping Station

SHAPES (S)

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

NOTE REFERENCING SYSTEM

1st digit: hundred metre zoning identifier

2nd digit: hundred metre section identifier

3rd digit: sewer by identifier

 D-W = Flow/Combined

 S-S = Surface Water

4th digit: next sequential number

1st digit:	hundred metre scaling identifier
2nd digit:	hundred metre scaling identifier
3rd digit:	sewer type identifier
4th digit:	next sequential node

Drawn by:	yadavsa	
Title:	226025_Willop Close, Dymchurch	
Date:	17/10/2016	

Appendix A.3 – Surface Water Management Calculations

Herrington Consulting Ltd				Page 1	
Unit 6 - Barham Business Park Elham Valley Road Barham CT4 6DQ		1432 - Willop Close, Dymchurch Discharge From The Site			
Date 31/10/2016 File 1432_SOURCE CONTROL.SRCX		Designed by SAH Checked by SMB			
Micro Drainage		Source Control 2016.1			
<u>Summary of Results for 100 year Return Period (+20%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	8.093	0.093	16.2	0.1	O K
30 min Summer	8.086	0.086	13.9	0.1	O K
60 min Summer	8.075	0.075	10.2	0.1	O K
120 min Summer	8.063	0.063	6.5	0.1	O K
180 min Summer	8.057	0.057	5.0	0.1	O K
240 min Summer	8.049	0.049	4.0	0.1	O K
360 min Summer	8.041	0.041	3.0	0.0	O K
480 min Summer	8.037	0.037	2.4	0.0	O K
600 min Summer	8.034	0.034	2.0	0.0	O K
720 min Summer	8.032	0.032	1.8	0.0	O K
960 min Summer	8.029	0.029	1.4	0.0	O K
1440 min Summer	8.021	0.021	1.0	0.0	O K
2160 min Summer	8.016	0.016	0.8	0.0	O K
2880 min Summer	8.013	0.013	0.6	0.0	O K
4320 min Summer	8.009	0.009	0.4	0.0	O K
5760 min Summer	8.007	0.007	0.4	0.0	O K
7200 min Summer	8.006	0.006	0.3	0.0	O K
8640 min Summer	8.006	0.006	0.2	0.0	O K
10080 min Summer	8.005	0.005	0.2	0.0	O K
15 min Winter	8.102	0.102	19.1	0.1	O K
30 min Winter	8.088	0.088	14.6	0.1	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	118.865	0.0	6.2	9	
30 min Summer	78.695	0.0	8.3	17	
60 min Summer	49.609	0.0	10.4	32	
120 min Summer	30.158	0.0	12.7	62	
180 min Summer	22.205	0.0	14.0	92	
240 min Summer	17.754	0.0	14.9	122	
360 min Summer	12.973	0.0	16.3	180	
480 min Summer	10.367	0.0	17.4	244	
600 min Summer	8.706	0.0	18.3	304	
720 min Summer	7.544	0.0	19.0	360	
960 min Summer	6.013	0.0	20.2	482	
1440 min Summer	4.360	0.0	21.9	720	
2160 min Summer	3.156	0.0	23.4	1092	
2880 min Summer	2.506	0.0	23.8	1436	
4320 min Summer	1.808	0.0	24.9	2172	
5760 min Summer	1.433	0.0	25.5	1904	
7200 min Summer	1.196	0.0	26.5	1192	
8640 min Summer	1.031	0.0	27.2	1968	
10080 min Summer	0.910	0.0	27.9	656	
15 min Winter	118.865	0.0	8.3	10	
30 min Winter	78.695	0.0	11.0	16	
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Unit 6 - Barham Business Park Elham Valley Road Barham CT4 6DQ		1432 - Willop Close, Dymchurch Discharge From The Site			
Date 31/10/2016 File 1432_SOURCE CONTROL.SRCX		Designed by SAH Checked by SMB			
Micro Drainage		Source Control 2016.1			
<u>Summary of Results for 100 year Return Period (+20%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	8.073	0.073	9.6	0.1	O K
120 min Winter	8.061	0.061	5.9	0.1	O K
180 min Winter	8.052	0.052	4.4	0.1	O K
240 min Winter	8.045	0.045	3.5	0.0	O K
360 min Winter	8.039	0.039	2.6	0.0	O K
480 min Winter	8.035	0.035	2.1	0.0	O K
600 min Winter	8.032	0.032	1.8	0.0	O K
720 min Winter	8.031	0.031	1.6	0.0	O K
960 min Winter	8.025	0.025	1.2	0.0	O K
1440 min Winter	8.018	0.018	0.9	0.0	O K
2160 min Winter	8.013	0.013	0.6	0.0	O K
2880 min Winter	8.011	0.011	0.5	0.0	O K
4320 min Winter	8.008	0.008	0.4	0.0	O K
5760 min Winter	8.005	0.005	0.3	0.0	O K
7200 min Winter	8.006	0.006	0.2	0.0	O K
8640 min Winter	8.006	0.006	0.2	0.0	O K
10080 min Winter	8.004	0.004	0.2	0.0	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
60 min Winter	49.609	0.0	13.9	34	
120 min Winter	30.158	0.0	16.9	58	
180 min Winter	22.205	0.0	18.7	94	
240 min Winter	17.754	0.0	19.9	124	
360 min Winter	12.973	0.0	21.8	186	
480 min Winter	10.367	0.0	23.2	238	
600 min Winter	8.706	0.0	24.4	298	
720 min Winter	7.544	0.0	25.3	374	
960 min Winter	6.013	0.0	27.0	476	
1440 min Winter	4.360	0.0	29.3	750	
2160 min Winter	3.156	0.0	31.6	1080	
2880 min Winter	2.506	0.0	32.9	1380	
4320 min Winter	1.808	0.0	34.3	2140	
5760 min Winter	1.433	0.0	35.7	1392	
7200 min Winter	1.196	0.0	36.4	160	
8640 min Winter	1.031	0.0	37.3	296	
10080 min Winter	0.910	0.0	39.3	7024	
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Unit 6 - Barham Business Park Elham Valley Road Barham CT4 6DQ	1432 - Willop Close, Dymchurch Discharge From The Site																																		
Date 31/10/2016	Designed by SAH																																		
File 1432_SOURCE CONTROL.SRCX	Checked by SMB																																		
Micro Drainage		Source Control 2016.1																																	
<u>Rainfall Details</u> <table> <tr> <td>Rainfall Model</td> <td>FSR</td> <td>Winter Storms</td> <td>Yes</td> </tr> <tr> <td>Return Period (years)</td> <td>100</td> <td>Cv (Summer)</td> <td>0.750</td> </tr> <tr> <td>Region</td> <td>England and Wales</td> <td>Cv (Winter)</td> <td>1.000</td> </tr> <tr> <td>M5-60 (mm)</td> <td>20.400</td> <td>Shortest Storm (mins)</td> <td>15</td> </tr> <tr> <td>Ratio R</td> <td>0.380</td> <td>Longest Storm (mins)</td> <td>10080</td> </tr> <tr> <td>Summer Storms</td> <td>Yes</td> <td>Climate Change %</td> <td>+20</td> </tr> </table> <u>Time Area Diagram</u> Total Area (ha) 0.028 <table> <thead> <tr> <th colspan="2">Time (mins)</th> <th>Area</th> </tr> <tr> <th>From:</th> <th>To:</th> <th>(ha)</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>4</td> <td>0.028</td> </tr> </tbody> </table>			Rainfall Model	FSR	Winter Storms	Yes	Return Period (years)	100	Cv (Summer)	0.750	Region	England and Wales	Cv (Winter)	1.000	M5-60 (mm)	20.400	Shortest Storm (mins)	15	Ratio R	0.380	Longest Storm (mins)	10080	Summer Storms	Yes	Climate Change %	+20	Time (mins)		Area	From:	To:	(ha)	0	4	0.028
Rainfall Model	FSR	Winter Storms	Yes																																
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Time (mins)		Area																																	
From:	To:	(ha)																																	
0	4	0.028																																	
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Unit 6 - Barham Business Park Elham Valley Road Barham CT4 6DQ	1432 - Willop Close, Dymchurch Discharge From The Site	
Date 31/10/2016	Designed by SAH	
File 1432_SOURCE CONTROL.SRCX	Checked by SMB	
Micro Drainage		Source Control 2016.1
<u>Model Details</u> Storage is Online Cover Level (m) 10.000 <u>Pipe Structure</u> Diameter (m) 1.000 Length (m) 5.000 Slope (1:X) 10.000 Invert Level (m) 8.000 <u>Pipe Outflow Control</u> Diameter (m) 1.000 Entry Loss Coefficient 0.500 Slope (1:X) 10.0 Coefficient of Contraction 0.600 Length (m) 5.000 Upstream Invert Level (m) 8.000 Manning's n 0.015		
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Unit 6 - Barham Business Park
Elham Valley Road
Barham CT4 6DQ

Date 31/10/2016
File 1432_CELLULAR STORAGE.SRCX

Micro Drainage

1432 - Willop Close, Dymchurch
Cellular Storage

Designed by SAH
Checked by SMB

Source Control 2016.1

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Summary of Results for 100 year Return Period (+20%)

Half Drain Time : 40 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.333	0.153	0.0	2.0	2.0	5.1	O K
30 min Summer	9.363	0.183	0.0	2.0	2.0	6.1	O K
60 min Summer	9.377	0.197	0.0	2.0	2.0	6.6	O K
120 min Summer	9.366	0.186	0.0	2.0	2.0	6.2	O K
180 min Summer	9.343	0.163	0.0	2.0	2.0	5.4	O K
240 min Summer	9.320	0.140	0.0	2.0	2.0	4.7	O K
360 min Summer	9.287	0.107	0.0	2.0	2.0	3.5	O K
480 min Summer	9.268	0.088	0.0	1.9	1.9	2.9	O K
600 min Summer	9.257	0.077	0.0	1.7	1.7	2.6	O K
720 min Summer	9.250	0.070	0.0	1.5	1.5	2.3	O K
960 min Summer	9.241	0.061	0.0	1.3	1.3	2.0	O K
1440 min Summer	9.230	0.050	0.0	1.0	1.0	1.7	O K
2160 min Summer	9.222	0.042	0.0	0.7	0.7	1.4	O K
2880 min Summer	9.217	0.037	0.0	0.6	0.6	1.2	O K
4320 min Summer	9.211	0.031	0.0	0.4	0.4	1.0	O K
5760 min Summer	9.207	0.027	0.0	0.3	0.3	0.9	O K
7200 min Summer	9.205	0.025	0.0	0.3	0.3	0.8	O K
8640 min Summer	9.203	0.023	0.0	0.2	0.2	0.8	O K
10080 min Summer	9.201	0.021	0.0	0.2	0.2	0.7	O K
15 min Winter	9.393	0.213	0.0	2.0	2.0	7.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	118.865	0.0	6.2	16
30 min Summer	78.695	0.0	8.2	27
60 min Summer	49.609	0.0	10.4	44
120 min Summer	30.158	0.0	12.6	78
180 min Summer	22.205	0.0	14.0	112
240 min Summer	17.754	0.0	14.9	142
360 min Summer	12.973	0.0	16.3	200
480 min Summer	10.367	0.0	17.4	256
600 min Summer	8.706	0.0	18.3	316
720 min Summer	7.544	0.0	19.0	376
960 min Summer	6.013	0.0	20.2	492
1440 min Summer	4.360	0.0	21.9	736
2160 min Summer	3.156	0.0	23.8	1100
2880 min Summer	2.506	0.0	25.2	1468
4320 min Summer	1.808	0.0	27.3	2180
5760 min Summer	1.433	0.0	28.9	2928
7200 min Summer	1.196	0.0	30.1	3672
8640 min Summer	1.031	0.0	31.2	4376
10080 min Summer	0.910	0.0	32.1	5120
15 min Winter	118.865	0.0	8.3	17

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Unit 6 - Barham Business Park Elham Valley Road Barham CT4 6DQ		1432 - Willop Close, Dymchurch Cellular Storage					
Date 31/10/2016 File 1432_CELLULAR STORAGE.SRCX		Designed by SAH Checked by SMB					
Micro Drainage		Source Control 2016.1					
<u>Summary of Results for 100 year Return Period (+20%)</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	9.441	0.261	0.0	2.0	2.0	8.7	O K
60 min Winter	9.459	0.279	0.0	2.0	2.0	9.3	O K
120 min Winter	9.443	0.263	0.0	2.0	2.0	8.7	O K
180 min Winter	9.403	0.223	0.0	2.0	2.0	7.4	O K
240 min Winter	9.361	0.181	0.0	2.0	2.0	6.0	O K
360 min Winter	9.297	0.117	0.0	2.0	2.0	3.9	O K
480 min Winter	9.267	0.087	0.0	1.9	1.9	2.9	O K
600 min Winter	9.254	0.074	0.0	1.6	1.6	2.5	O K
720 min Winter	9.246	0.066	0.0	1.4	1.4	2.2	O K
960 min Winter	9.237	0.057	0.0	1.2	1.2	1.9	O K
1440 min Winter	9.226	0.046	0.0	0.8	0.8	1.5	O K
2160 min Winter	9.219	0.039	0.0	0.6	0.6	1.3	O K
2880 min Winter	9.214	0.034	0.0	0.5	0.5	1.1	O K
4320 min Winter	9.208	0.028	0.0	0.4	0.4	0.9	O K
5760 min Winter	9.205	0.025	0.0	0.3	0.3	0.8	O K
7200 min Winter	9.203	0.023	0.0	0.2	0.2	0.8	O K
8640 min Winter	9.201	0.021	0.0	0.2	0.2	0.7	O K
10080 min Winter	9.200	0.020	0.0	0.2	0.2	0.7	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
30 min Winter	78.695	0.0	11.0	30			
60 min Winter	49.609	0.0	13.9	50			
120 min Winter	30.158	0.0	16.9	88			
180 min Winter	22.205	0.0	18.6	124			
240 min Winter	17.754	0.0	19.9	156			
360 min Winter	12.973	0.0	21.8	212			
480 min Winter	10.367	0.0	23.2	262			
600 min Winter	8.706	0.0	24.4	320			
720 min Winter	7.544	0.0	25.3	380			
960 min Winter	6.013	0.0	26.9	498			
1440 min Winter	4.360	0.0	29.3	738			
2160 min Winter	3.156	0.0	31.8	1100			
2880 min Winter	2.506	0.0	33.7	1468			
4320 min Winter	1.808	0.0	36.4	2148			
5760 min Winter	1.433	0.0	38.5	2904			
7200 min Winter	1.196	0.0	40.2	3568			
8640 min Winter	1.031	0.0	41.5	4376			
10080 min Winter	0.910	0.0	42.8	5136			
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Unit 6 - Barham Business Park Elham Valley Road Barham CT4 6DQ	1432 - Willop Close, Dymchurch Cellular Storage	
Date 31/10/2016	Designed by SAH	
File 1432_CELLULAR STORAGE.SRCX	Checked by SMB	
Micro Drainage		Source Control 2016.1

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	1.000
M5-60 (mm)	20.400	Shortest Storm (mins)	15
Ratio R	0.380	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.028

Time (mins)		Area
From:	To:	(ha)
0	4	0.028

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Unit 6 - Barham Business Park Elham Valley Road Barham CT4 6DQ	1432 - Willop Close, Dymchurch Cellular Storage	
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File 1432_CELLULAR STORAGE.SRCX	Checked by SMB	
Micro Drainage		Source Control 2016.1

Model Details

Storage is Online Cover Level (m) 10.000

Cellular Storage Structure

Invert Level (m) 9.180 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	35.0	35.0	0.321	0.0	42.6
0.320	35.0	42.6			

Hydro-Brake Optimum® Outflow Control

Unit Reference MD-SHE-0076-2000-0320-2000
Design Head (m) 0.320
Design Flow (l/s) 2.0
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface
Sump Available Yes
Diameter (mm) 76
Invert Level (m) 9.180
Minimum Outlet Pipe Diameter (mm) 100
Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.320	2.0
Flush-Flo™	0.114	2.0
Kick-Flo®	0.238	1.8
Mean Flow over Head Range	-	1.6

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.0	1.200	3.7	3.000	5.6	7.000	8.5
0.200	1.9	1.400	3.9	3.500	6.0	7.500	8.8
0.300	1.9	1.600	4.2	4.000	6.4	8.000	9.1
0.400	2.2	1.800	4.4	4.500	6.8	8.500	9.4
0.500	2.4	2.000	4.6	5.000	7.2	9.000	9.7
0.600	2.7	2.200	4.9	5.500	7.6	9.500	10.0
0.800	3.0	2.400	5.1	6.000	7.9		
1.000	3.4	2.600	5.3	6.500	8.2		

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Unit 6 - Barham Business Park Elham Valley Road Barham CT4 6DQ		1432 - Willop Close, Dymchurch Infiltration			
Date 31/10/2016 File 1432_INFILTRATION.SRCX		Designed by SAH Checked by SMB			
Micro Drainage		Source Control 2016.1			
<u>Summary of Results for 100 year Return Period (+20%)</u> Half Drain Time : 612 minutes.					
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	9.416	0.116	0.1	2.8	O K
30 min Summer	9.452	0.152	0.1	3.7	O K
60 min Summer	9.486	0.186	0.1	4.5	O K
120 min Summer	9.517	0.217	0.1	5.3	O K
180 min Summer	9.529	0.229	0.1	5.6	O K
240 min Summer	9.534	0.234	0.1	5.7	O K
360 min Summer	9.535	0.235	0.1	5.7	O K
480 min Summer	9.532	0.232	0.1	5.6	O K
600 min Summer	9.528	0.228	0.1	5.6	O K
720 min Summer	9.524	0.224	0.1	5.4	O K
960 min Summer	9.515	0.215	0.1	5.2	O K
1440 min Summer	9.495	0.195	0.1	4.7	O K
2160 min Summer	9.466	0.166	0.1	4.0	O K
2880 min Summer	9.439	0.139	0.1	3.4	O K
4320 min Summer	9.397	0.097	0.1	2.4	O K
5760 min Summer	9.368	0.068	0.1	1.6	O K
7200 min Summer	9.351	0.051	0.1	1.2	O K
8640 min Summer	9.345	0.045	0.1	1.1	O K
10080 min Summer	9.340	0.040	0.1	1.0	O K
15 min Winter	9.455	0.155	0.1	3.8	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)		
15 min Summer	118.865	0.0	19		
30 min Summer	78.695	0.0	33		
60 min Summer	49.609	0.0	62		
120 min Summer	30.158	0.0	122		
180 min Summer	22.205	0.0	182		
240 min Summer	17.754	0.0	242		
360 min Summer	12.973	0.0	360		
480 min Summer	10.367	0.0	412		
600 min Summer	8.706	0.0	474		
720 min Summer	7.544	0.0	534		
960 min Summer	6.013	0.0	666		
1440 min Summer	4.360	0.0	938		
2160 min Summer	3.156	0.0	1340		
2880 min Summer	2.506	0.0	1728		
4320 min Summer	1.808	0.0	2424		
5760 min Summer	1.433	0.0	3112		
7200 min Summer	1.196	0.0	3744		
8640 min Summer	1.031	0.0	4416		
10080 min Summer	0.910	0.0	5152		
15 min Winter	118.865	0.0	19		
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Unit 6 - Barham Business Park Elham Valley Road Barham CT4 6DQ		1432 - Willop Close, Dymchurch Infiltration			
Date 31/10/2016 File 1432_INFILTRATION.SRCX		Designed by SAH Checked by SMB			
Micro Drainage		Source Control 2016.1			
<u>Summary of Results for 100 year Return Period (+20%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	9.504	0.204	0.1	5.0	O K
60 min Winter	9.552	0.252	0.1	6.1	O K
120 min Winter	9.596	0.296	0.1	7.2	O K
180 min Winter	9.616	0.316	0.1	7.7	O K
240 min Winter	9.626	0.326	0.1	7.9	O K
360 min Winter	9.636	0.336	0.1	8.2	O K
480 min Winter	9.637	0.337	0.1	8.2	O K
600 min Winter	9.633	0.333	0.1	8.1	O K
720 min Winter	9.627	0.327	0.1	7.9	O K
960 min Winter	9.613	0.313	0.1	7.6	O K
1440 min Winter	9.584	0.284	0.1	6.9	O K
2160 min Winter	9.538	0.238	0.1	5.8	O K
2880 min Winter	9.493	0.193	0.1	4.7	O K
4320 min Winter	9.419	0.119	0.1	2.9	O K
5760 min Winter	9.367	0.067	0.1	1.6	O K
7200 min Winter	9.347	0.047	0.1	1.2	O K
8640 min Winter	9.341	0.041	0.1	1.0	O K
10080 min Winter	9.337	0.037	0.1	0.9	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)		
30 min Winter	78.695	0.0	33		
60 min Winter	49.609	0.0	62		
120 min Winter	30.158	0.0	120		
180 min Winter	22.205	0.0	178		
240 min Winter	17.754	0.0	236		
360 min Winter	12.973	0.0	352		
480 min Winter	10.367	0.0	462		
600 min Winter	8.706	0.0	570		
720 min Winter	7.544	0.0	670		
960 min Winter	6.013	0.0	752		
1440 min Winter	4.360	0.0	1054		
2160 min Winter	3.156	0.0	1492		
2880 min Winter	2.506	0.0	1904		
4320 min Winter	1.808	0.0	2636		
5760 min Winter	1.433	0.0	3232		
7200 min Winter	1.196	0.0	3752		
8640 min Winter	1.031	0.0	4488		
10080 min Winter	0.910	0.0	5232		
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Unit 6 - Barham Business Park Elham Valley Road Barham CT4 6DQ	1432 - Willop Close, Dymchurch Infiltration																	
Date 31/10/2016	Designed by SAH																	
File 1432_INFILTRATION.SRCX	Checked by SMB																	
Micro Drainage		Source Control 2016.1																
<u>Model Details</u> Storage is Online Cover Level (m) 10.000 <u>Infiltration Blanket Structure</u> <table> <tr> <td>Infiltration Coefficient Base (m/hr)</td> <td>0.01000</td> <td>Diameter/Width (m)</td> <td>9.0</td> </tr> <tr> <td>Safety Factor</td> <td>2.0</td> <td>Length (m)</td> <td>9.0</td> </tr> <tr> <td>Porosity</td> <td>0.30</td> <td>Cap Volume Depth (m)</td> <td>9.700</td> </tr> <tr> <td>Invert Level (m)</td> <td>9.300</td> <td></td> <td></td> </tr> </table>			Infiltration Coefficient Base (m/hr)	0.01000	Diameter/Width (m)	9.0	Safety Factor	2.0	Length (m)	9.0	Porosity	0.30	Cap Volume Depth (m)	9.700	Invert Level (m)	9.300		
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Summer</td><td>9.869</td><td>0.169</td><td>0.1</td><td>5.1</td><td>Flood Risk</td></tr><tr><td>600 min Summer</td><td>9.867</td><td>0.167</td><td>0.1</td><td>5.0</td><td>Flood Risk</td></tr><tr><td>720 min Summer</td><td>9.863</td><td>0.163</td><td>0.1</td><td>4.9</td><td>Flood Risk</td></tr><tr><td>960 min Summer</td><td>9.856</td><td>0.156</td><td>0.1</td><td>4.7</td><td>Flood Risk</td></tr><tr><td>1440 min Summer</td><td>9.838</td><td>0.138</td><td>0.1</td><td>4.1</td><td>Flood Risk</td></tr><tr><td>2160 min Summer</td><td>9.813</td><td>0.113</td><td>0.1</td><td>3.4</td><td>Flood Risk</td></tr><tr><td>2880 min Summer</td><td>9.791</td><td>0.091</td><td>0.1</td><td>2.7</td><td>Flood Risk</td></tr><tr><td>4320 min Summer</td><td>9.760</td><td>0.060</td><td>0.1</td><td>1.8</td><td>Flood Risk</td></tr><tr><td>5760 min Summer</td><td>9.747</td><td>0.047</td><td>0.1</td><td>1.4</td><td>Flood Risk</td></tr><tr><td>7200 min Summer</td><td>9.740</td><td>0.040</td><td>0.1</td><td>1.2</td><td>Flood Risk</td></tr><tr><td>8640 min Summer</td><td>9.735</td><td>0.035</td><td>0.1</td><td>1.1</td><td>Flood Risk</td></tr><tr><td>10080 min Summer</td><td>9.731</td><td>0.031</td><td>0.1</td><td>0.9</td><td>Flood Risk</td></tr><tr><td>15 min Winter</td><td>9.809</td><td>0.109</td><td>0.1</td><td>3.3</td><td>Flood Risk</td></tr></tbody></table> <table><thead><tr><th>Storm Event</th><th>Rain (mm/hr)</th><th>Flooded Volume (m³)</th><th>Time-Peak (mins)</th></tr></thead><tbody><tr><td>15 min Summer</td><td>118.865</td><td>0.0</td><td>18</td></tr><tr><td>30 min Summer</td><td>78.695</td><td>0.0</td><td>33</td></tr><tr><td>60 min Summer</td><td>49.609</td><td>0.0</td><td>62</td></tr><tr><td>120 min Summer</td><td>30.158</td><td>0.0</td><td>122</td></tr><tr><td>180 min Summer</td><td>22.205</td><td>0.0</td><td>182</td></tr><tr><td>240 min Summer</td><td>17.754</td><td>0.0</td><td>240</td></tr><tr><td>360 min 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Unit 6 - Barham Business Park Elham Valley Road Barham CT4 6DQ		1432 - Willop Close, Dymchurch Permeable Paving			
Date 31/10/2016		Designed by SAH			
File 1432_PERMEABLE PAVING.SRCX		Checked by SMB			
Micro Drainage		Source Control 2016.1			
<u>Summary of Results for 100 year Return Period (+20%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	9.848	0.148	0.1	4.4	Flood Risk
60 min Winter	9.887	0.187	0.1	5.6	Flood Risk
120 min Winter	9.921	0.221	0.1	6.6	Flood Risk
180 min Winter	9.936	0.236	0.1	7.1	Flood Risk
240 min Winter	9.943	0.243	0.1	7.3	Flood Risk
360 min Winter	9.948	0.248	0.1	7.4	Flood Risk
480 min Winter	9.946	0.246	0.1	7.4	Flood Risk
600 min Winter	9.941	0.241	0.1	7.2	Flood Risk
720 min Winter	9.937	0.237	0.1	7.1	Flood Risk
960 min Winter	9.925	0.225	0.1	6.8	Flood Risk
1440 min Winter	9.897	0.197	0.1	5.9	Flood Risk
2160 min Winter	9.854	0.154	0.1	4.6	Flood Risk
2880 min Winter	9.816	0.116	0.1	3.5	Flood Risk
4320 min Winter	9.761	0.061	0.1	1.8	Flood Risk
5760 min Winter	9.744	0.044	0.1	1.3	Flood Risk
7200 min Winter	9.737	0.037	0.1	1.1	Flood Risk
8640 min Winter	9.732	0.032	0.1	1.0	Flood Risk
10080 min Winter	9.728	0.028	0.1	0.8	Flood Risk
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)		
30 min Winter	78.695	0.0	33		
60 min Winter	49.609	0.0	62		
120 min Winter	30.158	0.0	120		
180 min Winter	22.205	0.0	178		
240 min Winter	17.754	0.0	236		
360 min Winter	12.973	0.0	348		
480 min Winter	10.367	0.0	452		
600 min Winter	8.706	0.0	496		
720 min Winter	7.544	0.0	564		
960 min Winter	6.013	0.0	714		
1440 min Winter	4.360	0.0	1010		
2160 min Winter	3.156	0.0	1428		
2880 min Winter	2.506	0.0	1812		
4320 min Winter	1.808	0.0	2424		
5760 min Winter	1.433	0.0	3048		
7200 min Winter	1.196	0.0	3744		
8640 min Winter	1.031	0.0	4464		
10080 min Winter	0.910	0.0	5240		
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Unit 6 - Barham Business Park Elham Valley Road Barham CT4 6DQ	1432 - Willop Close, Dymchurch Permeable Paving	
Date 31/10/2016	Designed by SAH	
File 1432_PERMEABLE PAVING.SRCX	Checked by SMB	
Micro Drainage		Source Control 2016.1

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	1.000
M5-60 (mm)	20.400	Shortest Storm (mins)	15
Ratio R	0.380	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.013

Time (mins)		Area
From:	To:	(ha)
0	4	0.013

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Unit 6 - Barham Business Park Elham Valley Road Barham CT4 6DQ	1432 - Willop Close, Dymchurch Permeable Paving																									
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<u>Model Details</u> Storage is Online Cover Level (m) 10.000 <u>Porous Car Park Structure</u> <table> <tr> <td>Infiltration Coefficient Base (m/hr)</td> <td>0.01000</td> <td>Width (m)</td> <td>10.0</td> </tr> <tr> <td>Membrane Percolation (mm/hr)</td> <td>1000</td> <td>Length (m)</td> <td>10.0</td> </tr> <tr> <td>Max Percolation (l/s)</td> <td>27.8</td> <td>Slope (1:X)</td> <td>0.0</td> </tr> <tr> <td>Safety Factor</td> <td>2.0</td> <td>Depression Storage (mm)</td> <td>5</td> </tr> <tr> <td>Porosity</td> <td>0.30</td> <td>Evaporation (mm/day)</td> <td>3</td> </tr> <tr> <td>Invert Level (m)</td> <td>9.700</td> <td>Membrane Depth (m)</td> <td>0</td> </tr> </table>			Infiltration Coefficient Base (m/hr)	0.01000	Width (m)	10.0	Membrane Percolation (mm/hr)	1000	Length (m)	10.0	Max Percolation (l/s)	27.8	Slope (1:X)	0.0	Safety Factor	2.0	Depression Storage (mm)	5	Porosity	0.30	Evaporation (mm/day)	3	Invert Level (m)	9.700	Membrane Depth (m)	0
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